ESL-TR-23-09-03

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 2022-December 2022

TCEQ

Juan-Carlos Baltazar, Ph.D., P.E., Jeff Haberl, Ph.D.,
Bahman Yazdani, P.E., Qinbo Li, Ph.D., Patrick Parker,
Gali Zilbershtein, Ph.D., David Claridge, Ph.D., P.E.

October 2023

ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION

TEXAS A&M ENGINEERING EXPERIMENT STATION

Energy Systems Laboratory

October 21, 2023

Ms. Lindley Anderson
Technical Specialist
Air Quality Division
Texas Commission on Environmental Quality
Austin, TX 78711-3087

Dear Ms. Anderson:

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

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

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

Sincerely,

David E. Claridge

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

Enclosure

Disclaimer

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 NOx emissions reduction calculation procedures that provide the TCEQ with a standardized, creditable NOx emissions reduction from energy efficiency and renewable energy (EE/RE) programs, which are acceptable to the US EPA. These activities have improved the accuracy of the creditable NOx emissions reduction from EE/RE initiatives contained in the TERP and have assisted the TCEQ, local governments, and the building industry with effective, standardized implementation and reporting.

c. NOx Emissions Reduction

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

Figure 1 shows the integrated NOx emissions reduction through 2027 for the electricity and natural gas savings from the various EE/RE programs.

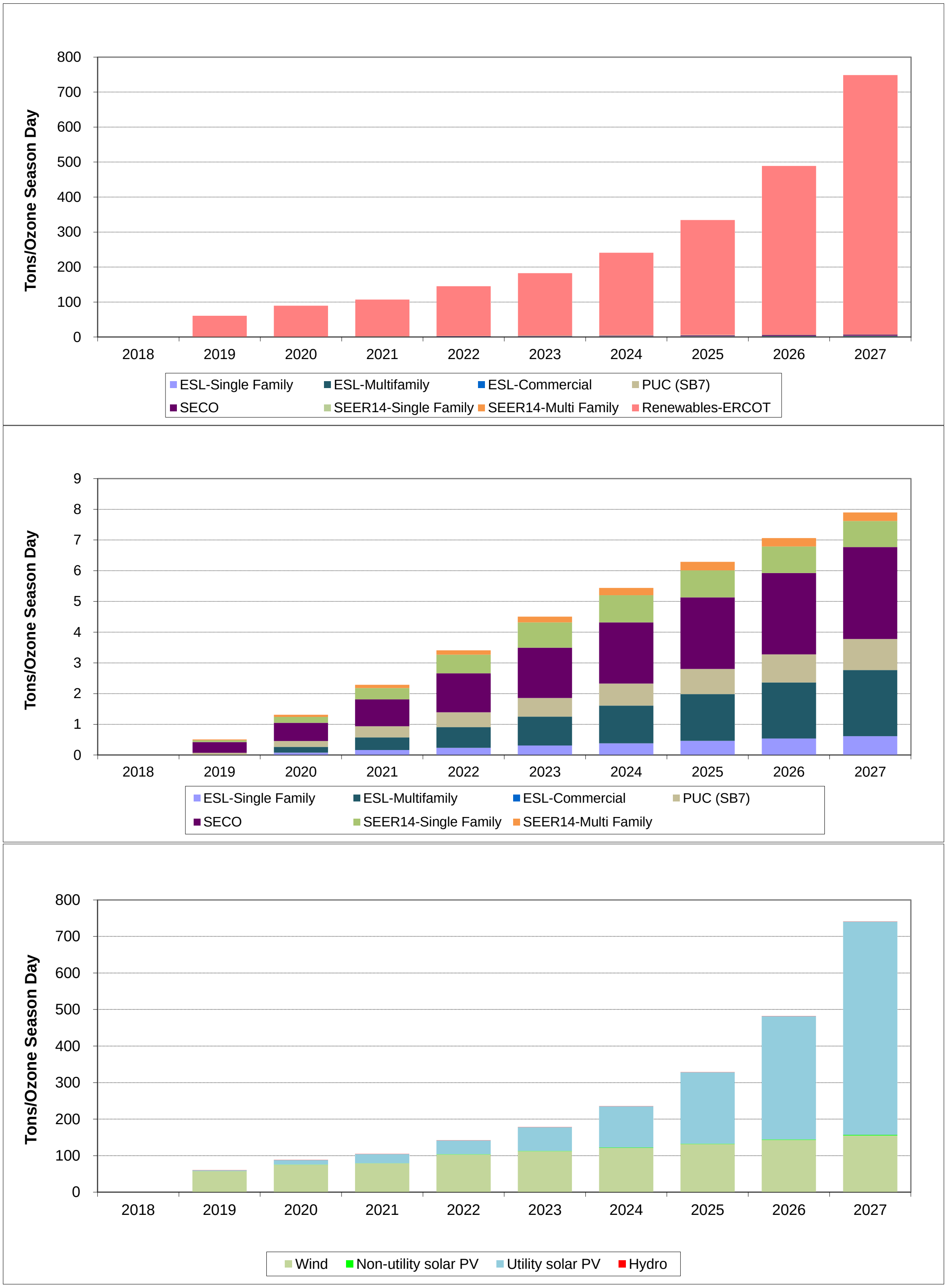


Figure 1: Integrated OSP NOx Emissions Reduction Projections through 2027. (Upper Plot) All Programs, (Middle Plot) All Programs Except Renewables, (Lower Plot) Renewables.

In 2022 (Table 1), the total integrated annual savings from all programs are 60,176,008 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 857,526 MWh/year (1.4% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program are 510,991 MWh/year (0.8%),
- Savings from SECO's Senate Bill 5 program are 1,140,211 MWh/year (1.9%),
- Electricity savings from renewable power generation are 56,941,742 MWh/year (94.6%), and
- Savings from residential air conditioner retrofits[1] are 725,539 MWh/year (1.2%).

In 2022, the total integrated OSP savings from all programs are 265,172 MWh/day, which would be 11,049 MW average hourly load reduction during the OSP period. The integrated OSP electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 2,349 MWh/day (0.9%),
- Savings from the PUC's Senate Bill 7 programs are 1,400 MWh/day (0.5%),
- Savings from SECO's Senate Bill 5 program are 3,122 MWh/day (1.2%),
- Electricity savings from renewable power generation are 256,313 MWh/day (96.7%), and
- Savings from residential air conditioner retrofits are 1,988 MWh/day (0.8%).

By 2027, the total integrated annual savings from all programs will be 373,481,128 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction will be 2,654,964 MWh/year (0.7% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program will be 1,087,084 MWh/year (0.3%),
- Savings from SECO's Senate Bill 5 program will be 2,480,463 MWh/year (0.7%),
- Electricity savings from renewable power generation will be 366,157,712 MWh/year (98.0%), and
- Savings from residential air conditioner retrofits will be 1,100,906 MWh/year (0.3%).

By 2027, the total integrated OSP savings from all programs will be 1,404,310 MWh/day, which would be 58,513 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 7,274 MWh/day (0.5%),
- Savings from the PUC's Senate Bill 7 programs will be 2,978 MWh/day (0.2%),
- Savings from SECO's Senate Bill 5 program will be 6,795 MWh/day (0.5%),
- Electricity savings from renewable power generation will be 1,384,247 MWh/day (98.6%), and
- Savings from residential air conditioner retrofits will be 3,016 MWh/day (0.2%).

In 2022 (Table **2**), the total integrated annual NOx emissions reductions from all programs are 34,142 tons-NOx/year. The integrated annual NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction are 355 tons-NOx/year (1.0% of the total NOx savings),
- NOx emissions reductions from the PUC's Senate Bill 7 programs are 188 tons-NOx/year (0.6%),
- NOx emissions reductions from SECO's Senate Bill 5 program are 493 tons-NOx/year (1.4%),
- NOx emissions reductions from renewable power generation are 32,816 tons-NOx/year (96.1%), and
- NOx emissions reductions from residential air conditioner retrofits are 290 tons-NOx/year (0.9%).

In 2022, the total integrated OSP NOx emissions reductions from all programs are 145.12 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 0.91 tons-NOx/day (0.6%),
- NOx emissions reductions from the PUC's Senate Bill 7 programs are 0.49 tons-NOx/day (0.3%),
- NOx emissions reductions from SECO's Senate Bill 5 program are 1.27 tons-NOx/day (0.9%),

[1] This assumes air conditioners in existing homes are replaced with the more efficient 14 units, versus an average of SEER 11, which is slightly more efficient than the previous minimum standard of SEER 10.

- NOx emissions reductions from renewable power generation are 141.71 tons-NOx/day (97.7%), and
- NOx emissions reductions from residential air conditioner retrofits are 0.75 tons-NOx/day (0.5%).

By 2027, the total integrated annual NOx emissions reductions from all programs will be 211,074 tons-NOx/year. The integrated annual NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction will be 1,080 tons-NOx/year (0.5% of the total NOx savings),
- NOx emissions reductions from the PUC's Senate Bill 7 programs will be 390 tons-NOx/year (0.2%),
- NOx emissions reductions from SECO's Senate Bill 5 program will be 1,146 tons-NOx/year (0.5%),
- NOx emissions reductions from renewable power generation will be 208,019 tons-NOx/year (98.6%), and
- NOx emissions reductions from residential air conditioner retrofits will be 438 tons-NOx/year (0.2%).

By 2027, the total integrated OSP NOx emissions reductions from all programs will be 748.83 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 2.77 tons-NOx/day (0.4%),
- NOx emissions reductions from the PUC's Senate Bill 7 programs will be 1.01 tons-NOx/day (0.1%),
- NOx emissions reductions from SECO's Senate Bill 5 program will be 2.99 tons-NOx/day (0.4%),
- NOx emissions reductions from renewable power generation will be 740.94 tons-NOx/day (98.9%), and
- NOx emissions reductions from residential air conditioner retrofits will be 1.13 tons-NOx/day (0.2%).

Table 1: Integrated Annual and OSP Electricity Savings for the Different Programs (Base Year 2018)

PROGRAM	ANNUAL (MWh)									
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
ESL-Single Family	0	0	74,850	158,185	228,167	299,749	373,020	448,076	525,014	603,936
ESL-Multifamily	0	0	175,080	380,168	629,359	889,230	1,160,524	1,444,026	1,740,567	2,051,028
ESL-Commercial	0	0	0	0	0	0	0	0	0	0
PUC (SB7)	0	83,347	195,887	376,958	510,991	638,321	759,286	874,202	983,372	1,087,084
SECO	0	359,121	567,339	828,391	1,140,211	1,436,440	1,717,857	1,985,203	2,239,183	2,480,463
Renewables-ERCOT	0	4,091,723	22,537,959	37,278,263	56,941,742	74,737,111	103,482,550	150,992,668	230,770,375	366,157,712
SEER14-Single Family	0	60,071	181,188	356,259	587,566	796,865	855,307	848,191	836,377	823,784
SEER14-Multi Family	0	33,152	74,374	105,771	137,973	183,666	238,352	280,988	276,696	277,122
Total Annual (MWh)	**0**	**4,627,414**	**23,806,679**	**39,483,996**	**60,176,008**	**78,981,382**	**108,586,896**	**156,873,354**	**237,371,584**	**373,481,128**

PROGRAM	OZONE SEASON PERIOD - OSP (MWh/day)									
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
ESL-Single Family	0	0	205	433	625	821	1,022	1,228	1,438	1,655
ESL-Multifamily	0	0	480	1,042	1,724	2,436	3,180	3,956	4,769	5,619
ESL-Commercial	0	0	0	0	0	0	0	0	0	0
PUC (SB7)	0	228	537	1,033	1,400	1,749	2,080	2,395	2,694	2,978
SECO	0	984	1,553	2,268	3,122	3,934	4,705	5,438	6,134	6,795
Renewables-ERCOT	0	114,596	150,844	181,516	256,313	324,194	431,455	605,958	895,831	1,384,247
SEER14-Single Family	0	165	496	976	1,610	2,183	2,343	2,324	2,291	2,257
SEER14-Multi Family	0	91	204	290	378	503	653	770	758	759
Total OSP (MWh)	**0**	**116,063**	**154,318**	**187,558**	**265,172**	**335,821**	**445,438**	**622,068**	**913,915**	**1,404,310**

Table 2: Integrated Annual and OSP NOx Emissions Reduction Values for the Different Programs (Base Year 2018)

PROGRAM	ANNUAL (in tons NOx)									
	2018	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
ESL-Single Family	0	0	31	66	95	125	155	186	217	249
ESL-Multifamily	0	0	73	159	260	365	475	590	706	831
ESL-Commercial	0	0	0	0	0	0	0	0	0	0
PUC (SB7)	0	25	74	141	188	233	275	315	353	390
SECO	0	121	230	341	493	637	774	905	1,028	1,146
Renewables-ERCOT	0	1,800	13,849	22,385	32,816	42,929	59,240	86,170	131,361	208,019
SEER14-Single Family	0	20	74	143	236	320	343	341	336	331
SEER14-Multi Family	0	10	27	40	54	71	91	106	105	107
Total Annual (Tons NOx)	**0**	**1,975**	**14,358**	**23,275**	**34,142**	**44,680**	**61,353**	**88,614**	**134,107**	**211,074**

PROGRAM	OZONE SEASON PERIOD - OSP (in tons NOx/day)									
	2018	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
ESL-Single Family	0.00	0.00	0.08	0.16	0.23	0.31	0.38	0.46	0.54	0.62
ESL-Multifamily	0.00	0.00	0.19	0.41	0.67	0.94	1.23	1.53	1.83	2.15
ESL-Commercial	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUC (SB7)	0.00	0.07	0.19	0.37	0.49	0.60	0.71	0.82	0.92	1.01
SECO	0.00	0.35	0.59	0.87	1.27	1.64	1.99	2.33	2.65	2.99
Renewables-ERCOT	0.00	60.45	88.21	104.65	141.71	178.12	235.38	328.23	482.09	740.94
SEER14-Single Family	0.00	0.06	0.19	0.37	0.61	0.83	0.89	0.88	0.86	0.85
SEER14-Multi Family	0.00	0.03	0.07	0.10	0.14	0.19	0.24	0.28	0.27	0.28
Total OSP (Tons NOx)	**0.00**	**60.96**	**89.52**	**106.93**	**145.12**	**182.62**	**240.82**	**334.52**	**489.16**	**748.83**

d. Technology Transfer

In 2022, The Laboratory, hosted the 2022 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 2022 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: Lindley Anderson, TCEQ, Dan Mantena, ERCOT, Therese Harris, PUCT, Eddy Trevino and Fred Yebra, SECO. Numerous additional individuals at the Energy Systems Laboratory contributed significantly to this report, including: Yu Sun, Jounghwan Ahn, and Xiaodi Hou.

Table of Contents

List of Figures

List of Tables

1 Overview

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

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

The report is organized in two volumes.

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

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

1.1 Legislative Background

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

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

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

- The Texas Building Energy Performance Standards (TBEPS) as the building energy code for all new residential and commercial buildings;
- A municipality or county may request the Laboratory to determine the energy impact of proposed energy code changes;
- An annual evaluation by the Public Utility Commission of Texas (PUCT), in cooperation with the Laboratory, of the emissions reduction of energy demand, peak electric loads and the associated air contaminant reductions from utility-sponsored programs established under Senate Bill 5, and utility-sponsored programs established under the electric utility restructuring act (Section 39.905 Utilities Code);
- A 5% electricity reduction goal each year for facilities of political subdivisions in non-attainment and near-non-attainment counties from 2002 through 2009; and
- Annual report to TCEQ to be provided by the Laboratory on the energy savings and resultant emissions reduction from 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 78th Legislature (2003), HB 1365 and HB 3235 amended TERP to enhance its effectiveness with these additional energy efficiency initiatives:

- TCEQ is required to conduct outreach to non-attainment and near-non-attainment counties on the benefits of implementing energy efficiency measures as a way to meet the air quality goals under the federal Clean Air Act;
- TCEQ is required 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 79th Legislature (2005) through SB 20, HB 2481 and HB 2129. These enhanced the effectiveness of Senate Bill 5 by adding the following energy efficiency initiatives:

- 5,880 MW of generating capacity is required from renewable energy technologies by 2015;
- 500 MW from non-wind renewables;
- The PUCT is required to establish a target of 10,000 megawatts of installed renewable capacity by 2025;
- The TCEQ is required to develop 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 80th Legislature (2007), through SB 12, and HB 3693 further amended Senate Bill 5 to enhance its effectiveness by adding the following energy efficiency initiatives:

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

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

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

- Each political subdivision, institution of higher education or state agency shall establish a goal to reduce the electric consumption by the entity by at least 5% each fiscal year for 10 years, beginning September 1, 2011. Each entity shall report 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 83rd Legislature (2013) did not change any of the Laboratory's previously established responsibilities under TERP.

During the 84th Legislature session (2015), made 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 85th Legislature (2017) did not change any of the Laboratory's previously established responsibilities under TERP.

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

The 87th Legislature (2021) amended Sec. 388.003 (i), (j) and (k) through H.B. 3215. The amendment focused on:

- Tying the energy rating index (ERI) voluntary compliance path with Standard 301 of the American National Standard for the Calculation and Labeling of the Energy Performance of Dwelling and Sleeping Units using an Energy Rating Index, commonly cited as ANSI/RESNET/ICC 301, as it existed on January 1, 2021. A building using this standard will be considered in compliance provided that:
  (1) the building meets the mandatory requirements of Section R406.2 of the 2018 International Energy Conservation Code; and
  (2) the building thermal envelope is equal to or greater than the levels of efficiency and solar heat gain coefficient in Table R402.1.2 or Table R402.1.4 of the 2018 International Energy Conservation Code.
- Updates to the energy rating index (ERI) values: ERI values for 2016 were deleted; ERI values for 2022 remained unchanged; new values for 2025 and 2028 were added for each climate zone. In each year jump (from 2022 to 2025 and from 2025 to 2028) the ERI values decrease by 2.

1.2 Laboratory Funding for the TERP

The Laboratory expended $181,855 in FY 2002; $372,226 in FY 2003; $635,683.84 in FY 2004; $1,107,366.13 in FY 2005; $952,012.70 in 2006; $947,114.62 in FY 2007; $908,512.65 in FY 2008; $949,927.94 in FY 2009; $902,843.35 in FY 2010, $853,421.69 in FY 2011; $434,481.91 in FY 2012 (with the 50% Legislature cut in ESL funding), $447,907.94 in FY 2013; $453,122.25 in FY 2014; $454,571.79 in FY 2015; $459,845.41 in FY 2016; $460,409.98 in FY 2017; $440,558.76 in FY 2018; $443,310.85 in FY 2019; $421,131.25 in FY 2020 (with additional 5% Legislature cut in ESL funding); and $415,847.31 in FY 2021. In FY 2022 the Laboratory expended $ $416,816.78. 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 residendial 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.

In the timeframe of 2020-2022, the laboratory provided recommendations and considered additional input from 2021 IECC 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 2021 IECC as well as the amendments from Austin Energy and NCTCOG.

1.4 Accomplishments since January 2022

Since January 2020, the Laboratory has accomplished the following:

- Calculated energy and resultant NOx reductions from implementation of the Texas Building Energy Performance Standards (IECC/IRC codes) to new residential and commercial construction for all non-attainment and near-non-attainment counties;
- Enhanced the Laboratory's IECC/IRC Code-Traceable Test Suite for determining emissions reduction due to code and above-code programs;
- Enhanced the IC3 calculator, which is an energy code compliance software based on the Texas Building Energy Performance Standards by resolving minor defects found in the model and webpage.
- Continued development and testing of key procedures for validating simulations of building energy performance;
- 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 in March 2022, virtual event. 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:
  Transitioning to a Clean Energy Economy; Increasing Resiliency Post-Uri; Increasing Resiliency Post-Uri; Speed and scale for "Baseload" Energy Efficiency: Addressing Inefficient Heat; Batteries, Long Duration Storage and the Grid; The Intersection of Energy and Emergency Preparedness; State of the State's Air Quality; EPA Region 6 Priorities with RA Earthea Nance; PLENARY: The Intersection of Air Quality, Public Health and Equity; Energy Codes in Texas; Engaging Communities in Sustainability and Resiliency; Integrating EVs and EV Fleets into the Grid; Large Building Energy Efficiency: Financing in both Public and Private Sectors; Replacing the Highest Polluting Power Plants with Cleaner, More Reliable Sources; PLENARY: The Future of Clean Energy in Texas; Growing and Training the Clean Energy Workforce; Local Power, Microgrids, and Resiliency; Rural Opportunities for Economic Development from Clean Energy; PLENARY: Industrial and Oil and Gas Innovation for Lower Emissions; Local Government Resilience; Industrial Innovation Hubs; The Need for New Transmission.
- Provided technical assistance to the TCEQ regarding specific issues, including:
  - Enhancement of the standardized, integrated NOx emissions reduction reporting procedures to the TCEQ for EE/RE projects, and
  - Enhancement of the procedures for weather normalizing NOx emissions reduction from renewable projects.
- Participated as exhibitors at several conferences, including at the 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, was host to the annual Texas Energy Summit, 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 online, March 2022.

- Haberl, J.; Yazdani, B.; Baltazar, J., 2022 “Energy Efficiency and Renewable Energy Impacts on NOx Emission Reductions in Texas” *Texas Energy Summit,* Austin, Texas, March 2022.

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

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

State adoption of the energy efficiency provisions of the International Residential Code (IRC) and International Energy Conservation Code (IECC) became effective September 1, 2001. The Laboratory has developed and delivered training to assist municipal inspectors to become certified energy inspectors. The Laboratory also supported code officials with guidance on interpretations as needed. This effort, based on a requirement of HB 3235, 78^{th} 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 2022, the following savings were calculated (2018 base year)[2]:

- In 2022, the annual electricity savings from code-compliant residential and commercial construction are 857,526 MWh/year (1.4% of the total electricity savings),
- Savings from residential air conditioner retrofits[3] are 725,539 MWh/year (1.2%).

[2] The savings reported for 2022 utilize the 2018 base year as required by the U.S.E.P.A.

[3] This assumes air conditioners in existing homes are replaced with the more efficient SEER 14 units, versus an average of SEER 11, which is slightly more efficient than the previous minimum standard of SEER 10.

- In 2022, the OSP electricity savings from code-compliant residential and commercial construction are 2,349 MWh/day (0.9%),
- Savings from residential air conditioner retrofits are 1,988 MWh/day (0.8%).

- By 2027, the annual electricity savings from code-compliant residential and commercial construction will be 2,654,964 MWh/year (0.7% of the total electricity savings),
- Savings from residential air conditioner retrofits will be 1,100,906 MWh/year (0.3%).

- By 2027, the OSP electricity savings from code-compliant residential and commercial construction will be 7,274 MWh/day (0.5%),
- Savings from residential air conditioner retrofits will be 3,016 MWh/day (0.2%).

- In 2022, the annual NOx emissions reduction from code-compliant residential and commercial construction are 355 tons-NOx/year (1.0% of the total NOx savings),
- NOx emissions reductions from residential air conditioner retrofits are 290 tons-NOx/year (0.9%).

- In 2022, the OSP NOx emissions reduction from code-compliant residential and commercial construction are 0.91 tons-NOx/day (0.6%),
- NOx emissions reductions from residential air conditioner retrofits are 0.75 tons-NOx/day (0.5%).

- By 2027, the NOx emissions reduction from code-compliant residential and commercial construction will be 1,080 tons-NOx/year (0.5% of the total NOx savings),
- NOx emissions reductions from residential air conditioner retrofits will be 438 tons-NOx/year (0.2%).

- By 2027, the OSP NOx emissions reduction from code-compliant residential and commercial Construction will be 2.77 tons-NOx/day (0.4%),
- NOx emissions reductions from residential air conditioner retrofits will be 1.13 tons-NOx/day (0.2%).

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, renewables, and residential air conditioner retrofits;
- 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 2022 (Table 24), the total integrated annual savings from all programs are 60,063,387 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 857,526 MWh/year (1.4% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program are 510,991 MWh/year (0.9%),
- Savings from SECO's Senate Bill 5 program are 1,140,211 MWh/year (1.9%),
- Electricity savings from renewable power generation are 56,829,121 MWh/year (94.6%), and
- Savings from residential air conditioner retrofits[4] are 725,539 MWh/year (1.2%).

[4] This assumes air conditioners in existing homes are replaced with the more efficient 14 units, versus an average of SEER 11, which is slightly more efficient than the previous minimum standard of SEER 10.

In 2022, the total integrated OSP savings from all programs are 264,830 MWh/day, which would be 11,035 MW average hourly load reduction during the OSP period. The integrated OSP electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 2,349 MWh/day (0.9%),
- Savings from the PUC's Senate Bill 7 programs are 1,400 MWh/day (0.5%),
- Savings from SECO's Senate Bill 5 program are 3,122 MWh/day (1.2%),
- Electricity savings from renewable power generation are 255,970 MWh/day (96.7%), and
- Savings from residential air conditioner retrofits are 1,988 MWh/day (0.8%).

By 2027, the total integrated annual savings from all programs will be 373,189,018 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction will be 2,654,964 MWh/year (0.7% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program will be 1,087,084 MWh/year (0.3%),
- Savings from SECO's Senate Bill 5 program will be 2,480,463 MWh/year (0.7%),
- Electricity savings from renewable power generation will be 365,865,602 MWh/year (98.0%), and
- Savings from residential air conditioner retrofits will be 1,100,906 MWh/year (0.3%).

By 2027, the total integrated OSP savings from all programs will be 1,403,423 MWh/day, which would be 58,476 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 7,274 MWh/day (0.5%),
- Savings from the PUC's Senate Bill 7 programs will be 2,978 MWh/day (0.2%),
- Savings from SECO's Senate Bill 5 program will be 6,795 MWh/day (0.5%),
- Electricity savings from renewable power generation will be 1,383,360 MWh/day (98.6%), and
- Savings from residential air conditioner retrofits will be 3,016 MWh/day (0.2%).

In 2022 (Table 25), the total integrated annual NOx emissions reductions from all programs are 34,087 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 355 tons-NOx/year (1.0% of the total NOx savings),
- NOx emissions reductions from the PUC's Senate Bill 7 programs are 188 tons-NOx/year (0.6%),
- NOx emissions reductions from SECO's Senate Bill 5 program are 493 tons-NOx/year (1.4%),
- NOx emissions reductions from renewable power generation are 32,761 tons-NOx/year (96.1%), and
- NOx emissions reductions from residential air conditioner retrofits are 290 tons-NOx/year (0.9%).

In 2022 (Figure 1-1), the total integrated OSP NOx emissions reductions from all programs are 144.96 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 0.91 tons-NOx/day (0.6%),
- NOx emissions reductions from the PUC's Senate Bill 7 programs are 0.49 tons-NOx/day (0.3%),
- NOx emissions reductions from SECO's Senate Bill 5 program are 1.27 tons-NOx/day (0.9%),
- NOx emissions reductions from renewable power generation are 141.55 tons-NOx/day (97.6%), and
- NOx emissions reductions from residential air conditioner retrofits are 0.75 tons-NOx/day (0.5%).

By 2027, the total integrated annual NOx emissions reductions from all programs will be 210,930 tons-NOx/year. The integrated annual NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction will be 1,080 tons-NOx/year (0.5% of the total NOx savings),
- NOx emissions reductions from the PUC's Senate Bill 7 programs will be 390 tons-NOx/year (0.2%),
- NOx emissions reductions from SECO's Senate Bill 5 program will be 1,146 tons-NOx/year (0.5%),
- NOx emissions reductions from renewable power generation will be 207,875 tons-NOx/year (98.6%), and
- NOx emissions reductions from residential air conditioner retrofits will be 438 tons-NOx/year (0.2%).

By 2027, the total integrated OSP NOx emissions reductions from all programs will be 748.42 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 will be 2.77 tons-NOx/day (0.4%),
- NOx emissions reductions from the PUC's Senate Bill 7 programs will be 1.01 tons-NOx/day (0.1%),
- NOx emissions reductions from SECO's Senate Bill 5 program will be 2.99 tons-NOx/day (0.4%),
- NOx emissions reductions from renewable power generation will be 740.52 tons-NOx/day (98.9%), and
- NOx emissions reductions from residential air conditioner retrofits will be 1.13 tons-NOx/day (0.2%).

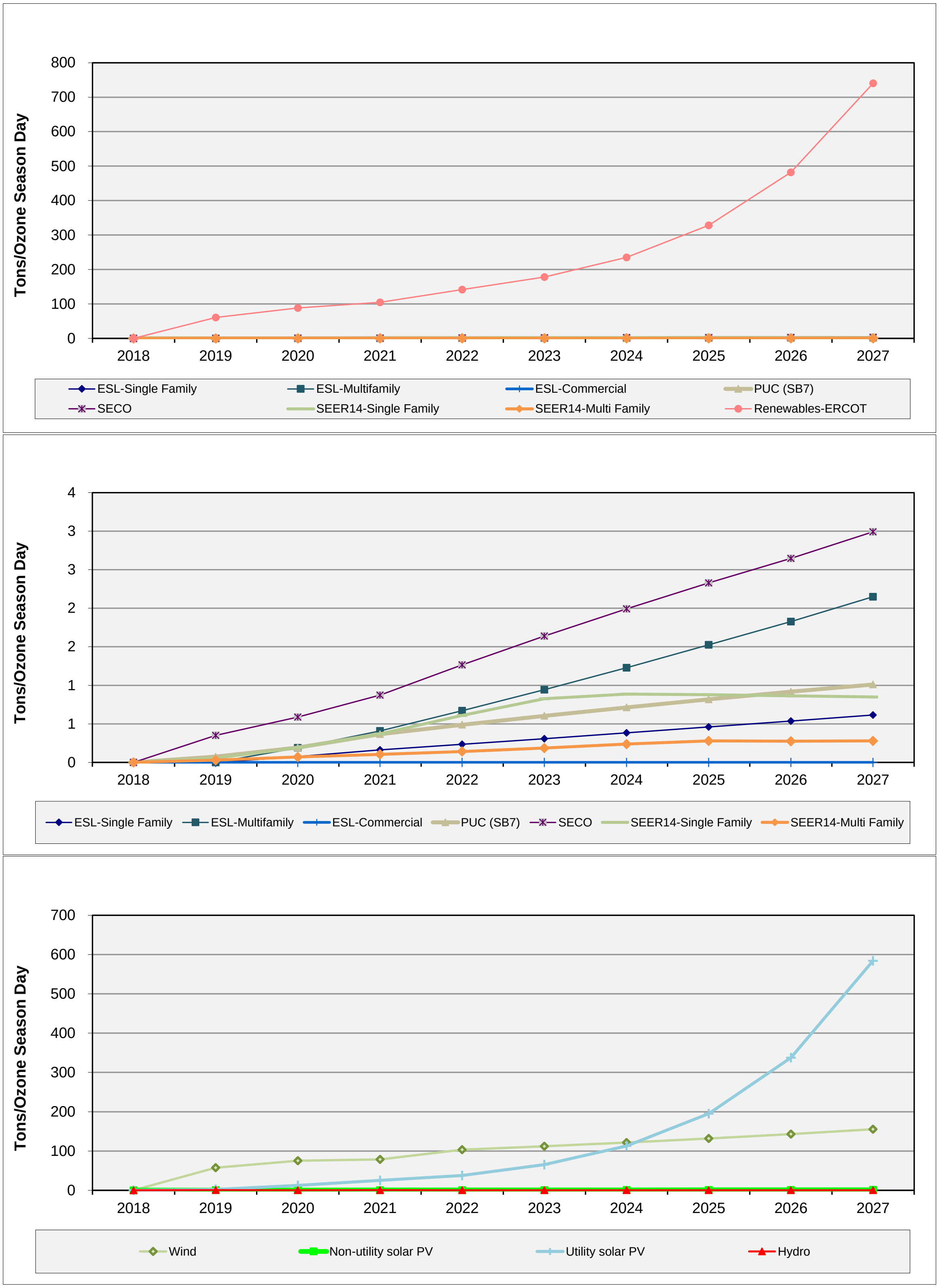


Figure 1-1: Integrated OSP Individual Programs NOx Emissions Reduction Projections through 2027. (Upper Plot) All Programs, (Middle Plot) All Programs Except Renewables, (Lower Plot) Renewables.

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.[5] 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.

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

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

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

The 2020 software updates include:

- IC3
  - Bug fixes
  - Revised 2015 AE IECC
- CEXIS API
  - Added support for 4 floor residential building required by 2015 IECC AE (revised)
- POLLER API
  - Added support for 4 floor residential building required by 2015 IECC AE (revised)

The 2021 software updates include:

- IC3
  - Bug fixes
  - Added base 2021 IECC
  - Added 2021 AE IECC
  - Changed EF to UEF for DHW
  - New Duct System Interface added
- CEXIS API
  - Added support for IECC 2021
- POLLER API
  - Added support for IECC 2021

The 2022 software updates include:

- IC3
  - Bug fixes
  - Revised 2021 energy option selection to make more intuitive

  - New search features added to project selection screen
  - Added 2021 NCTCOG IECC

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 2022, the Laboratory continued to work with the TCEQ to develop an integrated NOx emissions reductions calculation that provided the TCEQ with a creditable NOx emissions reductions from energy efficiency and renewable energy (EE/RE) programs reported to the TCEQ in 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 NOx emissions reductions from renewables and the quantification of NOx emissions reductions from the new Federal regulations for SEER 14 air conditioners.

1.10 Planned Focus for 2023

In FY 2023, the Energy Systems Laboratory will continue in its cooperative efforts with the TCEQ, PUCT, SECO, US EPA and others to evaluate the energy savings resulted from the EE/RE measures and programs of the TERP and their impact on air quality, and continue with the energy code state-wide implementation assistance under the Texas Building Energy Performance Standards program of the TERP. The Laboratory team will:

- Assist the TCEQ to obtain SIP credits from energy efficiency and renewable energy using the Laboratory's Emissions Reduction Calculator technology.
- Verify, document and report energy efficiency and renewable energy savings in all TERP EE/RE programs for the SIP in each non-attainment and affected county using the TCEQ/US EPA approved technology.
- Assist the PUCT with determining emissions reductions credits from energy efficiency programs funded by SB 7 and SB 5.
- Assist political subdivisions and Councils of Governments with calculating emissions reductions from local code changes and voluntary EE/RE programs for SIP inclusion.
- Continue to refine the cost-effective techniques to implement 15% above code (2009 IECC) energy efficiency in low-priced and moderately-priced residential housing.
- Continue to refine the cost-effective methods and techniques to implement 15% above code energy efficiency in commercial buildings.
- Continue to develop creditable procedures for calculating NOx emissions reductions from green renewable technologies, including wind power, solar energy and geothermal energy systems.
- Continue development of well-documented, integrated NOx emissions reductions methodologies for calculating and reporting NOx reductions, including a unified database framework for required reporting to TCEQ of potentially creditable measures from the ESL, PUCT, and SECO SB 5 initiatives.
- Upon request, provide written recommendations to the State Energy Conservation Office (SECO) about whether or not the energy efficiency provisions of 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.
- Continue to update all websites managed by the lab to meet the evolving TEES standards.
- Begin planning for the next version of IC3 to replace the current version which has become dated.
- Plan to publish a report about the LED lighting electricity savings in Texas residential buildings, the report title: Residential Lighting Energy Savings from High-Efficiency Fixtures in Texas.
- Plan to publish a report about the LED lighting electricity savings from Texas LED street light replacements, the report title: Street Lighting Energy Savings from High-Efficiency Fixtures in Texas.

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 2022, twenty-eight counties are designated as non-attainment counties that include: Brazoria, Chambers, Fort Bend, Galveston, Harris, Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Tarrant, Wise, Bexar, Freestone, Howard, Rusk, Anderson, El Paso, Hutchinson, Liberty, Montgomery, Navarro, Panola, Rockwall, Titus, and Waller[6]. These areas are shown on the map in Figure 2-1 as non-attainment.

These counties represent several geographic areas of the state, which have been assigned to different climate zones by the 2015 IECC[7] as shown in Figure 2-2, 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} ss≤ 9,000) for the Houston-Galveston-Beaumont-Port Arthur-Brazoria areas. Also shown in Figure 2-2 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.

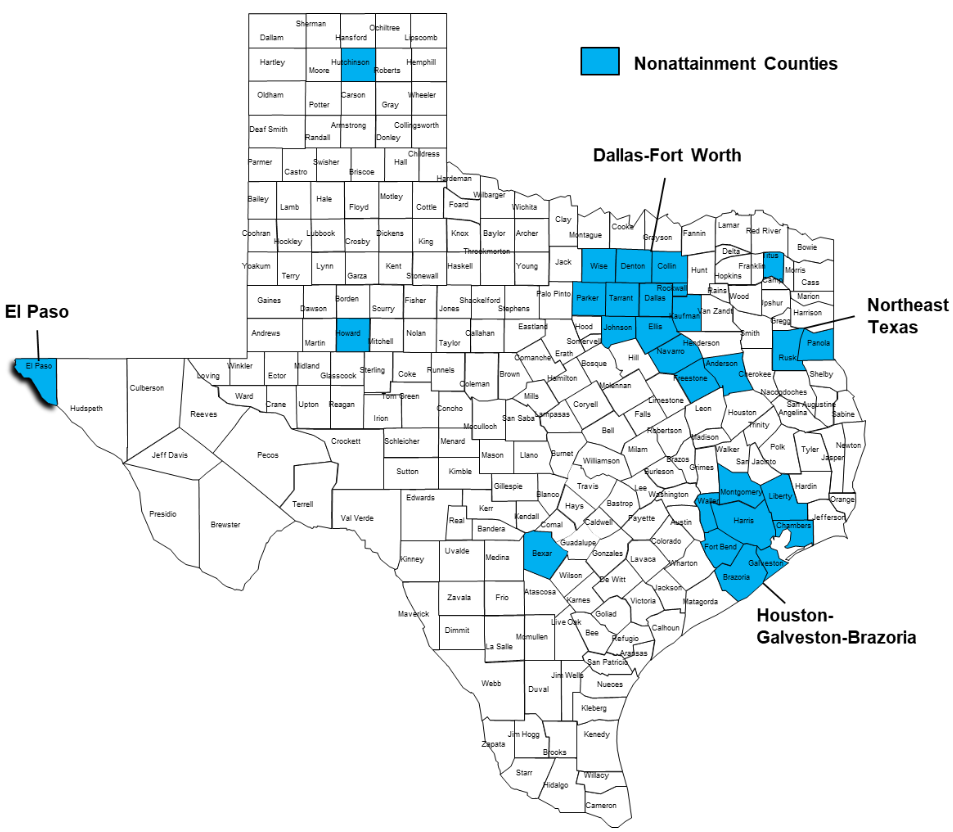
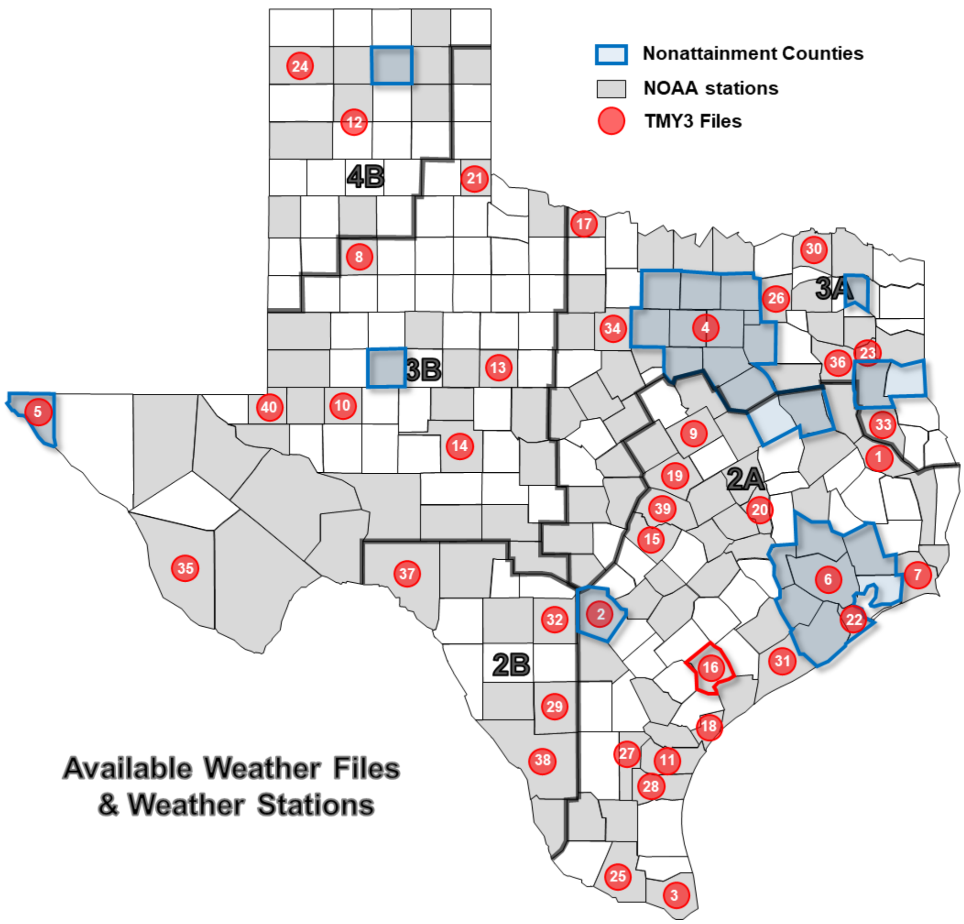


Figure 2-1: TCEQ Nonattainment Counties

---

[6] The EPA finalized nonattainment county designations were retrieved at https://www.tceq.texas.gov/airquality/sip/texas-sip

[7] 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.



List of Available TMY3 Weather Files

Texas TMY3 Weather Files

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

Figure 2-2: Available weather data and TMY3 weather files in the 2015 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.

These responsibilities were not updated in 2020.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

During the 84th Legislature session (2015), changes were made 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 85th Legislature (2017) did not change any of the Laboratory's previously established responsibilities under TERP.

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

The 87th Legislature (2021) amended Sec. 388.003 (i), (j) and (k) through H.B. 3215. The amendment focused on:

- Tying the energy rating index (ERI) voluntary compliance path with Standard 301 of the American National Standard for the Calculation and Labeling of the Energy Performance of Dwelling and Sleeping Units using an Energy Rating Index, commonly cited as ANSI/RESNET/ICC 301, as it existed on January 1, 2021. A building using this standard will be considered in compliance provided that:
  (1) the building meets the mandatory requirements of Section R406.2 of the 2018 International Energy Conservation Code; and
  (2) the building thermal envelope is equal to or greater than the levels of efficiency and solar heat gain coefficient in Table R402.1.2 or Table R402.1.4 of the 2018 International Energy Conservation Code.
- Updates to the energy rating index (ERI) values: ERI values for 2016 were deleted; ERI values for 2022 remained unchanged; new values for 2025 and 2028 were added for each climate zone. In each year jump (from 2022 to 2025 and from 2025 to 2028) the ERI values decrease by 2.

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 2020 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 2022 data

In this report, the weather normalization procedures, to develop together with the Stakeholders, were presented, and applied all the wind farms that reported their data to ERCOT during the 2022 measurement period, together with wind data from the zone average wind speed provided from ERCOT.

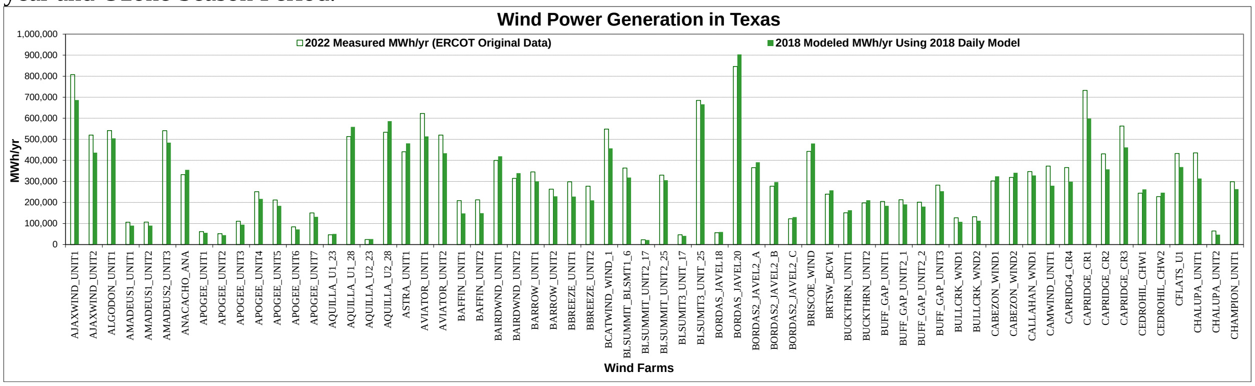
In the previous Wind and Renewables report to the TCEQ, weather normalization analysis methods were reviewed. This report used the same analysis method as the previous reports to present the same weather normalization procedure, including:

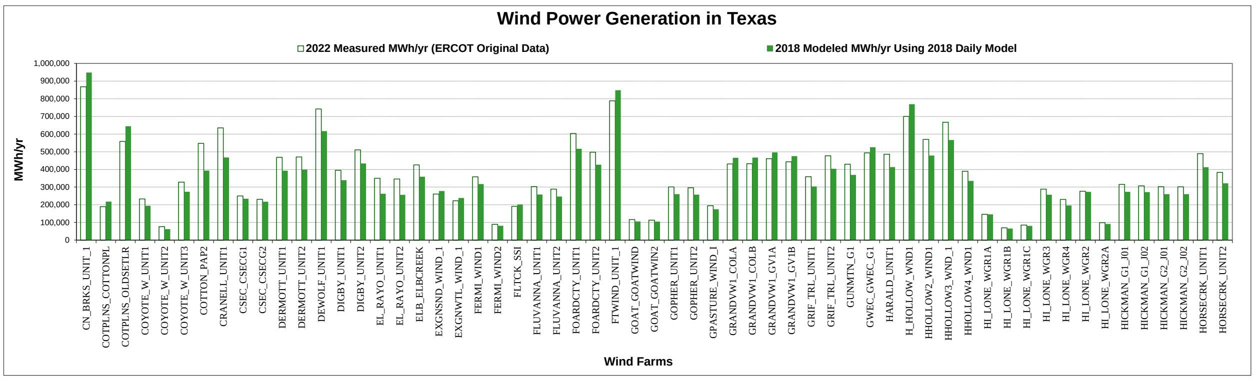
- the processing of weather and power generation data, modeling of daily power generation versus daily wind speed using the ASHRAE Inverse Model Toolkit (IMT) for two separate periods, i.e., Ozone Season Period (OSP), from May 1 to September 30, and Non-Ozone Season Period (Non-OSP).
- predicting 2018 wind power generation as a baseline, using developed coefficients from 2022 daily OSP and Non-OSP models for all the wind farms; and
- the analysis of monthly capacity factors generated using the models.

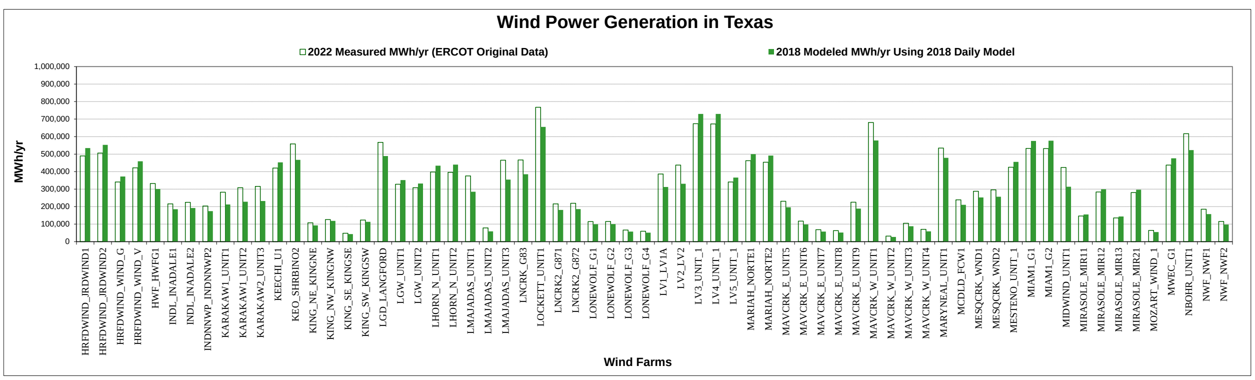
A summary of total wind power production in the base year (2018) for all of the wind farms in the ERCOT region using the developed procedure is presented, and the thirteen new wind farms with thirty-four new meters which started operation in 2022 were added, including Aguayo Wind U1, Appaloosa Run Wind (U1&U2), Board Creek WP (U1&U2), Desert Sky Wind 1 (A&B), Desert Sky Wind 2 (A&B), Elbow Creek Wind, El Suaz Ranch U1, Foxrot Wind (U1, U2&U3), Inertia Wind (U1, U2&U3), Lacy Creek Wind (U1, U2, U3&U4), Priddy Wind (U1&U2), Tg East Wind (U1, U2, U3&U4), Vortex Wind (U1, U2, U3&U4), and Young Wind (U1, U2&U3). Figure 3-1 shows the measured annual wind power generation in 2022 and the estimated wind power generation in 2018 using the developed method for those wind farms in the ERCOT region. The total measured wind power generation in 2022[8] is 102,671,395 MWh MWh/yr, which is 7.2% higher than what the same wind farms would have produced in 2018. Figure *3-2* shows the same comparison but for the Ozone Season Period. The measured wind power generation in the OSP of 2022 is 269,074 MWh/day, which is 3.2% higher than the 2018 OSP baseline wind production. For the analysis of this year, the measured 2022 wind power generation is slightly lower than the 2018 baseline wind power production.

[8] Total wind power generation of wind farms with more than six months of recorded data

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







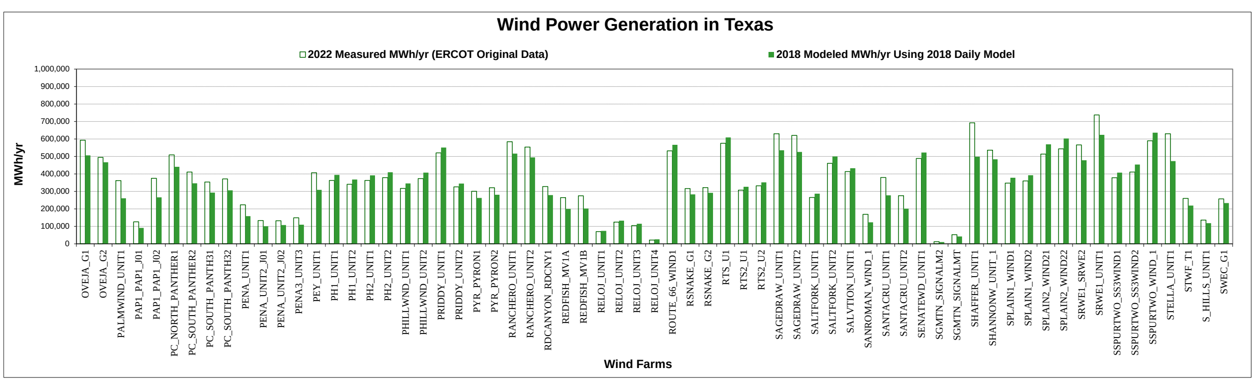


Figure 3-1: Comparison of 2022 Measured and 2018 Estimated Wind Power Production for Each Wind Farm

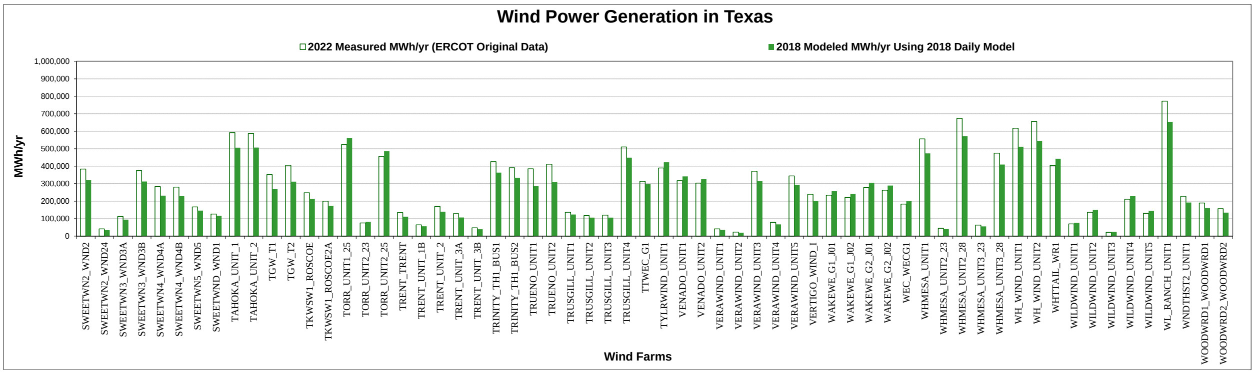
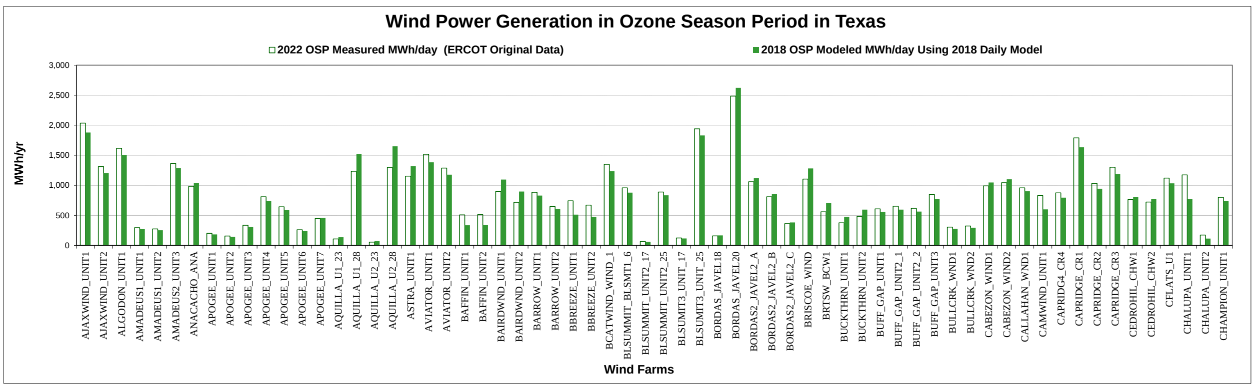
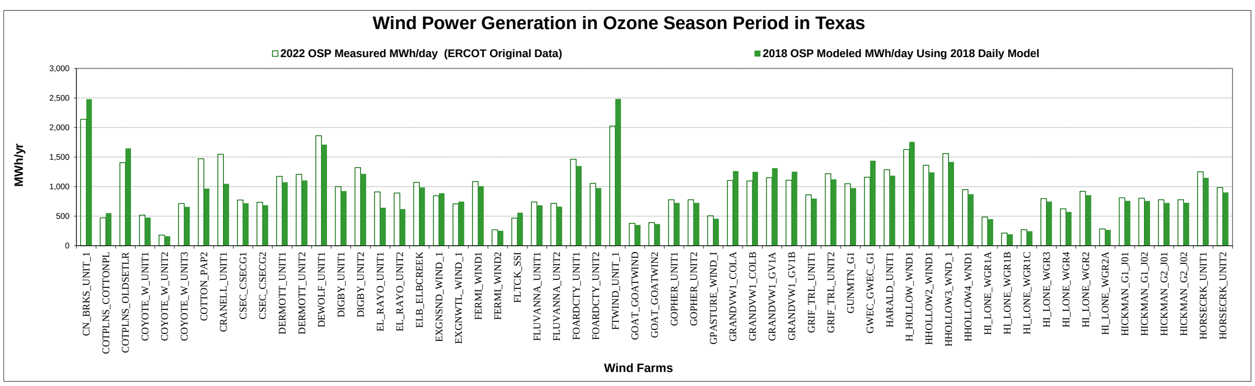


Figure 3-1: Comparison of 2022 Measured and 2018 Estimated Wind Power Production for Each Wind Farm (Continued)





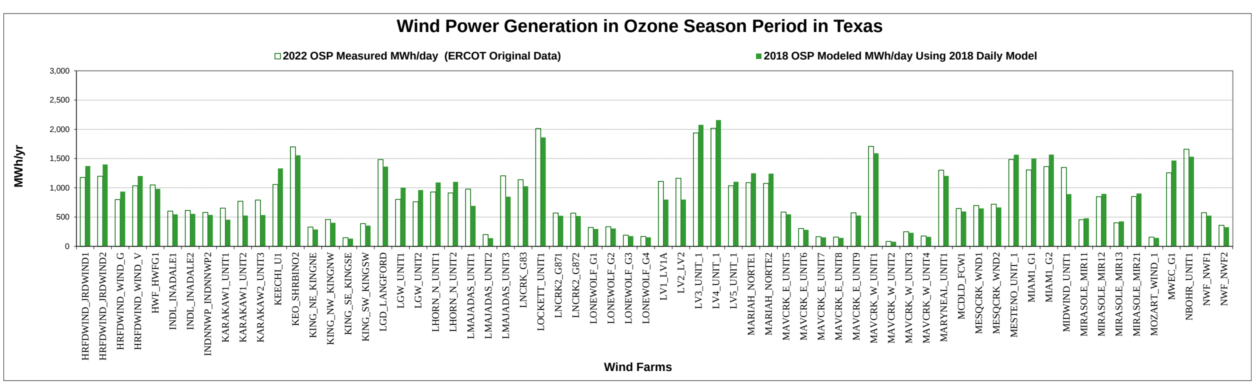
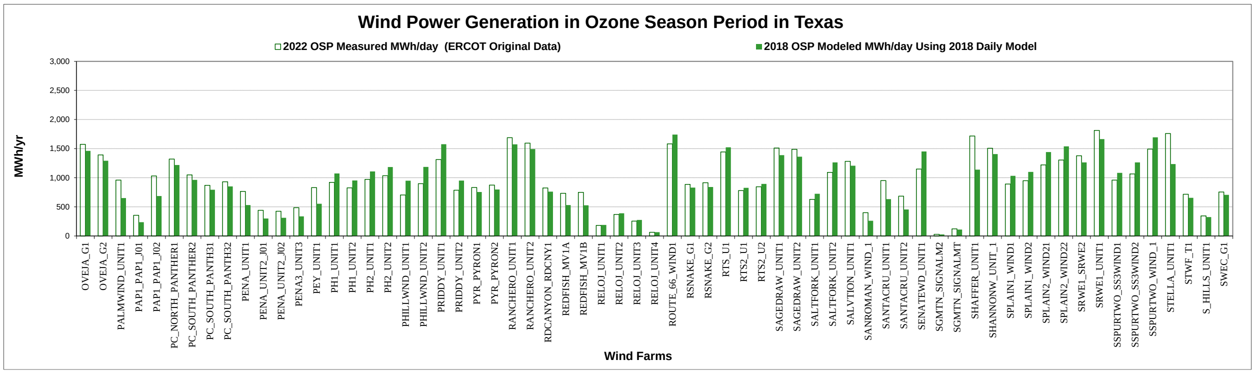


Figure 3-2: Comparison of 2022 OSP Measured and 2018 OSP Estimated Wind Power Production for Each Wind Farm



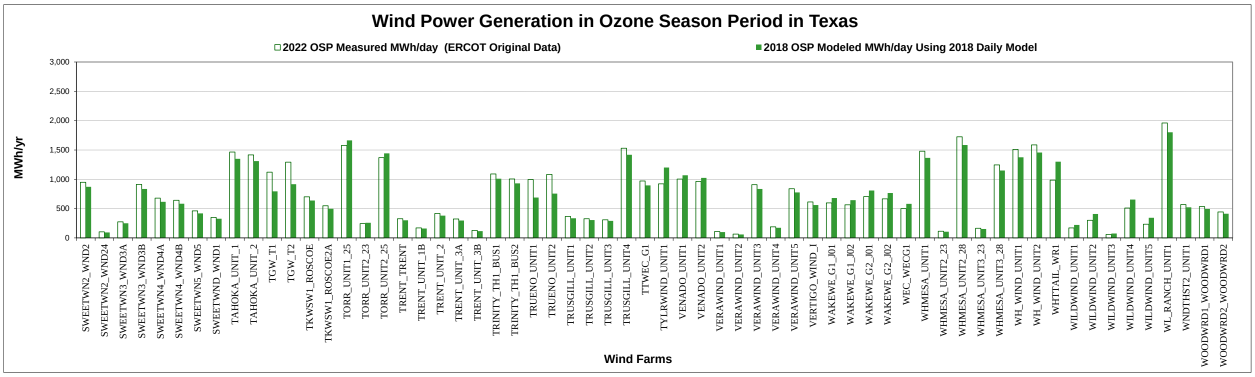


Figure 3-2: Comparison of 2022 OSP Measured and 2018 OSP Estimated Wind Power Production for Each Wind Farm (Continued)

3.2 Analysis of emissions reductions from wind farms

In this report, the procedure for calculating annual and peak-day, county-wide NOx reductions from electricity savings from wind projects implemented in the Competitive Load (CL) zones in ERCOT was presented. The calculation of the NOx emission reductions is based on the 2018 eGRID as modified according to ESL-TR-08-12-04 report (US EPA and ESL, 2008). As shown in Table *3* based on the 2022 measured ERCOT data, the total MWh savings for all the wind farms within the ERCOT region are 102,671,395 MWh/yr and 269,074 MWh/day for an average day in the OSP. The total NOx emissions reductions in 2022 across all the counties amounts are 61,972.6 tons/yr and 153.03 tons/day for the OSP.

Table 3: Electricity Generation and NOx Emission Reductions for All the Wind Farms in ERCOT Region in *2022*

	Annual	**OSP**
Measured Electricity Generation in 2022	102,671,395 [MWh/yr]	269,074 [MWh/day]
NOx Emission Reduction in 2022	61,972.6 [Tons/yr]	153.03 [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.

Table *4* presents a summary of the degradation analysis for the one hundred and sixty-four sites. Of the one hundred and sixty-four sites analyzed, eighty-six 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 0.1% to 55.1%, the remaining seventy-eight sites showed a decrease from -0.1% to -45.2%. The weighted average of this increase across all wind farms studied is 2.5% (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 Big Spring Wind Farm (-22.0%), Briscoe Wind 19 (-11.0%), Cedro Hill Wind (-10%), Gulf Wind 1 (-12.7%), Harbor Wind (-45.2%), Magic Valley Wind (Redfish) 1B (-10.1%), Ocotillo Windpower (-13.1%), Papalote Creek Wind Farm (-11.4%), Penascal Wind 1 (-15.5%), Penascal Wind 3 (-21.1%), Roscoe Wind Farm(-11%), San Roman Wind(-14.0%), Sand Bluff Wind (-18.4%), Sherbino 2 Wind(-29.3%) and Sweetwater Wind 5(-10.1%). 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 4: Summary of 90th Percentile Hourly Wind Power Analysis for 164 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	86.5	*3.7%*	81.2	-2.7%	90.4	8.4%	110	100
Baffin Wind 1	Dec-16	80.5	77.8	*-3.4%*	61.2	-24.0%	86.3	7.2%	73	100
Baffin Wind 2	Dec-16	73.3	75.8	*3.3%*	62.4	-14.9%	83.3	13.6%	73	102
Barton Chapel Wind 1	Dec-09	74.9	73.4	*-2.0%*	61.2	-18.2%	89.1	19.0%	157	120
Big Spring Wind Farm	Dec-02	27.2	21.2	*-22.0%*	11.1	-59.2%	27.2	0.0%	241	41
Blue Summit Wind	Oct-13	121.9	116.7	*-4.3%*	102.4	-16.0%	128.5	5.4%	111	135
Bobcat Bluff Wind	Nov-13	115.0	114.3	*-0.6%*	92.8	-19.4%	131.7	14.5%	110	150
Brazos Wind Ranch	Dec-04	127.5	116.1	*-9.0%*	6.8	-94.7%	139.4	9.3%	217	160
Briscoe Wind_19	Jun-16	123.4	109.8	*-11.0%*	79.1	-35.9%	128.3	4.0%	79	149.8
Buckthorn Wind 1 A	May-18	36.9	39.3	*6.3%*	36.9	0.0%	41.1	11.2%	56	44.9
Buckthorn Wind 1 B	May-18	47.7	50.0	*4.9%*	47.6	-0.1%	52.5	10.1%	56	55.7
Buffalo Gap 1	Nov-06	100.9	94.9	*-6.0%*	62.2	-38.3%	105.7	4.8%	194	120
Buffalo Gap 2	Apr-08	183.4	172.7	*-5.8%*	104.9	-42.8%	207.6	13.2%	177	233
Buffalo Gap 3	Apr-10	122.4	131.7	*7.6%*	84.3	-31.1%	152.1	24.2%	153	170
Bull Creek Wind Plant	Dec-09	93.9	92.5	*-1.4%*	41.5	-55.8%	130.4	38.9%	157	180
Cabezon Wind 1 A	Dec-19	79.2	81.0	*2.3%*	68.6	-13.4%	88.2	11.4%	37	115.2
Cabezon Wind 1 B	Dec-19	81.0	88.8	*9.6%*	79.6	-1.8%	96.2	18.7%	37	122.4
Callahan Divide Wind	Feb-06	93.3	95.0	*1.9%*	83.9	-10.0%	101.5	8.8%	203	114
Cameron County Wind (Camwind_Unit1)	Dec-16	128.0	126.0	*-1.5%*	103.7	-19.0%	142.5	11.4%	73	165
Camp Springs Wind 2	Jan-09	94.0	91.9	*-2.2%*	59.9	-36.2%	107.9	14.8%	168	120
Camp Springs Wind Energy Center	Apr-08	111.3	101.2	*-9.1%*	68.2	-38.8%	120.9	8.6%	177	130
Capricorn Ridge Wind 1&2	Aug-08	258.0	266.1	*3.1%*	174.5	-32.4%	309.3	19.9%	173	364
Capricorn Ridge Wind 4	May-09	83.5	88.8	*6.4%*	67.6	-19.0%	100.2	20.0%	164	112.5
Cedro Hill Wind	Dec-11	136.3	122.7	*-10.0%*	101.9	-25.2%	136.9	0.4%	133	150
Champion Wind Farm	Jan-09	89.4	99.6	*11.4%*	82.3	-8.0%	113.2	26.6%	168	126.5
Chapman Ranch Wind IA (Santa Cruz)	Mar-18	104.4	96.8	*-7.3%*	54.6	-47.7%	122.0	16.8%	58	150.6
Chapman Ranch Wind IB (Santa Cruz)	Mar-18	71.1	66.3	*-6.7%*	41.5	-41.7%	78.9	11.0%	58	98.4
Desert Sky Wind Farm	Dec-02	89.0	114.2	*28.3%*	11.5	-87.1%	134.4	50.9%	241	160.5
Doug Colbeck's Corner (Conway) B	Jan-17	90.1	92.7	*3.0%*	85.7	-4.8%	94.7	5.2%	72	100.2
Doug Colbeck's Corner (Conway) A	Jan-17	92.6	92.9	*0.3%*	91.2	-1.5%	95.2	2.8%	72	100.2
Elbow Creek Wind	Dec-09	94.5	95.9	*1.5%*	70.2	-25.7%	109.6	16.0%	157	121.9
Falvez Astra Wind	Jan-18	149.3	135.8	*-9.0%*	112.8	-24.5%	155.6	4.2%	60	163.2
Foard City Wind 1 A	Dec-19	108.6	165.9	*52.8%*	108.6	0.0%	173.9	60.2%	37	186.48
Foard City Wind 1 B	Dec-19	97.5	144.9	*48.7%*	97.5	0.0%	152.2	56.1%	37	163.8
Forest Creek Wind	Dec-07	105.2	99.8	*-5.2%*	69.3	-34.1%	111.2	5.7%	181	124.2
Goat Wind	Apr-09	67.0	100.5	*50.1%*	61.8	-7.8%	122.6	83.0%	165	150
Goldthwaite Wind 1	Dec-14	122.8	125.8	*2.4%*	115.8	-5.7%	134.4	9.4%	97	149
Grandview Wind 1 (Conway) GV1A	Nov-15	99.3	97.8	*-1.5%*	91.0	-8.3%	101.4	2.2%	86	107
Grandview Wind 1 (Conway) GV1B	Nov-15	94.0	93.4	*-0.7%*	89.5	-4.8%	98.0	4.2%	86	104
Green Mountain Wind 1 (Brazos)	Aug-18	92.7	92.4	*-0.3%*	82.7	-10.8%	103.3	11.4%	53	120
Green Mountain Wind 2 (Brazos)	Aug-18	82.8	82.7	*-0.1%*	75.3	-9.0%	90.0	8.8%	53	108
Green Pastures Wind I_19	Feb-16	125.2	124.6	*-0.5%*	66.9	-46.5%	139.2	11.2%	83	150
Gulf Wind 1	Jun-10	108.6	94.8	*-12.7%*	0.7	-99.4%	119.4	9.9%	151	141.6
Gulf Wind 2	Jun-10	116.5	105.0	*-9.9%*	3.1	-97.3%	126.3	8.4%	151	141.6
Gunsight Mountain Wind	Jan-17	109.5	111.5	*1.8%*	100.5	-8.2%	115.2	5.2%	72	119.9
Hackberry Wind	Dec-09	138.0	124.4	*-9.9%*	100.4	-27.2%	140.6	1.9%	157	165.5
Harbor Wind	Jan-13	6.1	3.3	*-45.2%*	0.0	-100.0%	7.1	15.9%	120	9
Hereford Wind G_19	Dec-15	80.9	82.7	*2.3%*	75.3	-6.9%	86.9	7.5%	85	99.9
Hereford Wind V_19	Dec-15	90.4	93.8	*3.8%*	90.4	0.0%	95.7	5.8%	85	100
Hidalgo & Starr Wind 11	Jul-17	45.1	43.2	*-4.0%*	37.1	-17.8%	47.3	5.1%	66	52
Hidalgo & Starr Wind 12	Jul-17	85.8	82.9	*-3.4%*	71.5	-16.7%	91.2	6.3%	66	98
Hidalgo & Starr Wind 21	Jul-17	85.0	81.6	*-4.0%*	68.1	-19.9%	89.2	4.9%	66	100
Horse Creek Wind 1	Dec-17	121.6	121.4	*-0.2%*	117.5	-3.3%	123.6	1.7%	61	131.1
Horse Creek Wind 2	Dec-17	92.3	92.2	*-0.1%*	90.5	-1.9%	93.8	1.6%	61	98.9
Horse Hollow Phase 1	Jun-06	157.0	169.0	*7.7%*	141.3	-10.0%	185.1	17.9%	199	213
Horse Hollow Phase 2	Aug-07	145.7	142.8	*-2.0%*	99.0	-32.1%	164.9	13.2%	185	184
Horse Hollow Phase 3	May-07	169.2	170.6	*0.8%*	123.9	-26.8%	187.7	11.0%	188	223.5
Horse Hollow Phase 4	Jun-07	88.6	91.5	*3.3%*	80.9	-8.7%	103.1	16.3%	187	115
Inadale Wind	Sep-10	117.9	139.6	*18.4%*	99.0	-16.0%	166.3	41.1%	148	197
Indian Mesa Wind Farm	Dec-02	48.0	55.5	*15.8%*	36.0	-24.9%	72.2	50.5%	241	82.5
Javelina II Wind 1	Dec-17	86.2	86.3	*0.0%*	83.2	-3.5%	89.1	3.3%	61	96

Table 4: Summary of 90th Percentile Hourly Wind Power Analysis for 164 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		
Javelina II Wind 2	Dec-17	64.9	65.9	*1.6%*	63.4	-2.3%	68.0	4.7%	61	74
Javelina II Wind 3	Dec-17	27.5	27.5	*0.1%*	26.4	-3.9%	28.5	3.8%	61	30
Javelina Wind 18&20_19	Sep-16	211.0	218.8	*3.7%*	209.6	-0.7%	229.3	8.7%	76	249.7
Jumbo Road Wind 1_19	Mar-16	117.3	124.3	*6.0%*	117.3	0.0%	129.1	10.1%	82	146.2
Jumbo Road Wind 2_19	Mar-16	119.7	128.7	*7.5%*	119.7	0.0%	134.7	12.5%	82	153.6
Karankawa Wind 1a	Dec-19	4.9	82.2	*N/A*	4.9	0.0%	90.9	N/A	37	103.32
Karankawa Wind 1b	Dec-19	1.3	82.8	*N/A*	1.3	0.0%	90.2	N/A	37	103.32
Karankawa Wind 2	Dec-19	8.3	80.4	*N/A*	8.3	0.0%	86.6	N/A	37	100.42
Keechi Wind 138 Kv Joplin_19	Dec-15	99.7	102.5	*2.9%*	99.5	-0.2%	104.0	4.3%	85	110
King Mountain-NE Wind Farm	Dec-02	41.8	43.2	*3.2%*	20.8	-50.3%	56.4	34.8%	241	79.3
King Mountain-NW Wind Farm	Dec-02	44.7	51.2	*14.5%*	27.7	-37.9%	65.3	46.1%	241	79.3
King Mountain-SE Wind Farm	Dec-02	21.6	21.5	*-0.4%*	11.8	-45.7%	28.1	29.8%	241	40.3
King Mountain-SW Wind Farm	Dec-02	41.6	44.4	*6.8%*	22.9	-44.9%	53.7	29.1%	241	79.3
Langford Wind	Dec-10	115.7	125.9	*8.8%*	107.8	-6.9%	141.3	22.1%	145	150
Lockett Wind Farm	Dec-19	153.8	175.6	*14.2%*	153.8	0.0%	180.1	17.1%	37	183.7
Logans Gap Wind I U1_19	Apr-16	88.5	86.5	*-2.3%*	80.6	-9.0%	90.6	2.3%	81	103.8
Logans Gap Wind I U2_19	Apr-16	83.8	83.1	*-0.8%*	77.5	-7.6%	86.6	3.3%	81	106.3
Lone Star-Mesquite Wind	Sep-08	140.4	143.8	*2.4%*	121.0	-13.9%	168.1	19.7%	172	200
Lone Star-Post Oak Wind	Mar-09	149.1	148.1	*-0.7%*	119.5	-19.8%	170.5	14.4%	166	200
Longhorn Wind North U1_19	Mar-16	91.0	92.6	*1.7%*	90.8	-0.3%	94.0	3.3%	82	100
Longhorn Wind North U2_19	Dec-15	88.9	93.2	*4.8%*	88.9	0.0%	95.0	6.9%	85	100
Loraine Windpark I	Dec-10	30.4	35.3	*16.1%*	25.9	-14.8%	42.3	39.2%	145	126
Loraine Windpark II	Dec-10	27.8	35.8	*28.7%*	25.7	-7.6%	43.3	55.7%	145	124.5
Loraine Windpark III	Jan-12	16.2	20.1	*23.9%*	16.2	0.0%	22.6	39.4%	132	26
Loraine Windpark IV	Dec-12	17.4	17.2	*-1.6%*	5.0	-71.5%	20.8	19.1%	121	24
Los Vientos I Wind	Oct-13	148.5	155.4	*4.6%*	94.5	-36.4%	175.1	17.9%	111	200.1
Los Vientos II Wind	Nov-13	153.3	145.0	*-5.4%*	121.1	-21.0%	164.3	7.2%	110	201.6
Los Vientos III Wind_19	Feb-16	154.0	167.6	*8.9%*	154.0	0.0%	175.9	14.3%	83	200
Los Vientos IV Wind	Apr-17	167.7	172.4	*2.8%*	160.1	-4.5%	180.0	7.3%	69	200
Los Vientos V Wind	Dec-16	92.1	90.7	*-1.5%*	80.7	-12.4%	96.9	5.2%	73	110
Magic Valley Wind (Redfish) 1A	Apr-13	88.6	81.0	*-8.5%*	61.9	-30.1%	90.7	2.4%	117	99.8
Magic Valley Wind (Redfish) 1B	Jul-13	94.2	84.7	*-10.1%*	64.7	-31.3%	94.6	0.4%	114	103.5
Mariah Del Norte 1	Dec-17	103.7	103.6	*-0.2%*	97.2	-6.3%	107.0	3.2%	61	115.2
Mariah Del Norte 2	Dec-17	105.6	103.7	*-1.8%*	95.5	-9.6%	107.9	2.2%	61	115.2
McAdoo Wind	Dec-09	111.7	133.0	*19.1%*	111.7	0.0%	143.6	28.5%	157	150
Mesquite Creek Wind 1_19	Dec-15	93.3	89.3	*-4.3%*	73.2	-21.5%	97.7	4.7%	85	105.6
Mesquite Creek Wind 2_19	Dec-15	90.5	88.7	*-2.0%*	77.3	-14.7%	96.2	6.2%	85	105.6
Miami Wind G1	Aug-15	125.8	127.7	*1.5%*	119.5	-5.0%	132.6	5.4%	89	144
Miami Wind G2	Aug-15	126.0	128.0	*1.6%*	120.9	-4.0%	133.4	5.9%	89	144
Midway Wind	Dec-19	122.8	128.1	*4.2%*	119.2	-3.0%	132.3	7.7%	37	162.8
Notrees Windpower	Feb-10	103.7	110.1	*6.3%*	90.6	-12.6%	122.9	18.6%	155	153
Ocotillo Windpower	Dec-09	39.1	34.0	*-13.1%*	2.6	-93.4%	47.2	20.7%	157	58.8
Panhandle Wind 1 U1	May-15	94.5	93.7	*-0.8%*	81.6	-13.6%	101.3	7.2%	92	109
Panhandle Wind 1 U2	May-15	90.6	89.5	*-1.2%*	76.6	-15.4%	98.0	8.2%	92	109
Panhandle Wind 2 U1	Oct-15	88.2	86.2	*-2.3%*	79.7	-9.6%	90.0	2.0%	87	94
Panhandle Wind 2 U2	Sep-15	90.2	89.0	*-1.3%*	83.2	-7.7%	93.4	3.6%	88	97
Panther Creek	Dec-09	114.4	123.5	*7.9%*	107.8	-5.8%	134.3	17.4%	157	142.5
Panther Creek 2	Dec-09	91.8	98.3	*7.1%*	83.5	-9.0%	108.4	18.1%	157	115.5
Panther Creek 3	Aug-10	128.5	140.8	*9.6%*	0.0	-100.0%	177.1	37.8%	149	199.5
Papalote Creek Phase II	Dec-11	174.2	159.9	*-8.2%*	120.7	-30.7%	176.3	1.2%	133	200.1
Papalote Creek Wind Farm	Dec-10	150.1	133.1	*-11.4%*	39.6	-73.6%	157.9	5.2%	145	180
Penascal Wind 1	Feb-11	133.2	112.5	*-15.5%*	55.8	-58.1%	141.5	6.2%	143	161
Penascal Wind 2	Dec-09	83.3	99.9	*19.9%*	57.7	-30.8%	125.4	50.5%	157	142
Penascal Wind 3	May-11	87.1	68.8	*-21.1%*	38.2	-56.2%	88.8	2.0%	140	101
Pyron	Dec-09	157.2	191.4	*21.8%*	151.4	-3.7%	220.1	40.0%	157	249
Rattlesnake Den Wind Phase 1 G1_19	Mar-16	97.0	88.2	*-9.1%*	70.3	-27.5%	99.7	2.8%	82	104.3
Rattlesnake Den Wind Phase 1 G2_19	Mar-16	93.5	87.1	*-6.9%*	76.2	-18.5%	97.3	4.0%	82	103
Red Canyon1	Aug-07	76.4	76.2	*-0.3%*	71.0	-7.0%	79.6	4.2%	185	84
Roscoe Wind Farm	Dec-08	169.4	150.7	*-11.0%*	108.1	-36.2%	179.8	6.2%	169	209
Route 66 Wind_19	Mar-16	139.0	135.8	*-2.3%*	120.7	-13.2%	142.6	2.5%	82	150

Table 4: Summary of 90th Percentile Hourly Wind Power Analysis for 164 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		
Saltfork_Unit1	Aug-17	58.1	60.7	*4.5%*	58.1	0.0%	61.7	6.2%	65	64
Saltfork_Unit2	Aug-17	100.9	104.1	*3.1%*	100.9	0.0%	105.4	4.4%	65	110
San Roman Wind	Dec-17	82.1	70.6	*-14.0%*	46.3	-43.6%	82.9	1.0%	61	95.2
Sand Bluff Wind	Nov-08	69.4	56.6	*-18.4%*	1.4	-98.0%	75.4	8.6%	170	90
Senate Wind	Sep-13	127.1	125.7	*-1.1%*	119.0	-6.4%	132.2	4.0%	112	150
Sendero Wind Energy_19	Aug-16	67.2	69.7	*3.7%*	64.7	-3.7%	72.6	8.1%	77	76
Shannon Wind_19	Oct-16	175.3	172.9	*-1.3%*	148.4	-15.3%	183.9	4.9%	75	204.1
Sherbino 2 Wind	Dec-12	125.7	88.8	*-29.3%*	13.3	-89.5%	125.7	0.0%	121	150
Silver Star Wind	Apr-09	40.6	40.9	*0.8%*	6.1	-85.0%	50.5	24.4%	165	60
South Plains Wind 2_19	Jul-16	89.2	89.6	*0.5%*	86.0	-3.6%	92.5	3.7%	78	98
South Plains Wind I_19	Jul-16	94.8	92.4	*-2.6%*	86.3	-9.0%	95.5	0.8%	78	102
South Plains Wind II A	Dec-16	120.2	134.9	*12.3%*	120.2	0.0%	141.3	17.5%	73	148.5
South Plains Wind II B	Dec-16	128.1	139.1	*8.5%*	128.1	0.0%	145.1	13.2%	73	151.8
Spinning Spur 3 (Wind 1)_19	Apr-16	87.5	90.4	*3.3%*	87.5	0.0%	91.6	4.7%	81	96
Spinning Spur 3 (Wind 2)_19	Apr-16	88.4	92.3	*4.5%*	88.4	0.0%	93.9	6.2%	81	98
Spinning Spur Wind Two	May-15	140.9	144.7	*2.8%*	139.0	-1.3%	149.4	6.1%	92	161
Stephens Ranch Wind 2_19	Mar-16	144.3	148.1	*2.7%*	144.3	0.0%	151.9	5.3%	82	164.7
Stephens Ranch Wind Phase 1	Nov-15	182.9	189.0	*3.3%*	182.9	0.0%	193.1	5.6%	86	211
Sweetwater Wind 1	Dec-04	34.1	33.4	*-1.9%*	28.8	-15.4%	36.2	6.2%	217	37.5
Sweetwater Wind 2	Jan-06	71.4	83.2	*16.6%*	71.4	0.0%	89.6	25.6%	204	97.5
Sweetwater Wind 3	Dec-06	99.6	103.7	*4.1%*	67.1	-32.7%	125.9	26.3%	193	135
Sweetwater Wind 4	Mar-08	161.0	170.8	*6.0%*	153.2	-4.9%	182.2	13.2%	178	240.8
Sweetwater Wind 5	Dec-08	66.5	59.8	*-10.1%*	43.9	-33.9%	69.3	4.3%	169	80.5
Sweetwater Wind24	Mar-08	13.1	13.5	*3.4%*	11.9	-9.1%	14.8	13.3%	178	16
Tahoka Wind 1	Dec-19	139.2	140.2	*0.7%*	139.2	0.0%	141.2	1.5%	37	150
Tahoka Wind 2	Dec-19	138.8	140.2	*1.0%*	138.8	0.0%	141.3	1.8%	37	150
Torrecillas Wind_23+25	Dec-19	130.6	131.0	*0.3%*	129.6	-0.7%	133.4	2.2%	37	150.5
Trent Mesa Wind Farm	Dec-02	108.8	101.4	*-6.8%*	33.3	-69.4%	132.8	22.0%	241	150
Trinity Hills Wind Farm 1	Dec-12	78.8	76.1	*-3.4%*	12.5	-84.2%	99.0	25.6%	121	118
Trinity Hills Wind Farm 2	Dec-12	74.8	74.0	*-1.1%*	23.9	-68.0%	89.9	20.3%	121	108
Turkey Track Wind Energy Center	Dec-09	77.4	120.0	*55.1%*	76.5	-1.1%	143.1	85.0%	157	169.5
Tyler Bluff Wind	Aug-17	104.0	107.1	*3.0%*	102.6	-1.4%	110.7	6.5%	65	125.6
Vertigo Wind (Formerly Green Pastures Wind 2	Nov-16	123.5	123.1	*-0.3%*	84.0	-32.0%	133.4	8.0%	74	150
Wake Wind 1	Apr-17	109.3	107.1	*-2.0%*	98.9	-9.5%	110.2	0.8%	69	114.9
Wake Wind 2	Apr-17	136.0	131.7	*-3.2%*	118.9	-12.6%	137.0	0.7%	69	142.3
Whirlwind	Dec-08	54.0	52.2	*-3.4%*	39.8	-26.3%	56.9	5.4%	169	60
Whitetail Wind	Oct-13	72.9	66.6	*-8.6%*	60.2	-17.4%	73.1	0.3%	111	92
Willow Springs Wind A	Jul-18	118.1	118.7	*0.5%*	116.8	-1.2%	121.0	2.4%	54	125
Willow Springs Wind B	Jul-18	117.7	118.2	*0.5%*	116.0	-1.4%	119.3	1.4%	54	125
Windthorst 2	Oct-15	50.3	56.6	*12.4%*	50.3	0.0%	59.4	18.1%	87	68
WKN Mozart Wind	Oct-13	22.4	21.1	*-5.9%*	16.8	-24.9%	25.8	15.0%	111	30
Wolf Ridge Wind	Dec-09	105.9	100.0	*-5.6%*	81.2	-23.4%	108.8	2.7%	157	112.5
Woodward Wind Farm	Dec-02	85.3	93.9	*10.2%*	65.2	-23.5%	112.4	31.8%	241	159.7
Weighted Average:				**2.5%**		**-21.3%**		**61.3%**	**Total:**	**20857.74**

Note: N/A means not applicable. These wind farms have completed operation until the year 2020.

3.4 Analysis of other renewable sources

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

This report also presents county-wide annual/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 was conducted based on the Lawrence Berkeley National Laboratory (LBNL) public dataset. In addition, the annual/OSP energy savings calculation for solar thermal was conducted based on the project data from various web sources. Finally, the power generation data for the other renewable energy projects (solar power, biomass, and hydroelectric), which were obtained from the ERCOT and the EIA, were used to evaluate the annual/OSP energy generation. Then, the annual NOx emission reductions calculation was conducted with the special version of Texas 2018 eGRID.

In 2022, the total annual/OSP energy savings from each renewable projects across all the counties were:

- solar photovoltaic projects (non-utility scale): not available in the present report;
  in addition, solar power projects (utility-scale): 24,182,820 MWh/yr and 85,682 MWh/day,
- solar thermal projects: 255 MWh/yr and 0.7 MWh/day,
- biomass projects: 625,349 MWh/yr and 2,252 MWh/day, and
- hydroelectric projects: 444,490 MWh/yr and 1,767 MWh/day.

In 2022, the annual NOx emission reductions from renewable projects across all the counties were:

- solar photovoltaic projects (non-utility scale): not available in the present report;
  in addition, solar power projects (utility-scale): 13,741.7 tons/yr,
- solar thermal projects: 0.1 tons/yr,
- hydroelectric projects: 168.1 tons/yr.

Table 5: Number of Identified Projects for Other Renewable Sources

Renewable Energy Projects	**Number of New Projects in 2022**	**Total Number of Projects up to 2022**	**Annual Measured/ Estimated Electricity Generation in 2022 [MWh/yr]**	**OSP Measured/ Estimated Electricity Generation in 2022 [MWh/day]**	**NOx Emission Reductions in 2022 [Tons/yr]**
Solar Photovoltaic[9]	N/A	N/A	N/A	N/A	N/A
Solar Power	33	150	24,182,820	85,682.0	13,741.7
Solar Thermal	0	41	255	0.7	0.1
Biomass	0	12	625,349	2,252.0	-
Hydroelectric	0	33	444,490	1,767.0	168.1
Geothermal	0	306	-	-	-
Landfill Gas-Fired[10]	1	36	-	-	-

[9] The analysis of non-utility scale solar PV projects could not be completed in the present report because the "Tracking the Sun" public database has not been updated yet for the year 2022. This analysis will be completed when the dataset is available at the end of the year and this report will be updated.

[10] Landfill gas-fired project information from EPA have seven sub-categories for their status: operational, candidates, potential, construction, shutdown, planned, and others. Only operational projects were considered.

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 (https://sa.ercot.com/rec/home) 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 2022 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. Five specific renewable sources were analyzed for this report. Table 6 contains the data reported by ERCOT from 2001 to 2022. Figure 3-3 is included to better illustrate the annual data collected by ERCOT.

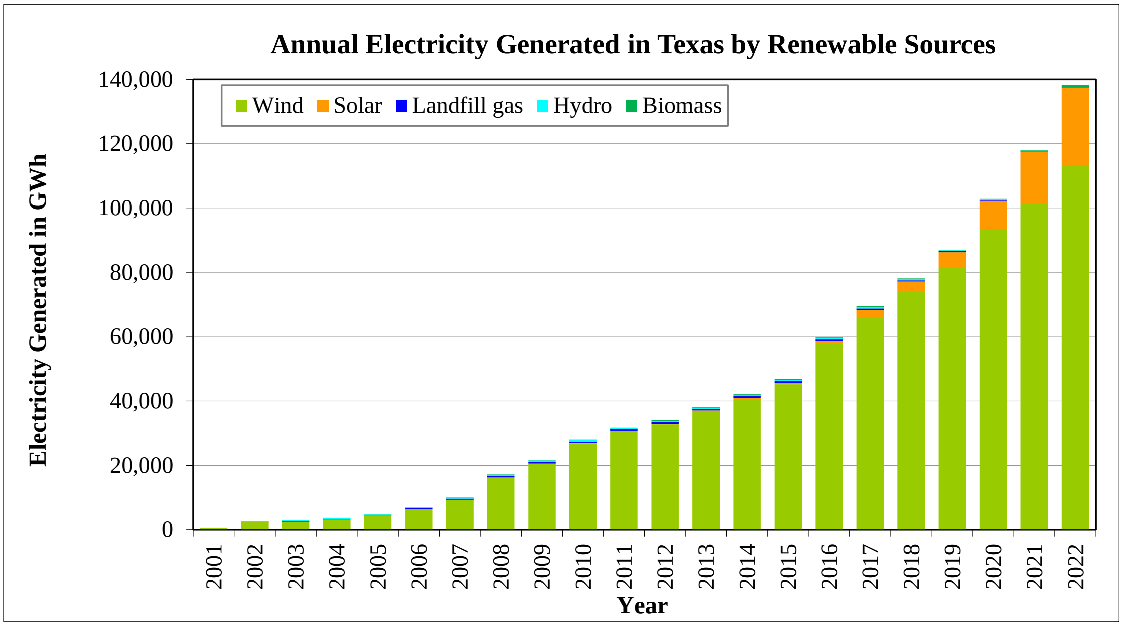
Table 6: Annual Electricity Generation by Renewable Resources (MWh, ERCOT: 2001 - 2022)

Year	Biomass (MWh)	Hydro (MWh)	Landfill gas (MWh)	Solar (MWh)*	Wind (MWh)	Total (MWh)
2001	0	30,639	0	0	565,597	596,236
2002	0	312,093	29,412	87	2,451,484	2,793,076
2003	39,496	239,684	154,206	220	2,515,482	2,949,087
2004	36,940	234,791	203,443	211	3,209,630	3,685,014
2005	58,637	310,302	213,777	227	4,221,568	4,804,512
2006	60,569	210,077	306,087	470	6,530,928	7,108,131
2007	54,101	382,882	356,339	1,844	9,351,168	10,146,333
2008	70,833	445,428	387,110	3,338	16,286,440	17,193,150
2009	73,364	507,507	412,923	4,492	20,596,105	21,594,390
2010	97,535	609,257	464,904	14,449	26,828,660	28,014,805
2011	137,004	267,113	497,645	36,580	30,769,674	31,708,016
2012	288,988	389,197	549,037	139,439	32,746,534	34,113,195
2013	200,564	294,238	550,845	178,326	36,909,385	38,133,358
2014	343,469	240,792	518,580	312,757	40,644,362	42,059,961
2015	349,600	414,289	561,915	410,318	45,165,341	46,901,462
2016	247,643	393,740	518,403	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	266,718	335,361	4,492,846	81,770,300	87,018,756
2020**	140,878	222,252	270,377	8,772,250	93,507,058	102,912,813
2021**	252,321	235,170	209,019	15,778,043	101,664,605	118,139,158
2022	470,827	226,941	191,136	24,131,729	113,347,551	138,368,184

Note: The REC Program tracks renewable generation in Texas, including non-ERCOT regions of Texas. Not all renewable is eligible for REC credit.

* Solar only includes the utility-scale solar PV projects.

** 2020 solar and 2021 wind, solar, hydro, and biomass REC data is updated due to ERCOT's data modification this year.



Note: In 2021, the unit for the annual electricity generation was revised from MWh to GWh.

Figure 3-3: Electricity Generation by Renewable Resources (ERCOT: 2001–2022 Annual)

4 Calculated NOx Reductions Potential from Energy Savings of New Construction in 2022

A complete reporting of the savings, using 2018 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[11]) and commercial buildings.

4.1 2022 Results for New Single-family Residential Construction

This section provides the potential electricity and natural gas savings and the associated NOx emissions reductions in 2022 using the 2018 base year which implemented the 2015 IECC for new single-family residences in Texas, including the 28 non-attainment counties as well as other counties in the ERCOT region[12]. To calculate the NOx emissions reductions, the following procedures were adopted. First, new construction activity was determined by county. To accomplish this, the number of 2022 building permits per county was obtained from the Real Estate Research Center at Texas A&M University (RERC 2023). 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 2022 Home Innovation Research Labs (HIRL) data[13] were used to determine the appropriate construction data corresponding to housing types. Then the NOx reductions potential from the electricity and natural gas savings in each county was calculated using the US EPA's 2018 eGRID database (USEPA 2018)[14].

In Table 7, the 2022 new single-family and 2015 IECC code-compliant building characteristics are shown for each county. The building characteristics reflect those published by the HIRL, ARI, and GAMA for Texas. The 2015 IECC code-compliant characteristics are the minimum building code characteristics required for each county for single-family residences (i.e., Type A.1). In Table 7, the rows are first sorted by the US EPA's non-attainment 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 7 represent the only changes that were made to the simulation to obtain the savings calculations. In cases where the 2022 values were more efficient than the 2015 IECC requirements, the 2022 values were used in the 2022 new single-family simulations. Otherwise, the 2015 IECC values were used in both simulations[15]. For example, in Collin County, according to the HIRL's survey data, the roof insulation is R-32.41, which is less than the code-required insulation of R-38. Therefore, R-38 was used in the 2022 simulation.

[11] The potential energy savings and NOx 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.
[12] The three new counties added in the 2003 Legislative session (i.e., Henderson, Hood, and Hunt) were included in the ERCOT region.
[13] 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
[14] This preliminary analysis does not include actual power transfers on the grid and assumes transmission and distribution losses of 5.25%. Counties were assigned to utility service districts as indicated.
[15] 2022 HIRL data and 2015 IECC are used for the 2022 new code-compliant simulations and 2018 HIRL data and 2015 IECC are used for the 2018 base-year simulations

In Table 8 the code-traceable simulation results for single-family residences are shown for each county. In a similar fashion to Table 7, Table 8 is first divided into the US EPA's non-attainment classification, 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[16] in the fourth column. In the fifth column, the total simulated energy use is listed if all-new construction had been built to 2018 base-year specifications. In the sixth column, the total county-wide energy use for the 2022 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 5.25% transmission and distribution loss are used in the 2022 report, which represents a fixed 1.0525 multiplier for the electricity use. In the eighth and ninth columns, the total annual 2018 base-year and 2022 natural gas use is shown for those residences that had natural gas-fired furnaces and domestic water heaters. Finally, in the tenth column, the total annual natural gas savings are shown for each county.

In Table 9, the annual electricity savings are assigned to CL Zones[17]. The total electricity savings for each CL Zone, as shown in Table 9, then entered into the bottom row of Table 10, which is the 2018 US EPA's eGRID database for Texas. Next, the county's NOx reductions (lbs) are calculated using the assigned 2018 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.

[16] The number of the new housing units in 2022 were obtained from the Real Estate Research Center at Texas A&M University.
[17] 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)

Table 7: 2022 and 2015 IECC Code-compliant Building Characteristics Used in the DOE-2 Simulations for New Single-family Residences

	County	Climate Zone	Division	2022 Average				2015 IECC			
			East or West	Glazing U-value (Btu/hr-ft^2-F)	SHGC	Roof Insulation (hr-ft^2-F/Btu)	Wall Insulation (hr-ft^2-F/Btu)	Glazing U-value (Btu/hr-ft^2-F)	SHGC	Roof Insulation (hr-ft^2-F/Btu)	Wall Insulation (hr-ft^2-F/Btu)
Non-attainment	BRAZORIA	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	CHAMBERS	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	FORT BEND	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	GALVESTON	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	HARRIS	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	COLLIN	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	DALLAS	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	DENTON	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	ELLIS	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	JOHNSON	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	KAUFMAN	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	PARKER	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	TARRANT	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	WISE	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	BEXAR	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	FREESTONE	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	HOWARD	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	RUSK	3	East Texas	0.39	0.53	28.6	16.2	0.35	0.25	38	20
	ANDERSON	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	EL PASO	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	Hutchinson	4	West Texas	0.39	0.53	32.4	16.2	0.35	0.40	49	20
	LIBERTY	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	MONTGOMERY	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	NAVARRO	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	Panola	3	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	ROCKWALL	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	TITUS	3	East Texas	0.39	0.53	28.6	16.2	0.35	0.25	38	20
	WALLER	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
Other ERCOT	ANDREWS	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	ANGELINA	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	ARANSAS	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	ARCHER	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	ATASCOSA	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	AUSTIN	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	BANDERA	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	BASTROP	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	BAYLOR	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	BEE	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	BELL	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	BEXAR	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	BLANCO	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	BORDEN	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	BOSQUE	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	BRAZORIA	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	BRAZOS	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	BREWSTER	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	BRISCOE	4	West Texas	0.39	0.53	32.4	16.2	0.35	0.4	49	20
	BROOKS	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	BROWN	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	BURLESON	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	BURNET	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	CALDWELL	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	CALHOUN	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	CALLAHAN	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	CAMERON	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	CHAMBERS	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	CHEROKEE	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	CHILDRESS	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	CLAY	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	COKE	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	COLEMAN	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	COLLIN	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	COLORADO	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	COMAL	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	COMANCHE	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	CONCHO	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	COOKE	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	CORYELL	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	COTTLE	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	CRANE	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	CROCKETT	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	CROSBY	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	CULBERSON	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20

Table 7: 2022 and 2015 IECC Code-compliant Building Characteristics Used in the DOE-2 Simulations for New Single-family Residences (Continued)

	County	Climate Zone	Division	2022 Average				2015 IECC			
			East or West	Glazing U-value (Btu/hr-ft^2-F)	SHGC	Roof Insulation (hr-ft^2-F/Btu)	Wall Insulation (hr-ft^2-F/Btu)	Glazing U-value (Btu/hr-ft^2-F)	SHGC	Roof Insulation (hr-ft^2-F/Btu)	Wall Insulation (hr-ft^2-F/Btu)
Other ERCOT	DALLAS	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	DAWSON	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	DE WITT	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	DELTA	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	DENTON	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	DICKENS	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	DIMMIT	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	DUVAL	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	EASTLAND	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	ECTOR	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	EDWARDS	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	ELLIS	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	ERATH	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	FALLS	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	FANNIN	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	FAYETTE	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	FISHER	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	FOARD	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	FORT BEND	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	FRANKLIN	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	FRIO	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	GALVESTON	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	GILLESPIE	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	GLASSCOCK	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	GOLIAD	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	GONZALES	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	GRAYSON	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	GREGG	3	East Texas	0.39	0.53	28.6	16.2	0.35	0.25	38	20
	GRIMES	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	GUADALUPE	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	HALL	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	HAMILTON	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	HARDEMAN	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	HARRIS	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	HARRISON	3	East Texas	0.39	0.53	28.6	16.2	0.35	0.25	38	20
	HASKELL	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	HAYS	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	HENDERSON	3	East Texas	0.39	0.53	28.6	16.2	0.35	0.25	38	20
	HIDALGO	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	HILL	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	HOOD	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	HOPKINS	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	HOUSTON	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	HUDSPETH	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	HUNT	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	IRION	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	JACK	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	JACKSON	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	JEFF DAVIS	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	JIM HOGG	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	JIM WELLS	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	JOHNSON	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	JONES	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	KARNES	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	KAUFMAN	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	KENDALL	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	KENEDY	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	KENT	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	KERR	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	KIMBLE	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	KING	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	KINNEY	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	KLEBERG	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	KNOX	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	LA SALLE	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	LAMAR	3	East Texas	0.39	0.53	28.6	16.2	0.35	0.25	38	20
	LAMPASAS	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	LAVACA	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	LEE	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	LEON	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	LIMESTONE	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	LIVE OAK	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	LLANO	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	LOVING	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20

Table 7: 2022 and 2015 IECC Code-compliant Building Characteristics Used in the DOE-2 Simulations for New Single-family Residences (Continued)

	County	Climate Zone	Division	2022 Average				2015 IECC			
			East or West	Glazing U-value (Btu/hr-ft^2-F)	SHGC	Roof Insulation (hr-ft^2-F/Btu)	Wall Insulation (hr-ft^2-F/Btu)	Glazing U-value (Btu/hr-ft^2-F)	SHGC	Roof Insulation (hr-ft^2-F/Btu)	Wall Insulation (hr-ft^2-F/Btu)
Other ERCOT	MADISON	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	MARTIN	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	MASON	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	MATAGORDA	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	MAVERICK	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	MCCULLOCH	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	MCLENNAN	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	MCMULLEN	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	MEDINA	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	MENARD	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	MIDLAND	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	MILAM	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	MILLS	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	MITCHELL	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	MONTAGUE	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	MONTGOMERY	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	MOTLEY	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	NACOGDOCHES	3	East Texas	0.39	0.53	28.6	16.2	0.35	0.25	38	20
	NOLAN	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	NUECES	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	PALO PINTO	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	PARKER	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	PECOS	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	PRESIDIO	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	RAINS	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	REAGAN	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	REAL	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	RED RIVER	3	East Texas	0.39	0.53	28.6	16.2	0.35	0.25	38	20
	REEVES	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	REFUGIO	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	ROBERTSON	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	ROCKWALL	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	RUNNELS	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	RUSK	3	East Texas	0.39	0.53	28.6	16.2	0.35	0.25	38	20
	SAN PATRICIO	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	SAN SABA	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	SCHLEICHER	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	SCURRY	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	SHACKELFORD	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	SMITH	3	East Texas	0.39	0.53	28.6	16.2	0.35	0.25	38	20
	SOMERVELL	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	STARR	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	STEPHENS	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	STERLING	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	STONEWALL	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	SUTTON	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	TARRANT	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	TAYLOR	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	TERRELL	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	THROCKMORTON	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	TOM GREEN	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	TRAVIS	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	UPSHUR	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	UPTON	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	UVALDE	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	VAL VERDE	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	VAN ZANDT	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	VICTORIA	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	WALLER	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	WARD	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	WASHINGTON	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	WEBB	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	WHARTON	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	WICHITA	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	WILBARGER	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	WILLACY	2	East Texas	0.39	0.53	28.6	16.2	0.4	0.25	38	13
	WILLIAMSON	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	WILSON	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	WINKLER	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	WISE	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	YOUNG	3	West Texas	0.39	0.53	32.4	16.2	0.35	0.25	38	20
	ZAPATA	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13
	ZAVALA	2	West Texas	0.39	0.53	32.4	16.2	0.4	0.25	38	13

Table 8: 2022 Annual Electricity and Natural Gas Savings from New Single-family Residences

2022 Summary TRY 2018

	County	Climate Zone	No. of Projected Units (2022)	2018 Base-year Total Annual Elec. Use (MWh/yr)	2022 Total Annual Elec. Use (MWh/yr)	Total Annual Elec. Savings (MWh/yr) w/ 5.25% of T&D Loss	2018 Base-year Total Annual NG Use (Therm/yr)	2022 Total Annual NG Use (Therm/yr)	Total Annual NG Savings (Therm/yr)
Non-attainment County	Brazoria	3	4,174	68,612	66,038	2,710	772,655	741,955	30,700
	Chambers	3	745	11,956	11,558	419	148,560	142,945	5,615
	Fort Bend	3	8,917	143,610	138,663	5,206	1,749,489	1,682,285	67,203
	Galveston	3	2,065	33,945	32,671	1,341	382,255	367,067	15,188
	Harris	2	18,156	292,405	282,333	10,600	3,562,152	3,425,320	136,833
	Collin	3	10,415	157,851	153,238	4,855	4,981,349	4,922,931	58,418
	Dallas	3	5,812	88,987	86,157	2,978	2,452,381	2,413,846	38,535
	Denton	3	8,102	124,102	120,164	4,145	3,404,538	3,348,221	56,317
	Ellis	3	2,330	35,674	34,540	1,194	983,147	967,698	15,448
	Johnson	2	1,292	19,782	19,153	662	545,161	536,595	8,566
	Kaufman	2	1,245	18,869	18,318	580	595,466	588,483	6,983
	Parker	2	750	11,156	10,830	343	318,101	312,888	5,213
	Tarrant	2	10,605	162,372	157,208	5,434	4,474,794	4,404,480	70,314
	Wise	3	198	3,001	2,913	92	94,701	93,590	1,111
	Bexar	2	5,596	83,856	81,100	2,900	1,581,279	1,542,440	38,839
	Freestone	2	9	141	136	5	3,477	3,420	57
	Howard	3	16	231	225	7	7,277	7,177	101
	Rusk	2	8	129	126	3	2,122	2,082	40
	Anderson	2	30	485	473	12	7,959	7,809	150
	El Paso	2	2,147	30,365	29,536	872	819,169	804,203	14,967
	Hutchinson	4	0	0	0	0	0	0	0
	Liberty	2	1,558	25,096	24,232	910	304,926	293,131	11,795
	Montgomery	3	11,820	190,363	183,806	6,901	2,319,048	2,229,967	89,082
	Navarro	3	607	9,490	9,148	359	234,501	230,683	3,818
	Panola	3	11	178	174	5	2,918	2,863	55
	Rockwall	2	2,497	37,845	36,739	1,164	1,194,280	1,180,274	14,006
	Titus	3	0	0	0	0	0	0	0
	Waller	2	90	1,449	1,400	53	17,658	16,979	678
Other ERCOT County	Andrews	3	24	347	338	10	10,916	10,765	151
	Angelina	2	141	2,280	2,224	58	37,407	36,701	705
	Aransas	2	197	3,254	3,130	130	32,789	31,365	1,423
	Archer	3	41	634	614	21	21,372	21,142	230
	Atascosa	2	68	1,019	986	35	19,239	18,765	474
	Austin	2	374	6,023	5,816	218	73,378	70,559	2,819
	Bandera	2	3	44	43	1	878	858	20
	Bastrop	2	1,853	30,369	29,454	964	370,546	360,531	10,014
	Baylor	3	0	0	0	0	0	0	0
	Bee	2	13	212	204	8	2,492	2,394	98
	Bell	2	2,343	36,630	35,312	1,387	905,165	890,428	14,736
	Blanco	3	24	351	340	12	6,376	6,209	167
	Borden	3	19	351	341	11	7,687	7,596	91
	Bosque	2	8	125	121	5	3,091	3,040	50
	Brazos	2	1,461	23,530	22,719	853	286,644	275,633	11,011
	Brewster	3	7	103	100	3	3,115	3,073	42
	Briscoe	4	7	107	104	3	4,156	4,153	3
	Brooks	2	0	0	0	0	0	0	0
	Brown	3	115	1,798	1,733	68	44,428	43,704	723
	Burleson	2	38	612	591	22	7,455	7,169	286
	Burnet	3	871	12,730	12,329	422	231,379	225,334	6,045
	Caldwell	3	285	4,165	4,033	138	75,815	73,829	1,986
	Calhoun	2	136	2,216	2,138	83	26,071	25,042	1,030
	Callahan	3	4	61	59	2	2,149	2,125	24
	Cameron	2	1,940	32,833	31,470	1,434	273,155	259,850	13,305
	Cherokee	2	47	760	741	19	12,469	12,234	235
	Childress	3	0	0	0	0	0	0	0
	Clay	3	8	124	120	4	4,170	4,125	45
	Coke	3	0	0	0	0	0	0	0
	Coleman	3	4	61	59	2	2,154	2,129	25
	Colorado	2	29	467	451	17	5,690	5,471	219
	Comal	3	2,536	38,002	36,753	1,314	716,605	699,004	17,601
	Comanche	3	2	31	30	1	773	760	13
	Concho	3	1	15	14	0	445	439	6
	Cooke	3	114	1,728	1,677	53	54,643	53,965	678
	Coryell	2	299	4,674	4,506	177	115,512	113,631	1,881
	Cottle	3	0	0	0	0	0	0	0
	Crane	3	0	0	0	0	0	0	0
	Crockett	3	19	279	271	8	8,455	8,342	113
	Crosby	3	3	55	54	2	1,214	1,199	14
	Culberson	3	8	113	110	3	3,049	2,994	56
	Dawson	3	1	34	33	1	719	709	10
	De Witt	2	22	358	346	13	4,217	4,051	167
	Delta	3	6	91	88	3	2,870	2,836	34
	Dickens	3	0	0	0	0	0	0	0
	Dimmit	2	0	0	0	0	0	0	0
	Duval	2	0	0	0	0	0	0	0
	Eastland	3	20	307	297	10	10,744	10,625	119
	Ector	3	888	12,839	12,488	370	403,898	398,313	5,585
	Edwards	2	0	0	0	0	0	0	0
	Erath	3	34	522	506	17	18,265	18,062	203
	Falls	2	4	63	60	2	1,545	1,520	25
	Fannin	3	63	955	927	29	30,198	29,823	375
	Fayette	2	14	225	218	8	2,747	2,641	106
	Fisher	3	0	0	0	0	0	0	0
	Foard	3	0	0	0	0	0	0	0
	Franklin	3	0	0	0	0	0	0	0

Table 8: 2022 Annual Electricity and Natural Gas Savings from New Single-family Residences (Continued)

2022 Summary TRY 2018									
	County	**Climate Zone**	**No. of Projected Units (2022)**	**2018 Base-year Total Annual Elec. Use (MWh/yr)**	**2022 Total Annual Elec. Use (MWh/yr)**	**Total Annual Elec. Savings (MWh/yr) w/ 5.25% of T&D Loss**	**2018 Base-year Total Annual NG Use (Therm/yr)**	**2022 Total Annual NG Use (Therm/yr)**	**Total Annual NG Savings (Therm/yr)**
	Frio	2	11	165	159	**6**	3,112	3,035	**77**
	Gillespie	3	86	1,257	1,217	**42**	22,846	22,249	**597**
	Glasscock	3	0	0	0	**0**	0	0	**0**
	Goliad	2	2	33	31	**1**	383	368	**15**
	Gonzales	2	8	120	116	**4**	2,261	2,205	**56**
	Grayson	3	2,378	36,037	34,983	**1,109**	1,139,840	1,125,694	**14,146**
	Grimes	2	115	1,852	1,788	**67**	22,563	21,696	**867**
	Guadalupe	2	1,566	23,466	22,695	**812**	442,509	431,641	**10,869**
	Hall	3	0	0	0	**0**	0	0	**0**
	Hamilton	3	16	250	241	**9**	6,181	6,081	**101**
	Hardeman	3	0	0	0	**0**	0	0	**0**
	Haskell	3	0	0	0	**0**	0	0	**0**
	Hays	2	4,809	70,285	68,071	**2,331**	1,277,499	1,244,122	**33,377**
	Henderson	2	300	4,876	4,761	**122**	84,170	82,529	**1,640**
	Hidalgo	2	3,862	65,362	62,649	**2,856**	543,775	517,288	**26,487**
	Hill	2	59	922	889	**35**	22,793	22,422	**371**
	Hopkins	3	36	546	530	**17**	17,218	17,016	**202**
	Houston	2	3	49	47	**1**	796	781	**15**
	Hood	2	119	1,770	1,718	**54**	50,679	49,889	**790**
	Hudspeth	3	0	0	0	**0**	0	0	**0**
	Hunt	2	696	10,547	10,239	**325**	333,612	329,471	**4,140**
	Irion	3	0	0	0	**0**	0	0	**0**
	Jack	3	8	123	119	**4**	4,298	4,250	**48**
	Jackson	2	4	65	63	**2**	767	737	**30**
	Jeff Davis	3	0	0	0	**0**	0	0	**0**
	Jim Hogg	2	0	0	0	**0**	0	0	**0**
	Jim Wells	2	6	99	95	**4**	999	955	**43**
	Jones	3	1	15	15	**0**	537	531	**6**
	Karnes	2	90	1,350	1,305	**47**	25,432	24,807	**625**
	Kendall	3	325	4,783	4,636	**156**	95,150	93,002	**2,148**
	Kenedy	2	0	0	0	**0**	0	0	**0**
	Kent	3	0	0	0	**0**	0	0	**0**
	Kerr	3	84	1,228	1,189	**41**	22,314	21,731	**583**
	Kimble	3	3	44	43	**1**	1,335	1,317	**18**
	King	3	0	0	0	**0**	0	0	**0**
	Kinney	2	0	0	0	**0**	0	0	**0**
	Kleberg	2	22	360	346	**14**	3,343	3,192	**151**
	Knox	3	0	0	0	**0**	0	0	**0**
	La Salle	2	0	0	0	**0**	0	0	**0**
	Lamar	3	57	922	899	**24**	15,063	14,778	**285**
	Lampasas	3	36	563	543	**21**	13,908	13,681	**226**
	Lavaca	2	11	194	186	**8**	2,737	2,640	**97**
Other ERCOT County	Lee	2	37	541	524	**18**	9,843	9,585	**258**
	Leon	2	0	0	0	**0**	0	0	**0**
	Limestone	2	12	188	181	**7**	4,636	4,560	**75**
	Live Oak	2	6	99	95	**4**	999	955	**43**
	Llano	3	272	3,975	3,850	**132**	72,256	70,368	**1,888**
	Loving	3	0	0	0	**0**	0	0	**0**
	Madison	2	5	81	78	**3**	981	943	**38**
	Martin	3	1	14	14	**0**	455	449	**6**
	Mason	3	2	29	28	**1**	531	517	**14**
	Matagorda	2	219	3,569	3,442	**133**	41,982	40,324	**1,658**
	Maverick	2	79	1,293	1,239	**57**	19,565	19,016	**548**
	Mcculloch	3	1	15	14	**0**	445	439	**6**
	Mclennan	2	916	14,320	13,805	**542**	353,876	348,114	**5,761**
	Mcmullen	2	0	0	0	**0**	0	0	**0**
	Medina	2	27	405	391	**14**	7,629	7,442	**187**
	Menard	3	0	0	0	**0**	0	0	**0**
	Midland	3	593	8,574	8,339	**247**	269,720	265,991	**3,730**
	Milam	2	36	563	543	**21**	13,908	13,681	**226**
	Mills	3	0	0	0	**0**	0	0	**0**
	Mitchell	3	1	15	15	**0**	537	531	**6**
	Montague	3	28	424	412	**13**	13,421	13,255	**167**
	Motley	3	0	0	0	**0**	0	0	**0**
	Nacogdoches	3	36	582	568	**15**	9,551	9,371	**180**
	Nolan	3	4	61	59	**2**	2,149	2,125	**24**
	Nueces	3	1,517	25,058	24,104	**1,004**	252,490	241,528	**10,962**
	Palo Pinto	3	54	829	803	**27**	29,008	28,687	**322**
	Pecos	3	11	162	157	**5**	4,895	4,830	**65**
	Potter	4	678	11,145	10,727	**440**	125,505	120,519	**4,987**
	Presidio	3	8	118	114	**4**	3,560	3,512	**48**
	Rains	3	9	136	132	**4**	4,305	4,254	**50**
	Reagan	3	1	14	14	**0**	456	449	**7**
	Real	2	0	0	0	**0**	0	0	**0**
	Red River	3	13	210	205	**5**	3,435	3,370	**65**
	Reeves	3	28	405	394	**12**	12,736	12,559	**176**
	Refugio	2	15	244	236	**9**	2,876	2,762	**114**
	Robertson	2	46	741	715	**27**	9,025	8,678	**347**
	Runnels	3	7	103	100	**3**	3,115	3,073	**42**
	San Patricio	2	378	6,244	6,006	**250**	62,914	60,183	**2,731**
	San Saba	3	0	0	0	**0**	0	0	**0**
	Schleicher	3	1	15	14	**0**	445	439	**6**
	Scurry	3	2	37	36	**1**	809	800	**10**
	Shackelford	3	0	0	0	**0**	0	0	**0**
	Smith	2	739	12,012	11,727	**300**	207,338	203,298	**4,041**

Table 8: 2022 Annual Electricity and Natural Gas Savings from New Single-family Residences (Continued)

2022 Summary TRY 2018

	County	Climate Zone	No. of Projected Units (2022)	2018 Base-year Total Annual Elec. Use (MWh/yr)	2022 Total Annual Elec. Use (MWh/yr)	Total Annual Elec. Savings (MWh/yr) w/ 5.25% of T&D Loss	2018 Base-year Total Annual NG Use (Therm/yr)	2022 Total Annual NG Use (Therm/yr)	Total Annual NG Savings (Therm/yr)
Other ERCOT County	Somervell	3	15	230	222	**8**	6,329	6,230	**99**
	Starr	2	0	0	0	**0**	0	0	**0**
	Stephens	3	6	92	89	**3**	3,223	3,187	**36**
	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	468	7,181	6,960	**233**	251,406	248,617	**2,789**
	Terrell	3	0	0	0	**0**	0	0	**0**
	Throckmorton	3	0	0	0	**0**	0	0	**0**
	Travis	3	7,579	110,770	107,280	**3,673**	2,013,342	1,960,740	**52,602**
	Tom Green	3	322	4,732	4,597	**142**	143,292	141,376	**1,916**
	Upton	3	1	14	14	**0**	456	449	**7**
	Uvalde	2	17	255	246	**9**	4,804	4,686	**118**
	Val Verde	2	131	1,963	1,899	**68**	37,017	36,108	**909**
	Van Zandt	3	34	515	500	**16**	16,262	16,071	**191**
	Victoria	2	202	3,292	3,175	**123**	38,723	37,194	**1,529**
	Ward	3	4	58	56	**2**	1,819	1,794	**25**
	Washington	2	181	2,915	2,815	**106**	35,512	34,148	**1,364**
	Webb	2	1,170	19,152	18,349	**846**	289,753	281,633	**8,120**
	Wharton	2	156	2,542	2,452	**95**	29,905	28,724	**1,181**
	Wichita	3	150	2,320	2,246	**78**	78,189	77,347	**841**
	Wilbarger	3	4	62	60	**2**	2,085	2,063	**22**
	Willacy	2	68	1,151	1,103	**50**	9,574	9,108	**466**
	Williamson	3	6,437	97,112	94,009	**3,266**	2,310,153	2,267,480	**42,673**
	Wilson	2	105	1,573	1,522	**54**	29,670	28,941	**729**
	Winkler	3	0	0	0	**0**	0	0	**0**
	Wood	3	25	419	408	**11**	7,217	7,086	**132**
	Young	3	5	77	74	**2**	2,686	2,656	**30**
	Zapata	2	0	0	0	**0**	0	0	**0**
	Zavala	2	2	33	31	**1**	495	481	**14**
Other TEXAS County	Armstrong	4	1	15	15	**0**	594	593	**0**
	Bailey	4	0	0	0	**0**	0	0	**0**
	Bowie	3	94	1,520	1,483	**39**	24,841	24,371	**470**
	Camp	3	8	129	126	**3**	2,114	2,074	**40**
	Carson	4	47	718	699	**20**	27,903	27,883	**20**
	Cass	3	6	97	95	**2**	1,586	1,556	**30**
	Castro	4	0	0	0	**0**	0	0	**0**
	Cochran	4	0	0	0	**0**	0	0	**0**
	Collingsworth	3	1	15	15	**1**	585	579	**6**
	Dallam	4	9	137	134	**4**	5,343	5,339	**4**
	Deaf Smith	4	34	519	506	**14**	20,185	20,171	**14**
	Donley	4	1	15	15	**0**	594	593	**0**
	Floyd	4	0	0	0	**0**	0	0	**0**
	Gaines	3	11	159	155	**5**	5,003	4,934	**69**
	Garza	3	0	0	0	**0**	0	0	**0**
	Gray	4	0	0	0	**0**	0	0	**0**
	Gregg	3	275	4,448	4,339	**114**	72,855	71,439	**1,416**
	Hale	4	29	443	431	**12**	17,217	17,205	**12**
	Hansford	4	1	15	15	**0**	594	593	**0**
	Hardin	2	508	8,153	7,882	**286**	101,217	97,371	**3,846**
	Harrison	2	66	1,067	1,041	**27**	17,485	17,145	**340**
	Hartley	4	0	0	0	**0**	0	0	**0**
	Hemphill	3	0	0	0	**0**	0	0	**0**
	Hockley	4	11	168	164	**5**	6,531	6,526	**5**
	Jasper	2	28	449	434	**16**	5,570	5,358	**212**
	Jefferson	2	650	10,433	10,086	**366**	129,303	124,382	**4,921**
	Lamb	4	0	0	0	**0**	0	0	**0**
	Lipscomb	4	0	0	0	**0**	0	0	**0**
	Lubbock	3	2,321	35,595	34,501	**1,152**	1,246,009	1,231,433	**14,576**
	Lynn	3	1	15	15	**0**	537	531	**6**
	Marion	3	5	81	79	**2**	1,325	1,299	**26**
	Moore	4	36	550	535	**15**	21,373	21,357	**15**
	Morris	3	1	16	16	**0**	264	259	**5**
	Newton	2	0	0	0	**0**	0	0	**0**
	Ochiltree	4	0	0	0	**0**	0	0	**0**
	Oldham	4	1	15	15	**0**	594	593	**0**
	Orange	2	180	2,889	2,793	**101**	35,807	34,444	**1,363**
	Parmer	4	1	15	15	**0**	594	593	**0**
	Polk	2	969	15,552	15,035	**545**	193,069	185,733	**7,336**
	Randall	4	91	1,390	1,353	**38**	54,025	53,987	**38**
	Roberts	4	0	0	0	**0**	0	0	**0**
	Sabine	3	1	16	16	**0**	265	260	**5**
	San Augustine	3	0	0	0	**0**	0	0	**0**
	San Jacinto	2	586	9,439	9,114	**342**	114,690	110,253	**4,436**
	Shelby	3	1	16	16	**0**	265	260	**5**
	Sherman	4	17	260	253	**7**	10,093	10,085	**7**
	Swisher	4	0	0	0	**0**	0	0	**0**
	Terry	3	2	31	30	**1**	1,074	1,061	**13**
	Trinity	2	4	64	62	**2**	850	818	**32**
	Tyler	2	4	64	62	**2**	797	767	**30**
	Upshur	3	2	34	33	**1**	577	567	**11**
	Walker	2	721	11,612	11,212	**421**	141,458	136,024	**5,434**
	Wheeler	3	0	0	0	**0**	0	0	**0**
	Yoakum	4	7	107	104	**3**	4,156	4,153	**3**
	TOTAL		**157,597**			**85,451**			**1,080,310**

Table 9: 2022 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) [2022-TRY 2018]
ERCOT	Houston (H)	20,328
	North (N)	27,690
	West (W)	1,231
	South (S)	23,980
SPP	-	1,878
SERC	-	9,471
WECC	-	872
Total		85,451

Table 10: 2022 Annual NOx Reductions from New Single-family Residences Using 2018 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	0.1445243	2937.91	0.0000183	0.51	0.0000009	0.00	0.0013540	32.47	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	2970.88	1.49
	Chambers	0.0232302	472.23	0.0000029	0.08	0.0000001	0.00	0.0002176	5.22	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	477.53	0.24
	Fort Bend	0.0925360	1881.08	0.0000117	0.33	0.0000006	0.00	0.0008669	20.79	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1902.20	0.95
	Galveston	0.0189140	384.49	0.0000024	0.07	0.0000001	0.00	0.0001772	4.25	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	388.80	0.19
	Harris	0.1374166	2793.42	0.0000174	0.48	0.0000008	0.00	0.0012874	30.87	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	2824.77	1.41
	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	0.0587430	556.36	0.0000000	0.00	556.36	0.28
	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
Beaumont/ Port Arthur Area	Hardin	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0027101	25.67	0.0000000	0.00	25.67	0.01
	Jefferson	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.9687861	9175.51	0.0000000	0.00	9175.51	4.59
	Orange	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.8865417	8396.56	0.0000000	0.00	8396.56	4.20
Dallas/ Fort Worth Area	Collin	0.0000743	1.51	0.0004556	12.62	0.0000220	0.03	0.0000046	0.11	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	14.26	0.01
	Dallas	0.0019090	38.81	0.0117105	324.26	0.0005656	0.70	0.0001195	2.87	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	366.63	0.18
	Denton	0.0066429	135.04	0.0407509	1128.40	0.0019683	2.42	0.0004158	9.97	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1275.83	0.64
	Henderson	0.0001509	3.07	0.0009255	25.63	0.0000447	0.06	0.0000094	0.23	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	28.98	0.01
	Hood	0.0008451	17.18	0.0051842	143.55	0.0002504	0.31	0.0000529	1.27	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	162.31	0.08
	Hunt	0.0000043	0.09	0.0000263	0.73	0.0000013	0.00	0.0000003	0.01	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.82	0.00
	Tarrant	0.0004188	8.51	0.0025693	71.14	0.0001241	0.15	0.0000262	0.63	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	80.44	0.04
	Ellis	0.0013349	27.14	0.0081890	226.75	0.0003955	0.49	0.0000835	2.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	256.38	0.13
	Johnson	0.0002010	4.09	0.0012332	34.15	0.0000596	0.07	0.0000126	0.30	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	38.61	0.02
	Kaufman	0.0034596	70.33	0.0212228	587.66	0.0010251	1.26	0.0002165	5.19	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	664.44	0.33
	Parker	0.0005940	12.07	0.0036438	100.90	0.0001760	0.22	0.0000372	0.89	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	114.08	0.06
	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	0.0031300	63.63	0.0192012	531.68	0.0009275	1.14	0.0001959	4.70	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	601.15	0.30
El Paso Area	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	1065.55	1065.55	0.53
San Antonio Area	Bexar	0.0253670	515.66	0.0017108	47.37	0.0000826	0.10	0.2025905	4858.15	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	5421.29	2.71
	Comal	0.0005285	10.74	0.0000356	0.99	0.0000017	0.00	0.0042210	101.22	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	112.95	0.06
	Guadalupe	0.0030546	62.09	0.0002060	5.70	0.0000100	0.01	0.0243949	584.99	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	652.80	0.33
	Wilson	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
Austin Area	Bastrop	0.0024800	50.41	0.0001673	4.63	0.0000081	0.01	0.0198060	474.95	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	530.01	0.27
	Caldwell	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	0.0004731	9.62	0.0000319	0.88	0.0000015	0.00	0.0037782	90.60	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	101.10	0.05
	Travis	0.0046184	93.88	0.0003115	8.62	0.0000150	0.02	0.0368846	884.50	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	987.03	0.49
	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
North East Texas Area	Gregg	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0053705	10.09	0.0000000	0.00	0.0000000	0.00	10.09	0.01
	Harrison	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.2702671	507.66	0.0000000	0.00	0.0000000	0.00	507.66	0.25
	Rusk	0.0322708	656.00	0.1979648	5481.66	0.0095620	11.77	0.0020197	48.43	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	6197.87	3.10
	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
	Upshur	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
Corpus Christi Area	Nueces	0.0042426	86.24	0.0002861	7.92	0.0000138	0.02	0.0338828	812.51	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	906.70	0.45
	San Patricio	0.0063692	129.47	0.0004296	11.89	0.0000207	0.03	0.0508668	1219.79	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1361.19	0.68
Victoria Area	Victoria	0.0016730	34.01	0.0001128	3.12	0.0000054	0.01	0.0133614	320.41	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	357.55	0.18
Other ERCOT Counties	Anderson	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
	Angelina	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
	Atascosa	0.0077084	156.70	0.0005199	14.40	0.0000251	0.03	0.0615620	1476.27	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1647.39	0.82
	Bell	0.0004444	9.03	0.0027262	75.49	0.0001317	0.16	0.0000278	0.67	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	85.35	0.04
	Bosque	0.0007214	14.67	0.0044257	122.55	0.0002138	0.26	0.0000452	1.08	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	138.56	0.07
	Brazos	0.0005654	11.49	0.0034687	96.05	0.0001675	0.21	0.0000354	0.85	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	108.60	0.05
	Calhoun	0.0111852	227.37	0.0007544	20.89	0.0000364	0.04	0.0893292	2142.13	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	2390.44	1.20
	Cameron	0.0000231	0.47	0.0000016	0.04	0.0000001	0.00	0.0001843	4.42	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	4.93	0.00
	Cherokee	0.0001844	3.75	0.0011310	31.32	0.0000546	0.07	0.0000115	0.28	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	35.41	0.02
	Coke	0.0000223	0.45	0.0001365	3.78	0.0231815	28.54	0.0000014	0.03	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	32.80	0.02
	Colorado	0.0016158	32.85	0.0001090	3.02	0.0000053	0.01	0.0129041	309.44	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	345.31	0.17
	Ector	0.0001338	2.72	0.0008206	22.72	0.1393442	171.53	0.0000084	0.20	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	197.17	0.10
	Fayette	0.0204274	415.25	0.0013777	38.15	0.0000665	0.08	0.1631405	3912.14	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	4365.62	2.18
	Freestone	0.0042261	85.91	0.0259247	717.86	0.0012522	1.54	0.0002645	6.34	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	811.65	0.41
	Frio	0.0097614	198.43	0.0006583	18.23	0.0000318	0.04	0.0779581	1869.45	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	2086.15	1.04
	Goliad	0.0077047	156.62	0.0005196	14.39	0.0000251	0.03	0.0615328	1475.57	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1646.61	0.82
	Grayson	0.0002857	5.81	0.0017525	48.53	0.0000846	0.10	0.0000179	0.43	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	54.87	0.03
	Grimes	0.0029942	60.87	0.0183678	508.61	0.0008872	1.09	0.0001874	4.49	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	575.06	0.29
	Hidalgo	0.0140830	286.28	0.0009498	26.30	0.0000459	0.06	0.1124720	2697.10	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	3009.73	1.50
	Hill	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
	Howard	0.0000467	0.95	0.0002865	7.93	0.0486558	59.89	0.0000029	0.07	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	68.85	0.03
	Lamar	0.0031379	63.79	0.0192492	533.01	0.0009298	1.14	0.0001964	4.71	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	602.65	0.30
	Limestone	0.0231674	470.95	0.1421203	3935.32	0.0068646	8.45	0.0014500	34.77	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	4449.49	2.22
	Llano	0.0001855	3.77	0.0000125	0.35	0.0000006	0.00	0.0014818	35.53	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	39.65	0.02
	McLennan	0.0043688	88.81	0.0268006	742.11	0.0012945	1.59	0.0002734	6.56	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	839.07	0.42
	Milam	0.0002486	5.05	0.0000168	0.46	0.0000008	0.00	0.0019850	47.60	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	53.12	0.03
	Mitchell	0.0000072	0.15	0.0000443	1.23	0.0075244	9.26	0.0000005	0.01	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	10.65	0.01
	Nacogdoches	0.0002714	5.52	0.0016647	46.10	0.0000804	0.10	0.0000170	0.41	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	52.12	0.03
	Nolan	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
	Palo Pinto	0.0010391	21.12	0.0063745	176.51	0.0003079	0.38	0.0000650	1.56	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	199.57	0.10
	Pecos	0.0000029	0.06	0.0000180	0.50	0.0030637	3.77	0.0000002	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	4.34	0.00
	Reagan	0.0000002	0.00	0.0000015	0.04	0.0002476	0.30	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.35	0.00
	Red River	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
	Robertson	0.0184177	374.40	0.1129830	3128.51	0.0054573	6.72	0.0011527	27.64	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	3537.26	1.77
	Scurry	0.0001246	2.53	0.0007646	21.17	0.1298311	159.82	0.0000078	0.19	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	183.71	0.09
	Titus	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
	Ward	0.0000206	0.42	0.0001265	3.50	0.0214790	26.44	0.0000013	0.03	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	30.39	0.02
	Webb	0.0000253	0.51	0.0000017	0.05	0.0000001	0.00	0.0002020	4.84	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	5.40	0.00
	Wharton	0.0006585	13.39	0.0000444	1.23	0.0000021	0.00	0.0052594	126.12	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	140.74	0.07
	Wichita	0.0000051	0.10	0.0000315	0.87	0.0053432	6.58	0.0000003	0.01	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	7.56	0.00
	Wilbarger	0.0008609	17.50	0.0052810	146.23	0.8967472	1103.85	0.0000539	1.29	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1268.87	0.63
	Wood	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
	Young	0.0000257	0.52	0.0001578	4.37	0.0267892	32.98	0.0000016	0.04	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	37.91	0.02
Other SPP Counties	Cass	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0127595	23.97	0.0000000	0.00	0.0000000	0.00	23.97	0.01
	Gaines	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
	Gray	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
	Hale	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0616792	115.86	0.0000000	0.00	0.0000000	0.00	115.86	0.06
	Hemphill	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0246062	46.22	0.0000000	0.00	0.0000000	0.00	46.22	0.02
	Hutchinson	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0134856	25.33	0.0000000	0.00	0.0000000	0.00	25.33	0.01
	Lamb	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.2117054	397.66	0.0000000	0.00	0.0000000	0.00	397.66	0.20
	Lubbock	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0695988	130.73	0.0000000	0.00	0.0000000	0.00	130.73	0.07
	Marion	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0272898	51.26	0.0000000	0.00	0.0000000	0.00	51.26	0.03
	Moore	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
	Morris	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0002270	0.43	0.0000000	0.00	0.0000000	0.00	0.43	0.00
	Potter	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.2710995	509.23	0.0000000	0.00	0.0000000	0.00	509.23	0.25
	Titus	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
	Yoakum	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0438855	82.43	0.0000000	0.00	0.0000000	0.00	82.43	0.04
Other SERC Counties	Jasper	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
	Newton	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0870000	823.99	0.0000000	0.00	823.99	0.41
	San Jacinto	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0072219	68.40	0.0000000	0.00	68.40	0.03
	Tyler	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
	Total	**0.6511639**	**13236.93**	**0.6960448**	**19273.53**	**1.3354567**	**1643.88**	**0.9887171**	**23709.60**	**1.3648074**	**2563.62**	**2.0110028**	**19046.49**	**1.2223686**	**1065.55**	**80539.59**	**40.27**
Energy Savings (MWh)		20,328		27,690		1,231		23,980		1,878		9,471		872			

4.2 2022 Results for New Multi-family Residential Construction

This section provides the potential electricity and natural gas savings and the associated NOx emissions reductions in 2022 using the 2018 base year which implemented the 2015 IECC for new multi-family residences in the 28 non-attainment counties as well as other counties in the ERCOT region[18]. To calculate the NOx emissions reductions, the following procedures were adopted. First, new construction activity was determined by county. To accomplish this, the number of 2022 building permits per county was obtained from the Real Estate Research Center at Texas A&M University (RERC 2023). 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 2022 HIRL's survey data[19] were used to determine the appropriate construction data corresponding to housing types. Then, the NOx reductions potential from the electricity and natural gas savings in each county was calculated using the US EPA's 2018 eGRID database[20].

In Table 11, the 2022 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 11, the rows are first sorted by the US EPA's non-attainment 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 11 represent the changes for building envelope that were made to the simulations to obtain the savings calculations. In cases where the 2022 new multi-family values were more efficient than the 2015 IECC requirements, the 2022 new multi-family values were used in 2022 new multi-family simulations. Otherwise, the 2015 IECC values were used in both simulations. For the 2021 new multi-family simulations, the more efficient values from 2022 HIRL data and 2015 IECC were applied. Similarly, for the base-year simulations, the more efficient values from 2018 HIRL data and 2015 IECC were used.

In Table 12, the code-traceable simulation results for multi-family residences are shown for each county. In a similar fashion to Table 11, Table 12 is first divided into the US EPA's non-attainment classification, 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[21] in the fourth column. In the fifth column, the total simulated energy use is listed if all-new construction had been built to 2018 base-year specifications. In the sixth column, the total county-wide energy use for the 2022 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 5.25% transmission and distribution loss is used, which represents a fixed 1.0525 multiplier for electricity use. In the eighth and ninth columns, the total annual 2018 base-year and 2022 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 12 are assigned to CL Zones[22] in a similar fashion to the single-family residential assignments. The total electricity savings for each CL Zone, as shown in Table 13, are then entered into the bottom row of Table 14, the 2018 US EPA's eGRID database for Texas. Next, the county's NOx reductions (lbs) are calculated using the assigned 2018 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

---

[19] The three new counties added in the 2003 Legislative session (i.e., Henderson, Hood, and Hunt) were included in the ERCOT region.
[20] The NAHB Research Center announced that it has changed its name to Home Innovation Research Labs (HIRL). See more at: http://www.homeinnovation.com
[21] This analysis assumes transmission and distribution losses of 5.25%. Counties were assigned to utility service districts as indicated.
[22] The number of the new housing units in 2022 were obtained from the Real Estate Research Center at Texas A&M University.
[23] 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).

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 11: 2022 and 2015 IECC Code-compliant Building Characteristics Used in the DOE-2 Simulations for New Multi-family Residences

	County	Climate Zone	Division	2022 Average				2015 IECC			
			East or West	Glazing U-value (Btu/hr-ft^2-F)	SHGC	Roof Insulation (hr-ft^2-F/Btu)	Wall Insulation (hr-ft^2-F/Btu)	Glazing U-value (Btu/hr-ft^2-F)	SHGC	Roof Insulation (hr-ft^2-F/Btu)	Wall Insulation (hr-ft^2-F/Btu)
Non-attainment	BRAZORIA	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	CHAMBERS	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	FORT BEND	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	GALVESTON	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	HARRIS	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	COLLIN	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	DALLAS	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	DENTON	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	ELLIS	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	JOHNSON	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	KAUFMAN	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	PARKER	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	TARRANT	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	WISE	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	BEXAR	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	FREESTONE	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	HOWARD	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	RUSK	3	East Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	ANDERSON	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	EL PASO	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	Hutchinson	4	West Texas	0.39	0.53	35.2	15.5	0.35	0.40	49	20
	LIBERTY	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	MONTGOMERY	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	NAVARRO	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	Panola	3	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	ROCKWALL	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	TITUS	3	East Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	WALLER	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
Other ERCOT	ANDREWS	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	ANGELINA	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	ARANSAS	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	ARCHER	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	ATASCOSA	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	AUSTIN	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	BANDERA	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	BASTROP	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	BAYLOR	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	BEE	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	BELL	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	BEXAR	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	BLANCO	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	BORDEN	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	BOSQUE	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	BRAZORIA	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	BRAZOS	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	BREWSTER	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	BRISCOE	4	West Texas	0.39	0.53	35.2	15.5	0.35	0.4	49	20
	BROOKS	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	BROWN	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	BURLESON	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	BURNET	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	CALDWELL	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	CALHOUN	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	CALLAHAN	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	CAMERON	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	CHAMBERS	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	CHEROKEE	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	CHILDRESS	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	CLAY	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	COKE	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	COLEMAN	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	COLLIN	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	COLORADO	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	COMAL	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	COMANCHE	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	CONCHO	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	COOKE	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	CORYELL	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	COTTLE	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	CRANE	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	CROCKETT	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	CROSBY	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	CULBERSON	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20

Table 11: 2022 and 2015 IECC Code-compliant Building Characteristics Used in the DOE-2 Simulations for New Multi-family Residences (Continued)

	County	Climate Zone	Division	2022 Average				2015 IECC			
			East or West	Glazing U-value (Btu/hr-ft^2-F)	SHGC	Roof Insulation (hr-ft^2-F/Btu)	Wall Insulation (hr-ft^2-F/Btu)	Glazing U-value (Btu/hr-ft^2-F)	SHGC	Roof Insulation (hr-ft^2-F/Btu)	Wall Insulation (hr-ft^2-F/Btu)
Other ERCOT	DALLAS	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	DAWSON	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	DE WITT	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	DELTA	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	DENTON	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	DICKENS	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	DIMMIT	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	DUVAL	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	EASTLAND	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	ECTOR	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	EDWARDS	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	ELLIS	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	ERATH	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	FALLS	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	FANNIN	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	FAYETTE	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	FISHER	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	FOARD	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	FORT BEND	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	FRANKLIN	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	FRIO	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	GALVESTON	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	GILLESPIE	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	GLASSCOCK	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	GOLIAD	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	GONZALES	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	GRAYSON	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	GREGG	3	East Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	GRIMES	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	GUADALUPE	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	HALL	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	HAMILTON	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	HARDEMAN	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	HARRIS	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	HARRISON	3	East Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	HASKELL	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	HAYS	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	HENDERSON	3	East Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	HIDALGO	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	HILL	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	HOOD	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	HOPKINS	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	HOUSTON	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	HUDSPETH	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	HUNT	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	IRION	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	JACK	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	JACKSON	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	JEFF DAVIS	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	JIM HOGG	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	JIM WELLS	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	JOHNSON	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	JONES	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	KARNES	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	KAUFMAN	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	KENDALL	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	KENEDY	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	KENT	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	KERR	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	KIMBLE	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	KING	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	KINNEY	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	KLEBERG	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	KNOX	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	LA SALLE	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	LAMAR	3	East Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	LAMPASAS	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	LAVACA	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	LEE	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	LEON	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	LIMESTONE	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	LIVE OAK	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	LLANO	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	LOVING	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20

Table 11: 2022 and 2015 IECC Code-compliant Building Characteristics Used in the DOE-2 Simulations for New Multi-family Residences (Continued)

	County	Climate Zone	Division	2022 Average				2015 IECC			
			East or West	Glazing U-value (Btu/hr-ft^2-F)	SHGC	Roof Insulation (hr-ft^2-F/Btu)	Wall Insulation (hr-ft^2-F/Btu)	Glazing U-value (Btu/hr-ft^2-F)	SHGC	Roof Insulation (hr-ft^2-F/Btu)	Wall Insulation (hr-ft^2-F/Btu)
Other ERCOT	MADISON	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	MARTIN	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	MASON	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	MATAGORDA	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	MAVERICK	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	MCCULLOCH	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	MCLENNAN	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	MCMULLEN	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	MEDINA	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	MENARD	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	MIDLAND	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	MILAM	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	MILLS	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	MITCHELL	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	MONTAGUE	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	MONTGOMERY	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	MOTLEY	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	NACOGDOCHES	3	East Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	NAVARRO	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	NOLAN	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	NUECES	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	PALO PINTO	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	PARKER	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	PECOS	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	PRESIDIO	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	RAINS	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	REAGAN	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	REAL	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	RED RIVER	3	East Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	REEVES	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	REFUGIO	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	ROBERTSON	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	ROCKWALL	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	RUNNELS	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	SAN PATRICIO	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	SAN SABA	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	SCHLEICHER	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	SCURRY	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	SHACKELFORD	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	SMITH	3	East Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	SOMERVELL	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	STARR	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	STEPHENS	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	STERLING	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	STONEWALL	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	SUTTON	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	TARRANT	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	TAYLOR	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	TERRELL	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	THROCKMORTON	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	TOM GREEN	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	TRAVIS	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	UPSHUR	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	UPTON	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	UVALDE	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	VAL VERDE	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	VAN ZANDT	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	VICTORIA	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	WALLER	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	WARD	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	WASHINGTON	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	WEBB	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	WHARTON	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	WICHITA	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	WILBARGER	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	WILLACY	2	East Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	WILLIAMSON	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	WILSON	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	WINKLER	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	WISE	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	YOUNG	3	West Texas	0.39	0.53	35.2	15.5	0.35	0.25	38	20
	ZAPATA	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13
	ZAVALA	2	West Texas	0.39	0.53	35.2	15.5	0.4	0.25	38	13

Table 12: 2022 Annual Electricity and Natural Gas Savings from New Multi-family Residences

2022 Summary TRY 2018									
	County	Climate Zone	No. of Projected Units (2022)	2018 Base-year Total Annual Elec. Use (MWh/yr)	2022 Total Annual Elec. Use (MWh/yr)	Total Annual Elec. Savings (MWh/yr) w/ 5.25% of T&D Loss	2018 Base-year Total Annual NG Use (Therm/yr)	2022 Total Annual NG Use (Therm/yr)	Total Annual NG Savings (Therm/yr)
Non-attainment County	Brazoria	2	4	385	374	11.93	2,671	2,629	42.03
	Chambers	2	0	0	0	0.00	0	0	0.00
	Fort Bend	2	3,517	335,306	326,026	9,767.77	2,460,643	2,415,266	45,376.73
	Galveston	2	364	35,052	34,021	1,085.24	243,033	239,208	3,824.28
	Harris	2	20,631	1,966,932	1,912,492	57,298.50	14,434,326	14,168,142	266,183.47
	Collin	2	8,746	843,451	822,438	22,115.70	9,507,167	9,281,982	225,185.29
	Dallas	2	11,470	1,108,204	1,079,278	30,444.71	11,123,304	10,872,510	250,793.84
	Denton	2	4,160	402,249	391,728	11,072.80	4,024,948	3,933,059	91,889.34
	Ellis	3	408	39,420	38,391	1,082.95	395,668	386,747	8,921.00
	Johnson	3	1,000	96,618	94,096	2,654.29	969,774	947,908	21,865.20
	Kaufman	2	396	38,190	37,238	1,001.35	430,464	420,268	10,195.90
	Parker	2	154	14,648	14,295	371.47	148,084	144,826	3,258.54
	Tarrant	3	7,585	732,844	713,716	20,132.79	7,355,733	7,189,886	165,847.54
	Wise	3	243	23,435	22,851	614.47	264,148	257,892	6,256.58
	Bexar	3	11,796	1,136,524	1,104,156	34,067.45	8,397,420	8,234,367	163,053.18
	Freestone	2	0	0	0	0.00	0	0	0.00
	Howard	3	0	0	0	0.00	0	0	0.00
	Rusk	2	0	0	0	0.00	0	0	0.00
	Anderson	2	157	14,663	14,329	351.22	138,065	135,131	2,934.17
	El Paso	3	319	29,504	28,841	698.38	276,861	271,074	5,786.98
	Hutchinson	4	0	0	0	0.00	0	0	0.00
	Liberty	3	0	0	0	0.00	0	0	0.00
	Montgomery	3	3,370	321,291	312,399	9,359.50	2,357,795	2,314,315	43,480.12
	Navarro	3	0	0	0	0.00	0	0	0.00
	Panola	3	0	0	0	0.00	0	0	0.00
	Rockwall	2	22	2,122	2,069	55.63	23,915	23,348	566.44
	Titus	3	16	1,543	1,505	40.46	17,392	16,981	411.96
	Waller	2	141	13,443	13,071	391.60	98,650	96,830	1,819.20
Other ERCOT County	Andrews	3	0	0	0	0.00	0	0	0.00
	Angelina	2	6	560	548	13.42	5,276	5,164	112.13
	Aransas	2	0	0	0	0.00	0	0	0.00
	Archer	3	0	0	0	0.00	0	0	0.00
	Atascosa	2	2	194	188	6.46	1,434	1,404	30.38
	Austin	2	0	0	0	0.00	0	0	0.00
	Bandera	2	0	0	0	0.00	0	0	0.00
	Bastrop	3	26	2,472	2,404	71.57	17,741	17,437	304.05
	Baylor	3	0	0	0	0.00	0	0	0.00
	Bee	2	0	0	0	0.00	0	0	0.00
	Bell	2	1,229	121,656	117,606	4,262.77	1,121,054	1,089,961	31,093.78
	Blanco	3	0	0	0	0.00	0	0	0.00
	Borden	3	0	0	0	0.00	0	0	0.00
	Bosque	2	2	198	191	6.94	1,824	1,774	50.60
	Brazos	2	230	21,928	21,321	638.78	160,918	157,950	2,967.49
	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	4	396	383	13.87	3,649	3,547	101.20
	Burleson	2	0	0	0	0.00	0	0	0.00
	Burnet	3	6	571	555	16.54	4,092	4,024	68.50
	Caldwell	3	53	5,039	4,901	145.89	0	0	0.00
	Calhoun	2	0	0	0	0.00	0	0	0.00
	Callahan	3	0	0	0	0.00	0	0	0.00
	Cameron	2	569	57,331	55,232	2,209.72	329,477	324,593	4,884.22
	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	0	0	0	0.00	0	0	0.00
	Comal	3	1,835	176,799	171,764	5,299.57	1,306,313	1,280,948	25,364.75
	Comanche	3	2	198	191	6.94	1,824	1,774	50.60
	Concho	3	0	0	0	0.00	0	0	0.00
	Cooke	3	0	0	0	0.00	0	0	0.00
	Coryell	2	110	10,889	10,526	381.53	100,338	97,555	2,783.01
	Cottle	3	0	0	0	0.00	0	0	0.00
	Crane	3	0	0	0	0.00	0	0	0.00
	Crockett	3	0	0	0	0.00	0	0	0.00
	Crosby	3	0	0	0	0.00	0	0	0.00
	Culberson	3	10	932	908	25.35	8,772	8,551	221.24
	Dawson	3	0	0	0	0.00	0	0	0.00
	De Witt	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	5	489	474	14.94	6,075	5,888	186.77
	Ector	3	0	0	0	0.00	0	0	0.00
	Edwards	2	0	0	0	0.00	0	0	0.00
	Erath	3	178	17,396	16,891	531.99	216,258	209,609	6,648.99
	Falls	2	0	0	0	0.00	0	0	0.00
	Fannin	3	17	1,639	1,598	42.92	18,510	18,062	447.99
	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

Table 12: 2022 Annual Electricity and Natural Gas Savings from New Multi-family Residences (Continued)

2022 Summary TRY 2018									
	County	**Climate Zone**	**No. of Projected Units (2022)**	**2018 Base-year Total Annual Elec. Use (MWh/yr)**	**2022 Total Annual Elec. Use (MWh/yr)**	**Total Annual Elec. Savings (MWh/yr) w/ 5.25% of T&D Loss**	**2018 Base-year Total Annual NG Use (Therm/yr)**	**2022 Total Annual NG Use (Therm/yr)**	**Total Annual NG Savings (Therm/yr)**
	Frio	2	0	0	0	0.00	0	0	0.00
	Gillespie	3	2	190	185	5.51	1,364	1,341	22.83
	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	722	69,611	67,880	1,822.66	786,130	767,104	19,026.31
	Grimes	2	4	381	371	11.11	2,799	2,747	51.61
	Guadalupe	3	478	46,054	44,743	1,380.49	340,282	333,675	6,607.28
	Hall	3	0	0	0	0.00	0	0	0.00
	Hamilton	3	6	594	574	20.81	5,473	5,321	151.80
	Hardeman	3	0	0	0	0.00	0	0	0.00
	Haskell	3	0	0	0	0.00	0	0	0.00
	Hays	3	729	69,324	67,415	2,009.52	497,235	488,913	8,322.22
	Henderson	2	254	23,751	23,218	560.09	233,370	228,317	5,053.78
	Hidalgo	2	2,064	207,964	200,348	8,015.56	1,195,149	1,177,432	17,717.11
	Hill	2	2	198	191	6.94	1,824	1,774	50.60
	Hood	3	0	0	0	0.00	0	0	0.00
	Hopkins	3	12	1,157	1,128	30.34	13,044	12,735	308.97
	Houston	2	0	0	0	0.00	0	0	0.00
	Hudspeth	3	0	0	0	0.00	0	0	0.00
	Hunt	2	65	6,267	6,111	164.09	70,774	69,061	1,712.89
	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	81	7,703	7,491	223.28	55,248	54,324	924.69
	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	5	493	476	17.83	3,020	2,976	43.62
	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	34	3,279	3,197	85.97	36,959	36,084	875.41
	Lampasas	3	0	0	0	0.00	0	0	0.00
Other ERCOT County	Lavaca	2	0	0	0	0.00	0	0	0.00
	Lee	2	0	0	0	0.00	0	0	0.00
	Leon	2	0	0	0	0.00	0	0	0.00
	Limestone	2	8	792	766	27.75	7,297	7,095	202.40
	Live Oak	2	0	0	0	0.00	0	0	0.00
	Llano	3	8	761	740	22.05	5,457	5,365	91.33
	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	6	578	562	17.42	4,185	4,112	73.45
	Maverick	2	22	2,155	2,088	69.88	14,040	13,822	217.63
	Mcculloch	3	0	0	0	0.00	0	0	0.00
	Mclennan	2	429	42,466	41,052	1,487.98	391,320	380,466	10,853.73
	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	36	3,471	3,385	90.88	39,198	38,249	948.68
	Motley	3	0	0	0	0.00	0	0	0.00
	Nacogdoches	3	0	0	0	0.00	0	0	0.00
	Nolan	3	0	0	0	0.00	0	0	0.00
	Nueces	2	5	490	475	15.88	3,191	3,141	49.46
	Palo Pinto	3	0	0	0	0.00	0	0	0.00
	Pecos	3	15	1,438	1,398	41.62	15,459	15,030	428.99
	Potter	4	80	7,704	7,477	238.51	53,414	52,573	840.50
	Presidio	3	0	0	0	0.00	0	0	0.00
	Rains	3	0	0	0	0.00	0	0	0.00
	Reagan	3	0	0	0	0.00	0	0	0.00
	Real	2	0	0	0	0.00	0	0	0.00
	Red River	3	0	0	0	0.00	0	0	0.00
	Reeves	3	0	0	0	0.00	0	0	0.00
	Refugio	2	0	0	0	0.00	0	0	0.00
	Robertson	2	0	0	0	0.00	0	0	0.00
	Runnels	3	0	0	0	0.00	0	0	0.00
	San Patricio	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
	Smith	3	153	14,306	13,986	337.37	140,574	137,529	3,044.21

Table 12: 2022 Annual Electricity and Natural Gas Savings from New Multi-family Residences (Continued)

2022 Summary TRY 2018									
	County	Climate Zone	No. of Projected Units (2022)	2018 Base-year Total Annual Elec. Use (MWh/yr)	2022 Total Annual Elec. Use (MWh/yr)	Total Annual Elec. Savings (MWh/yr) w/ 5.25% of T&D Loss	2018 Base-year Total Annual NG Use (Therm/yr)	2022 Total Annual NG Use (Therm/yr)	Total Annual NG Savings (Therm/yr)
Other ERCOT County	Somervell	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	326	31,860	30,935	974.32	396,068	383,891	12,177.36
	Terrell	3	0	0	0	0.00	0	0	0.00
	Throckmorton	3	0	0	0	0.00	0	0	0.00
	Tom Green	3	0	0	0	0.00	0	0	0.00
	Travis	3	18,291	1,739,385	1,691,480	50,420.03	12,475,890	12,267,081	208,808.89
	Upton	3	0	0	0	0.00	0	0	0.00
	Uvalde	2	13	1,253	1,217	37.54	9,255	9,075	179.70
	Val Verde	2	12	1,156	1,123	34.66	8,543	8,377	165.87
	Van Zandt	3	30	2,893	2,821	75.86	32,611	31,838	772.42
	Victoria	2	0	0	0	0.00	0	0	0.00
	Ward	3	0	0	0	0.00	0	0	0.00
	Washington	2	0	0	0	0.00	0	0	0.00
	Webb	2	102	9,990	9,682	324.01	65,094	64,085	1,009.03
	Wharton	2	4	386	375	11.62	2,790	2,741	48.97
	Wichita	3	216	21,158	20,536	654.53	254,072	246,423	7,648.94
	Wilbarger	3	64	6,269	6,085	193.94	75,281	73,014	2,266.35
	Willacy	2	0	0	0	0.00	0	0	0.00
	Williamson	2	3,572	344,874	335,483	9,884.28	3,022,085	2,952,407	69,677.60
	Wilson	2	2	193	187	5.78	1,424	1,396	27.65
	Winkler	3	0	0	0	0.00	0	0	0.00
	Wood	3	0	0	0	0.00	0	0	0.00
	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 County	Armstrong	4	0	0	0	0.00	0	0	0.00
	Bailey	4	0	0	0	0.00	0	0	0.00
	Bowie	3	15	0	0	0.00	0	0	0.00
	Camp	3	0	0	0	0.00	0	0	0.00
	Carson	4	0	0	0	0.00	0	0	0.00
	Cass	3	0	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	20	1,944	1,900	46.26	26,573	26,246	326.74
	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
	Gregg	2	162	15,138	14,792	364.16	142,266	139,346	2,920.73
	Hale	4	0	0	0	0.00	0	0	0.00
	Hansford	4	0	0	0	0.00	0	0	0.00
	Hardin	2	0	0	0	0.00	0	0	0.00
	Harrison	3	232	21,679	21,183	521.60	203,740	199,557	4,182.77
	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
	Jasper	2	4	381	371	10.89	2,844	2,791	52.47
	Jefferson	2	14	1,333	1,297	38.10	9,954	9,768	185.85
	Lamb	4	0	0	0	0.00	0	0	0.00
	Lipscomb	4	0	0	0	0.00	0	0	0.00
	Lubbock	3	954	93,191	90,496	2,836.66	1,158,417	1,122,995	35,422.29
	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
	Orange	2	16	1,524	1,483	43.55	11,376	11,166	209.87
	Parmer	4	0	0	0	0.00	0	0	0.00
	Polk	2	18	1,714	1,668	48.95	12,803	12,561	241.79
	Randall	4	84	8,163	7,979	194.30	111,606	110,234	1,372.31
	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	0	0	0	0.00	0	0	0.00
	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
	Upshur	3	0	0	0	0.00	0	0	0.00
	Walker	2	94	8,962	8,714	261.07	65,766	64,554	1,212.80
	Wheeler	3	0	0	0	0.00	0	0	0.00
	Yoakum	4	0	0	0	0.00	0	0	0.00
	TOTAL		**108,248**			**299,993**			**1,819,537**

Table 13: 2022 Totalized Annual Electricity Savings by CL Zone from New Multi-family Residences

Electric Power Market	CL Zone	Total Electricity Savings by CL Zone (MWh) [2022-TRY 2018]
ERCOT	Houston (H)	68,555
	North (N)	100,820
	West (W)	1,951
	South (S)	114,313
SPP	-	4,155
SERC	-	9,501
WECC	-	698
Total		299,993

Table 14: 2022 Annual NOx Reductions from New Multi-family Residences Using 2018 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	0.1445243	9907.87	0.0000183	1.85	0.0000009	0.00	0.0013540	154.78	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	10064.50	5.03
	Chambers	0.0232302	1592.55	0.0000029	0.30	0.0000001	0.00	0.0002176	24.88	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1617.72	0.81
	Fort Bend	0.0925360	6343.81	0.0000117	1.18	0.0000006	0.00	0.0008669	99.10	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	6444.10	3.22
	Galveston	0.0189140	1296.65	0.0000024	0.24	0.0000001	0.00	0.0001772	20.26	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1317.15	0.66
	Harris	0.1374166	9420.60	0.0000174	1.76	0.0000008	0.00	0.0012874	147.17	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	9569.52	4.78
	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	0.0587430	558.12	0.0000000	0.00	558.12	0.28
	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
Beaumont/ Port Arthur Area	Hardin	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0027101	25.75	0.0000000	0.00	25.75	0.01
	Jefferson	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.9687861	9204.43	0.0000000	0.00	9204.43	4.60
	Orange	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.8865417	8423.02	0.0000000	0.00	8423.02	4.21
Dallas/ Fort Worth Area	Collin	0.0000743	5.09	0.0004556	45.94	0.0000220	0.04	0.0000046	0.53	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	51.60	0.03
	Dallas	0.0019090	130.87	0.0117105	1180.65	0.0005656	1.10	0.0001195	13.66	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1326.28	0.66
	Denton	0.0066429	455.41	0.0407509	4108.50	0.0019683	3.84	0.0004158	47.53	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	4615.27	2.31
	Henderson	0.0001509	10.34	0.0009255	93.31	0.0000447	0.09	0.0000094	1.08	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	104.82	0.05
	Hood	0.0008451	57.94	0.0051842	522.67	0.0002504	0.49	0.0000529	6.05	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	587.14	0.29
	Hunt	0.0000043	0.29	0.0000263	2.65	0.0000013	0.00	0.0000003	0.03	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	2.98	0.00
	Tarrant	0.0004188	28.71	0.0025693	259.04	0.0001241	0.24	0.0000262	3.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	290.99	0.15
	Ellis	0.0013349	91.51	0.0081890	825.61	0.0003955	0.77	0.0000835	9.55	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	927.45	0.46
	Johnson	0.0002010	13.78	0.0012332	124.34	0.0000596	0.12	0.0000126	1.44	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	139.67	0.07
	Kaufman	0.0034596	237.17	0.0212228	2139.68	0.0010251	2.00	0.0002165	24.75	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	2403.60	1.20
	Parker	0.0005940	40.72	0.0036438	367.37	0.0001760	0.34	0.0000372	4.25	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	412.68	0.21
	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	0.0031300	214.58	0.0192012	1935.87	0.0009275	1.81	0.0001959	22.39	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	2174.65	1.09
El Paso Area	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	853.67	853.67	0.43
San Antonio Area	Bexar	0.0253670	1739.04	0.0017108	172.48	0.0000826	0.16	0.2025905	23158.63	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	25070.32	12.54
	Comal	0.0005285	36.23	0.0000356	3.59	0.0000017	0.00	0.0042210	482.51	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	522.34	0.26
	Guadalupe	0.0030546	209.41	0.0002060	20.77	0.0000100	0.02	0.0243949	2788.64	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	3018.83	1.51
	Wilson	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
Austin Area	Bastrop	0.0024800	170.02	0.0001673	16.86	0.0000081	0.02	0.0198060	2264.08	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	2450.97	1.23
	Caldwell	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	0.0004731	32.43	0.0000319	3.22	0.0000015	0.00	0.0037782	431.90	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	467.55	0.23
	Travis	0.0046184	316.62	0.0003115	31.40	0.0000150	0.03	0.0368846	4216.38	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	4564.43	2.28
	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
North East Texas Area	Gregg	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0053705	22.32	0.0000000	0.00	0.0000000	0.00	22.32	0.01
	Harrison	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.2702671	1123.02	0.0000000	0.00	0.0000000	0.00	1123.02	0.56
	Rusk	0.0322708	2212.32	0.1979648	19958.80	0.0095620	18.66	0.0020197	230.88	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	22420.65	11.21
	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
	Upshur	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
Corpus Christi Area	Nueces	0.0042426	290.85	0.0002861	28.85	0.0000138	0.03	0.0338828	3873.23	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	4192.95	2.10
	San Patricio	0.0063692	436.64	0.0004296	43.31	0.0000207	0.04	0.0508668	5814.71	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	6294.70	3.15
Victoria Area	Victoria	0.0016730	114.69	0.0001128	11.38	0.0000054	0.01	0.0133614	1527.37	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1653.45	0.83
Other ERCOT Counties	Anderson	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
	Angelina	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
	Atascosa	0.0077084	528.45	0.0005199	52.41	0.0000251	0.05	0.0615620	7037.31	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	7618.22	3.81
	Bell	0.0004444	30.47	0.0027262	274.86	0.0001317	0.26	0.0000278	3.18	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	308.76	0.15
	Bosque	0.0007214	49.46	0.0044257	446.20	0.0002138	0.42	0.0000452	5.16	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	501.23	0.25
	Brazos	0.0005654	38.76	0.0034687	349.71	0.0001675	0.33	0.0000354	4.05	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	392.85	0.20
	Calhoun	0.0111852	766.80	0.0007544	76.05	0.0000364	0.07	0.0893292	10211.44	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	11054.37	5.53
	Cameron	0.0000231	1.58	0.0000016	0.16	0.0000001	0.00	0.0001843	21.07	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	22.81	0.01
	Cherokee	0.0001844	12.64	0.0011310	114.03	0.0000546	0.11	0.0000115	1.32	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	128.09	0.06
	Coke	0.0000223	1.53	0.0001365	13.76	0.0231815	45.23	0.0000014	0.16	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	60.67	0.03
	Colorado	0.0016158	110.77	0.0001090	10.99	0.0000053	0.01	0.0129041	1475.10	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1596.86	0.80
	Ector	0.0001338	9.17	0.0008206	82.73	0.1393442	271.86	0.0000084	0.96	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	364.72	0.18
	Fayette	0.0204274	1400.40	0.0013777	138.90	0.0000665	0.13	0.1631405	18649.01	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	20188.43	10.09
	Freestone	0.0042261	289.72	0.0259247	2613.73	0.0012522	2.44	0.0002645	30.23	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	2936.13	1.47
	Frio	0.0097614	669.19	0.0006583	66.37	0.0000318	0.06	0.0779581	8911.59	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	9647.22	4.82
	Goliad	0.0077047	528.20	0.0005196	52.39	0.0000251	0.05	0.0615328	7033.97	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	7614.61	3.81
	Grayson	0.0002857	19.58	0.0017525	176.69	0.0000846	0.17	0.0000179	2.04	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	198.48	0.10
	Grimes	0.0029942	205.27	0.0183678	1851.84	0.0008872	1.73	0.0001874	21.42	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	2080.26	1.04
	Hidalgo	0.0140830	965.46	0.0009498	95.76	0.0000459	0.09	0.1124720	12856.96	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	13918.27	6.96
	Hill	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
	Howard	0.0000467	3.20	0.0002865	28.89	0.0486558	94.93	0.0000029	0.33	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	127.35	0.06
	Lamar	0.0031379	215.12	0.0192492	1940.71	0.0009298	1.81	0.0001964	22.45	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	2180.09	1.09
	Limestone	0.0231674	1588.24	0.1421203	14328.56	0.0068646	13.39	0.0014500	165.75	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	16095.94	8.05
	Llano	0.0001855	12.72	0.0000125	1.26	0.0000006	0.00	0.0014818	169.38	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	183.37	0.09
	McLennan	0.0043688	299.51	0.0268006	2702.03	0.0012945	2.53	0.0002734	31.26	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	3035.32	1.52
	Milam	0.0002486	17.04	0.0000168	1.69	0.0000008	0.00	0.0019850	226.91	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	245.65	0.12
	Mitchell	0.0000072	0.50	0.0000443	4.47	0.0075244	14.68	0.0000005	0.05	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	19.69	0.01
	Nacogdoches	0.0002714	18.60	0.0016647	167.84	0.0000804	0.16	0.0000170	1.94	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	188.54	0.09
	Nolan	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
	Palo Pinto	0.0010391	71.24	0.0063745	642.67	0.0003079	0.60	0.0000650	7.43	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	721.94	0.36
	Pecos	0.0000029	0.20	0.0000180	1.82	0.0030637	5.98	0.0000002	0.02	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	8.02	0.00
	Reagan	0.0000002	0.02	0.0000015	0.15	0.0002476	0.48	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.65	0.00
	Red River	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
	Robertson	0.0184177	1262.62	0.1129830	11390.93	0.0054573	10.65	0.0011527	131.77	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	12795.97	6.40
	Scurry	0.0001246	8.54	0.0007646	77.09	0.1298311	253.30	0.0000078	0.89	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	339.82	0.17
	Titus	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
	Ward	0.0000206	1.41	0.0001265	12.75	0.0214790	41.90	0.0000013	0.15	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	56.22	0.03
	Webb	0.0000253	1.73	0.0000017	0.17	0.0000001	0.00	0.0002020	23.09	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	24.99	0.01
	Wharton	0.0006585	45.15	0.0000444	4.48	0.0000021	0.00	0.0052594	601.22	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	650.84	0.33
	Wichita	0.0000051	0.35	0.0000315	3.17	0.0053432	10.42	0.0000003	0.04	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	13.99	0.01
	Wilbarger	0.0008609	59.02	0.0052810	532.43	0.8967472	1749.52	0.0000539	6.16	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	2347.13	1.17
	Wood	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
	Young	0.0000257	1.76	0.0001578	15.91	0.0267892	52.26	0.0000016	0.18	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	70.12	0.04
Other SPP Counties	Cass	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0127595	53.02	0.0000000	0.00	0.0000000	0.00	53.02	0.03
	Gaines	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
	Gray	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
	Hale	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0616792	256.29	0.0000000	0.00	0.0000000	0.00	256.29	0.13
	Hemphill	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0246062	102.24	0.0000000	0.00	0.0000000	0.00	102.24	0.05
	Hutchinson	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0134856	56.04	0.0000000	0.00	0.0000000	0.00	56.04	0.03
	Lamb	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.2117054	879.69	0.0000000	0.00	0.0000000	0.00	879.69	0.44
	Lubbock	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0695988	289.20	0.0000000	0.00	0.0000000	0.00	289.20	0.14
	Marion	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0272898	113.40	0.0000000	0.00	0.0000000	0.00	113.40	0.06
	Moore	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
	Morris	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0002270	0.94	0.0000000	0.00	0.0000000	0.00	0.94	0.00
	Potter	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.2710995	1126.48	0.0000000	0.00	0.0000000	0.00	1126.48	0.56
	Titus	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
	Yoakum	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0438855	182.35	0.0000000	0.00	0.0000000	0.00	182.35	0.09
Other SERC Counties	Jasper	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
	Newton	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0870000	826.59	0.0000000	0.00	826.59	0.41
	San Jacinto	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0072219	68.62	0.0000000	0.00	68.62	0.03
	Tyler	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
	Total	**0.6511639**	**44640.56**	**0.6960448**	**70175.19**	**1.3354567**	**2605.43**	**0.9887171**	**113022.77**	**1.3648074**	**5671.09**	**2.0110028**	**19106.52**	**1.2223686**	**853.67**	**256075.22**	**128.04**

Energy Savings (MWh)		68,555		100,820		1,951		114,313		4,155		9,501		698	

4.3 2022 Results for New Residential Construction (Single-family and Multi-family)

Table 15 presents the individual and combined annual electricity savings and NOx emissions reductions resulted from the new single-family and multi-family construction in 2022. In addition, Table 15 includes the combined natural gas savings from the new construction for both single-family and multi-family and the corresponding NOx emissions reductions[23].

The total NOx reductions from electricity and natural gas savings from total new single-family and multi-family construction in 2022 are 179.48 tons NOx/year, including 39.94 tons NOx/year (22 %) from single-family residential electricity savings, 127.30 tons NOx/year (71 %) from multi-family residential electricity savings, and 13.34 tons NOx/year (7 %) from natural gas savings from both single-family and multi-family residences. Figure 4-1 through Figure 4-5 show the electricity savings and NOx reductions tabulated in Table 15. Figure 4-1 shows the annual electricity savings by county using a stacked bar chart and Figure 4-2 shows the spatial distribution of the electricity savings by county across the state. Figure 4-3 shows the annual NOx reductions by using a stacked bar chart. Figure 4-4 and Figure 4-5 show the spatial distribution of the NOx reductions from electricity only, and electricity and natural gas, by county across the state, respectively.

[24] 0.092 lb-NOx/MMBtu of emission rate was used for the calculation.

Table 15: 2022 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/ 5.25% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 5.25% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 5.25% 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 Counties	Brazoria	2,710.00	1.49	11.93	5.03	2,721.93	6.52	30,741.68	0.14	6.66
	Chambers	418.52	0.24	0.00	0.81	418.52	1.05	5,614.70	0.03	1.07
	Fort Bend	5,206.11	0.95	9,767.77	3.22	14,973.87	4.17	112,579.79	0.52	4.69
	Galveston	1,340.72	0.19	1,085.24	0.66	2,425.96	0.85	19,012.29	0.09	0.94
	Harris	10,600.21	1.41	57,298.50	4.78	67,898.71	6.20	403,016.35	1.85	8.05
	Collin	4,855.30	0.01	22,115.70	0.03	26,971.00	0.03	283,603.42	1.30	1.34
	Dallas	2,978.31	0.18	30,444.71	0.66	33,423.01	0.85	289,328.80	1.33	2.18
	Denton	4,144.79	0.64	11,072.80	2.31	15,217.59	2.95	148,206.02	0.68	3.63
	Ellis	1,193.99	0.13	1,082.95	0.46	2,276.94	0.59	24,369.46	0.11	0.70
	Johnson	662.07	0.02	2,654.29	0.07	3,316.36	0.09	30,431.47	0.14	0.23
	Kaufman	580.40	0.33	1,001.35	1.20	1,581.75	1.53	17,179.16	0.08	1.61
	Parker	342.82	0.06	371.47	0.21	714.29	0.26	8,471.76	0.04	0.30
	Tarrant	5,434.43	0.04	20,132.79	0.15	25,567.22	0.19	236,161.24	1.09	1.27
	Wise	92.30	0.30	614.47	1.09	706.77	1.39	7,367.17	0.03	1.42
	Bexar	2,900.27	2.71	34,067.45	12.54	36,967.73	15.25	201,892.22	0.93	16.17
	Freestone	5.33	0.29	0.00	1.47	5.33	1.87	56.61	0.00	1.87
	Howard	6.66	0.03	0.00	0.06	6.66	0.10	100.63	0.00	0.10
	Rusk	3.30	3.10	0.00	11.21	3.30	14.31	40.02	0.00	14.31
	Anderson	12.39		351.22		363.61		3,084.25	0.01	
	El Paso	871.71	0.53	698.38	0.43	1,570.09	0.96	20,753.71	0.10	1.06
	Hutchinson	0.00	0.01	0.00	0.03	0.00	0.04	0.00	0.00	0.04
	Liberty	910.27		0.00		910.27		11,795.04	0.05	
	Montgomery	6,900.99	0.28	9,359.50	0.28	16,260.50	0.56	132,561.67	0.61	1.17
	Navarro	359.31		0.00		359.31		3,817.77	0.02	
	Panola	4.54		0.00		4.54		55.03	0.00	
	Rockwall	1,164.06		55.63		1,219.69		14,572.21	0.07	
	Titus	0.00		40.46		40.46		411.96	0.00	
	Waller	52.55		391.60		444.15		2,497.48	0.01	
	Andrews	9.99		0.00		9.99		150.95	0.00	
	Angelina	58.23		13.42		71.65		817.50	0.00	
	Aransas	130.42		0.00		130.42		1,423.49	0.01	
	Archer	21.35		0.00		21.35		229.97	0.00	
	Armstrong	0.42		0.00		0.42		0.42	0.00	
	Atascosa	35.39	0.82	6.46	3.81	41.85	4.63	504.34	0.00	4.64
	Austin	218.36		0.00		218.36		2,818.65	0.01	
	Bandera	1.44		0.00		1.44		19.83	0.00	
	Bastrop	963.74	0.27	71.57	1.23	1,035.30	1.49	10,318.18	0.05	1.54
	Baylor	0.00		0.00		0.00		0.00	0.00	
	Bee	7.89		0.00		7.89		98.42	0.00	
	Bell	1,386.91	0.04	4,262.77	0.15	5,649.68	0.20	45,830.26	0.21	0.41
	Blanco	11.63	0.41	0.00		11.63		166.57	0.00	
	Borden	10.51	0.02	0.00		10.51		91.26	0.00	
Other ERCOT Counties	Bosque	4.74	0.07	6.94	0.25	11.67	0.32	100.92	0.00	0.32
	Brazos	852.99	0.05	638.78	0.20	1,491.77	0.25	13,978.33	0.06	0.32
	Brewster	3.09		0.00		3.09		41.64	0.00	
	Briscoe	2.95		0.00		2.95		2.95	0.00	
	Brooks	0.00		0.00		0.00		0.00	0.00	
	Brown	68.07		13.87		81.95		824.50	0.00	
	Burleson	22.19		0.00		22.19		286.39	0.00	
	Burnet	422.13		16.54		438.67		6,113.67	0.03	
	Caldwell	138.03		145.89		283.92		1,986.46	0.01	
	Calhoun	82.52	1.20	0.00	5.53	82.52	6.72	1,029.61	0.00	6.73
	Callahan	1.99		0.00		1.99		23.84	0.00	
	Cameron	1,434.45	0.00	2,209.72	0.01	3,644.16	0.01	18,189.24	0.08	0.10
	Carson	19.80		0.00		19.80		19.78	0.00	
	Castro	0.00		0.00		0.00		0.00	0.00	
	Cherokee	19.41		0.00	0.06	19.41	0.08	235.12	0.00	0.08
	Childress	0.00		0.00		0.00		0.00	0.00	
	Clay	4.16		0.00		4.16		44.87	0.00	
	Coke	0.00	0.02	0.00	0.03	0.00	0.05	0.00	0.00	0.05
	Coleman	1.99		0.00		1.99		25.12	0.00	
	Collingsworth	0.51		0.00		0.51		5.62	0.00	
	Colorado	16.93	0.17	0.00	0.80	16.93	0.97	218.56	0.00	0.97
	Comal	1,314.35	0.06	5,299.57	0.26	6,613.92	0.32	42,965.86	0.20	0.52
	Comanche	1.18		6.94		8.12		63.18	0.00	
	Concho	0.44		0.00		0.44		5.95	0.00	
	Cooke	53.17		0.00		53.17		678.17	0.00	
	Coryell	176.99		381.53		558.52		4,663.59	0.02	
	Cottle	0.00		0.00		0.00		0.00	0.00	
	Crane	0.00		0.00		0.00		0.00	0.00	
	Crockett	8.37		0.00		8.37		113.03	0.00	
	Crosby	1.66		0.00		1.66		14.41	0.00	
	Culberson	3.23		25.35		28.58		276.92	0.00	
	Dawson	1.09		0.00		1.09		9.94	0.00	
	De Witt	13.35	0.00	0.00	0.00	13.35	0.00	166.55	0.00	0.00
	Deaf Smith	14.32		46.26		60.59		341.05	0.00	
	Delta	2.80		0.00		2.80		33.65	0.00	
	Dickens	0.00		0.00		0.00		0.00	0.00	
	Dimmit	0.00		0.00		0.00		0.00	0.00	
	Donley	0.42		0.00		0.42		0.42	0.00	
	Duval	0.00		0.00		0.00		0.00	0.00	
	Eastland	9.97		14.94		24.91		305.95	0.00	
	Ector	369.71	0.10	0.00	0.18	369.71	0.28	5,585.14	0.03	0.31
	Edwards	0.00		0.00		0.00		0.00	0.00	
	Erath	16.95		531.99		548.94		6,851.60	0.03	

Table 15: 2022 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/ 5.25% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 5.25% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 5.25% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual N.G. Savings (Therm/County)	Annual Nox Reductions (Tons)	Annual Nox Reductions (Tons)
	Falls	2.37	0.00	0.00		2.37		25.16	0.00	
	Fannin	29.39		42.92		72.30		822.76	0.00	
	Fayette	8.17	2.18	0.00	10.09	8.17	12.28	105.51	0.00	12.28
	Fisher	0.00		0.00		0.00		0.00	0.00	
	Floyd	0.00		0.00		0.00		0.00	0.00	
	Foard	0.00		0.00		0.00		0.00	0.00	
	Franklin	0.00		0.00		0.00		0.00	0.00	
	Frio	5.72	1.04	0.00	4.82	5.72	5.87	76.67	0.00	5.87
	Garza	0.00		0.00		0.00		0.00	0.00	
	Gillespie	41.68		5.51		47.19		619.71	0.00	
	Glasscock	0.00		0.00		0.00		0.00	0.00	
	Goliad	1.21	0.82	0.00	3.81	1.21	4.63	15.14	0.00	4.63
	Gonzales	4.15		0.00		4.15		55.52	0.00	
	Gray	0.00		0.00		0.00		0.00	0.00	
	Grayson	1,109.20	0.03	1,822.66	0.10	2,931.86	0.13	33,172.60	0.15	0.28
	Grimes	67.14		11.11	1.04	78.25	1.33	918.31	0.00	1.33
	Guadalupe	811.62	0.33	1,380.49	1.51	2,192.11	1.84	17,476.10	0.08	1.92
	Hale	12.22	0.06	0.00	0.13	12.22	0.19	12.21	0.00	0.19
	Hall	0.00		0.00		0.00		0.00	0.00	
	Hamilton	9.47		20.81		30.28		252.43	0.00	
	Hardeman	0.00		0.00		0.00		0.00	0.00	
	Haskell	0.00		0.00		0.00		0.00	0.00	
	Hays	2,330.68	0.05	2,009.52	0.23	4,340.21	0.28	41,699.08	0.19	0.48
	Henderson	121.88	0.01	560.09	0.05	681.97	0.07	6,694.07	0.03	0.10
	Hidalgo	2,855.59	1.50	8,015.56	6.96	10,871.15	8.46	44,203.69	0.20	8.67
	Hill	34.92		6.94		41.86		421.69	0.00	
	Hood	54.39	0.08	0.00	0.29	54.39	0.37	790.14	0.00	0.38
	Hopkins	16.78		30.34		47.13		510.89	0.00	
	Houston	1.24		0.00		1.24		15.01	0.00	
	Hunt	324.64	0.00	164.09	0.00	488.73	0.00	5,853.27	0.03	0.03
	Irion	0.00		0.00		0.00		0.00	0.00	
	Jack	3.99		0.00		3.99		47.67	0.00	
	Jackson	2.43		0.00		2.43		30.28	0.00	
	Jeff Davis	0.00		0.00		0.00		0.00	0.00	
	Jim Hogg	0.00		0.00		0.00		0.00	0.00	
	Jim Wells	3.97		0.00		3.97		43.36	0.00	
	Jones	0.50		0.00		0.50		5.96	0.00	
	Karnes	47.06		0.00		47.06		624.64	0.00	
	Kendall	155.51		0.00		155.51		2,148.32	0.01	
	Kenedy	0.00		0.00		0.00		0.00	0.00	
	Kent	0.00		0.00		0.00		0.00	0.00	
Other ERCOT Counties	Kerr	40.71		223.28		263.99		1,507.69	0.01	
	Kimble	1.32		0.00		1.32		17.85	0.00	
	King	0.00		0.00		0.00		0.00	0.00	
	Kinney	0.00		0.00		0.00		0.00	0.00	
	Kleberg	14.31		17.83		32.14		194.85	0.00	
	Knox	0.00		0.00		0.00		0.00	0.00	
	La Salle	0.00		0.00		0.00		0.00	0.00	
	Lamar	23.64	0.30	85.97	1.09	109.62	1.39	1,160.55	0.01	1.40
	Lampasas	21.31		0.00		21.31		226.42	0.00	
	Lavaca	8.34		0.00		8.34		96.95	0.00	
	Lee	17.92		0.00		17.92		257.89	0.00	
	Leon	0.00		0.00		0.00		0.00	0.00	
	Limestone	7.10	2.22	27.75	8.05	34.85	10.27	277.88	0.00	10.27
	Live Oak	3.97		0.00		3.97		43.36	0.00	
	Llano	131.82	0.02	22.05	0.09	153.88	0.11	1,979.14	0.01	0.12
	Loving	0.00		0.00		0.00		0.00	0.00	
	Lubbock	1,151.67	0.07	2,836.66	0.14	3,988.33	0.21	49,998.17	0.23	0.44
	Lynn	0.50		0.00		0.50		6.28	0.00	
	Madison	2.92		0.00		2.92		37.68	0.00	
	Martin	0.42		0.00		0.42		6.29	0.00	
	Mason	0.97		0.00		0.97		13.88	0.00	
	Matagorda	132.88		17.42		150.30		1,731.42	0.01	
	Maverick	57.09		69.88		126.98		765.93	0.00	
	Mcculloch	0.44		0.00		0.44		5.95	0.00	
	Mclennan	542.21	0.42	1,487.98	1.52	2,030.19	1.94	16,614.98	0.08	2.01
	Mcmullen	0.00		0.00		0.00		0.00	0.00	
	Medina	13.99		0.00		13.99		187.39	0.00	
	Menard	0.00		0.00		0.00		0.00	0.00	
	Midland	246.89		0.00		246.89		3,729.72	0.02	
	Milam	21.40	0.03	0.00	0.12	21.40	0.15	226.42	0.00	0.15
	Mills	0.00		0.00		0.00		0.00	0.00	
	Mitchell	0.50	0.01	0.00	0.01	0.50	0.02	5.96	0.00	0.02
	Montague	13.06		90.88		103.94		1,115.25	0.01	
	Motley	0.00		0.00		0.00		0.00	0.00	
	Nacogdoches	14.87	0.03	0.00	0.09	14.87	0.12	180.09	0.00	0.12
	Nolan	1.99		0.00		1.99		23.84	0.00	
	Nueces	1,004.27	0.45	15.88	2.10	1,020.16	2.55	11,011.06	0.05	2.60
	Oldham	0.42		0.00		0.42		0.42	0.00	
	Palo Pinto	26.92	0.10	0.00	0.36	26.92	0.46	321.80	0.00	0.46
	Parmer	0.42		0.00		0.42		0.42	0.00	
	Pecos	4.85	0.00	41.62	0.00	46.47	0.01	494.42	0.00	0.01
	Potter	440.20	0.25	238.51	0.56	678.71	0.82	5,827.17	0.03	0.84
	Presidio	3.53		0.00		3.53		47.59	0.00	
	Rains	4.20		0.00		4.20		50.48	0.00	

Table 15: 2022 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/ 5.25% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 5.25% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual Electricity Savings per County w/ 5.25% 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	Randall	38.34		194.30		232.64		1,410.61	0.01	
	Reagan	0.42	0.00	0.00	0.00	0.42	0.00	6.64	0.00	0.00
	Real	0.00		0.00		0.00		0.00	0.00	
	Red River	5.39		0.00		5.39		65.03	0.00	
	Reeves	11.66		0.00		11.66		176.11	0.00	
	Refugio	9.10		0.00		9.10		113.56	0.00	
	Roberts	0.00		0.00		0.00		0.00	0.00	
	Robertson	26.86	1.77	0.00	6.40	26.86	8.17	346.68	0.00	8.17
	Runnels	3.09		0.00		3.09		41.64	0.00	
	San Patricio	250.24	0.68	0.00	3.15	250.24	3.83	2,731.37	0.01	3.84
	San Saba	0.00		0.00		0.00		0.00	0.00	
	Schleicher	0.44		0.00		0.44		5.95	0.00	
	Scurry	1.11	0.09	0.00	0.17	1.11	0.26	9.61	0.00	0.26
	Shackelford	0.00		0.00		0.00		0.00	0.00	
	Smith	300.24		337.37		637.61		7,084.78	0.03	
	Somervell	7.69		0.00		7.69		99.45	0.00	
	Starr	0.00		0.00		0.00		0.00	0.00	
	Stephens	2.99		0.00		2.99		35.76	0.00	
	Sterling	0.00		0.00		0.00		0.00	0.00	
	Stonewall	0.00		0.00		0.00		0.00	0.00	
	Sutton	0.00		0.00		0.00		0.00	0.00	
	Swisher	0.00		0.00		0.00		0.00	0.00	
	Taylor	233.27		974.32		1,207.59		14,966.31	0.07	
	Terrell	0.00		0.00		0.00		0.00	0.00	
	Throckmorton	0.00		0.00		0.00		0.00	0.00	
	Tom Green	141.92		0.00		141.92		1,915.52	0.01	
	Travis	3,673.16	0.49	50,420.03	2.28	54,093.20	2.78	261,410.93	1.20	3.98
	Upton	0.42		0.00		0.42		6.64	0.00	
	Uvalde	8.81		37.54		46.36		297.68	0.00	
	Val Verde	67.89		34.66		102.55		1,075.08	0.00	
	Van Zandt	15.85		75.86		91.71		963.12	0.00	
	Victoria	122.56	0.18	0.00	0.83	122.56	1.01	1,529.27	0.01	1.01
	Walker	420.95		261.07		682.02		6,646.62	0.03	
	Ward	1.67	0.02	0.00	0.03	1.67	0.04	25.16	0.00	0.04
Other TEXAS Counties	Washington	105.68		0.00		105.68		1,364.11	0.01	
	Webb	845.55	0.00	324.01	0.01	1,169.56	0.02	9,129.42	0.04	0.06
	Wharton	94.65	0.07	11.62	0.33	106.27	0.40	1,229.99	0.01	0.40
	Wheeler	0.00		0.00		0.00		0.00	0.00	
	Wichita	78.09	0.00	654.53	0.01	732.62	0.01	8,490.30	0.04	0.05
	Wilbarger	2.08	0.63	193.94	1.17	196.02	1.81	2,288.79	0.01	1.82
	Willacy	50.28		0.00		50.28		466.36	0.00	
	Williamson	3,266.06		9,884.28		13,150.34		112,350.79	0.52	
	Wilson	54.42		5.78		60.20		756.40	0.00	
	Winkler	0.00		0.00		0.00		0.00	0.00	
	Wood	11.23		0.00		11.23		131.70	0.00	
	Young	2.49	0.02	0.00	0.04	2.49	0.05	29.80	0.00	0.05
	Zapata	0.00		0.00		0.00		0.00	0.00	
	Zavala	1.45		0.00		1.45		13.88	0.00	
	Bailey	0.00		0.00		0.00		0.00	0.00	
	Bowie	38.99		0.00		38.99		470.24	0.00	
	Camp	3.32		0.00		3.32		40.02	0.00	
	Cass	2.49	0.01	0.00	0.03	2.49	0.04	30.02	0.00	0.04
	Cochran	0.00		0.00		0.00		0.00	0.00	
	Dallam	3.79		0.00		3.79		3.79	0.00	
	Gaines	4.58		0.00		4.58		69.19	0.00	
	Gregg	114.00	0.01	364.16	0.01	478.16	0.02	4,336.98	0.02	0.04
	Hansford	0.42		0.00		0.42		0.42	0.00	
	Hardin	285.63	0.01	0.00	0.01	285.63	0.03	3,845.88	0.02	0.04
	Harrison	27.36	0.25	521.60	0.56	548.96	0.82	4,522.67	0.02	0.84
	Hartley	0.00		0.00		0.00		0.00	0.00	
	Hemphill	0.00	0.02	0.00	0.05	0.00	0.07	0.00	0.00	0.07
	Hockley	4.63		0.00		4.63		4.63	0.00	
	Hudspeth	0.00		0.00		0.00		0.00	0.00	
	Jasper	15.75		10.89		26.64		264.45	0.00	
	Jefferson	365.60	4.59	38.10	4.60	403.69	9.19	5,106.76	0.02	9.21
	Lamb	0.00	0.20	0.00	0.44	0.00	0.64	0.00	0.00	0.64
	Lipscomb	0.00		0.00		0.00		0.00	0.00	
	Marion	2.07	0.03	0.00	0.06	2.07	0.08	25.75	0.00	0.08
	Moore	15.17		0.00		15.17		15.15	0.00	
	Morris	0.41	0.00	0.00	0.00	0.41	0.00	5.00	0.00	0.00
	Newton	0.00	0.41	0.00	0.41	0.00	0.83	0.00	0.00	0.83
	Ochiltree	0.00		0.00		0.00		0.00	0.00	
	Orange	101.27	4.20	43.55	4.21	144.82	8.41	1,572.58	0.01	8.42
	Polk	544.84		48.95		593.79		7,577.73	0.03	
	Sabine	0.41		0.00		0.41		5.00	0.00	
	San Augustine	0.00		0.00		0.00		0.00	0.00	
	San Jacinto	342.37	0.03	0.00	0.03	342.37	0.07	4,436.39	0.02	0.09
	Shelby	0.41		0.00		0.41		5.00	0.00	
	Sherman	7.16		0.00		7.16		7.16	0.00	
	Terry	0.99		0.00		0.99		12.56	0.00	
	Trinity	2.17		0.00		2.17		32.34	0.00	
	Tyler	2.25		0.00		2.25		30.28	0.00	
	Upshur	0.90		0.00		0.90		10.54	0.00	
	Yoakum	2.95	0.04	0.00	0.09	2.95	0.13	2.95	0.00	0.13
	TOTAL	**85,450.51**	**39.94**	**299,993.06**	**127.30**	**385,443.57**	**167.24**	**2,899,847.68**	**13.34**	**179.48**

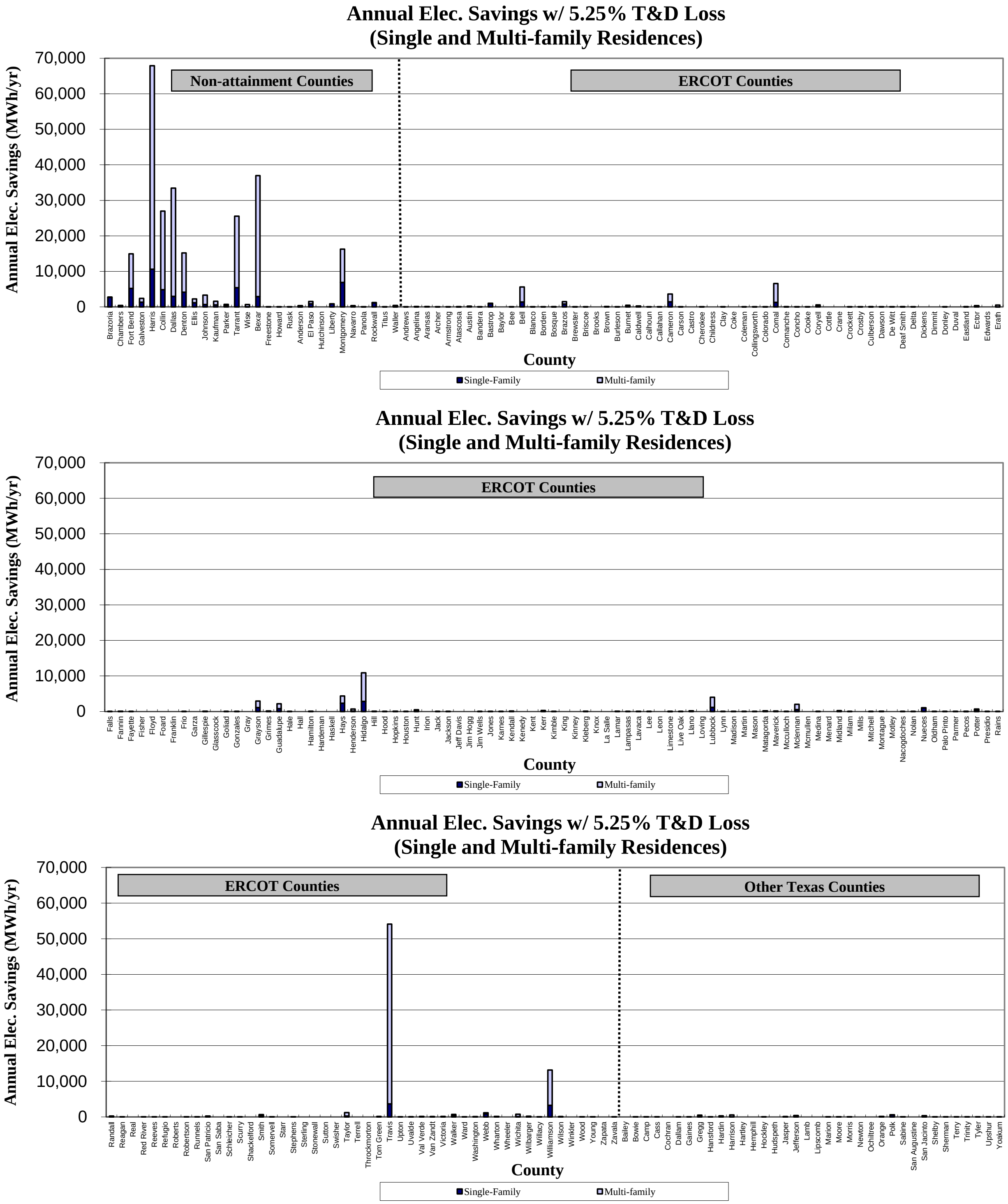


Figure 4-1: 2022 Annual Electricity Savings by County from New Single-family and Multi-family Residences

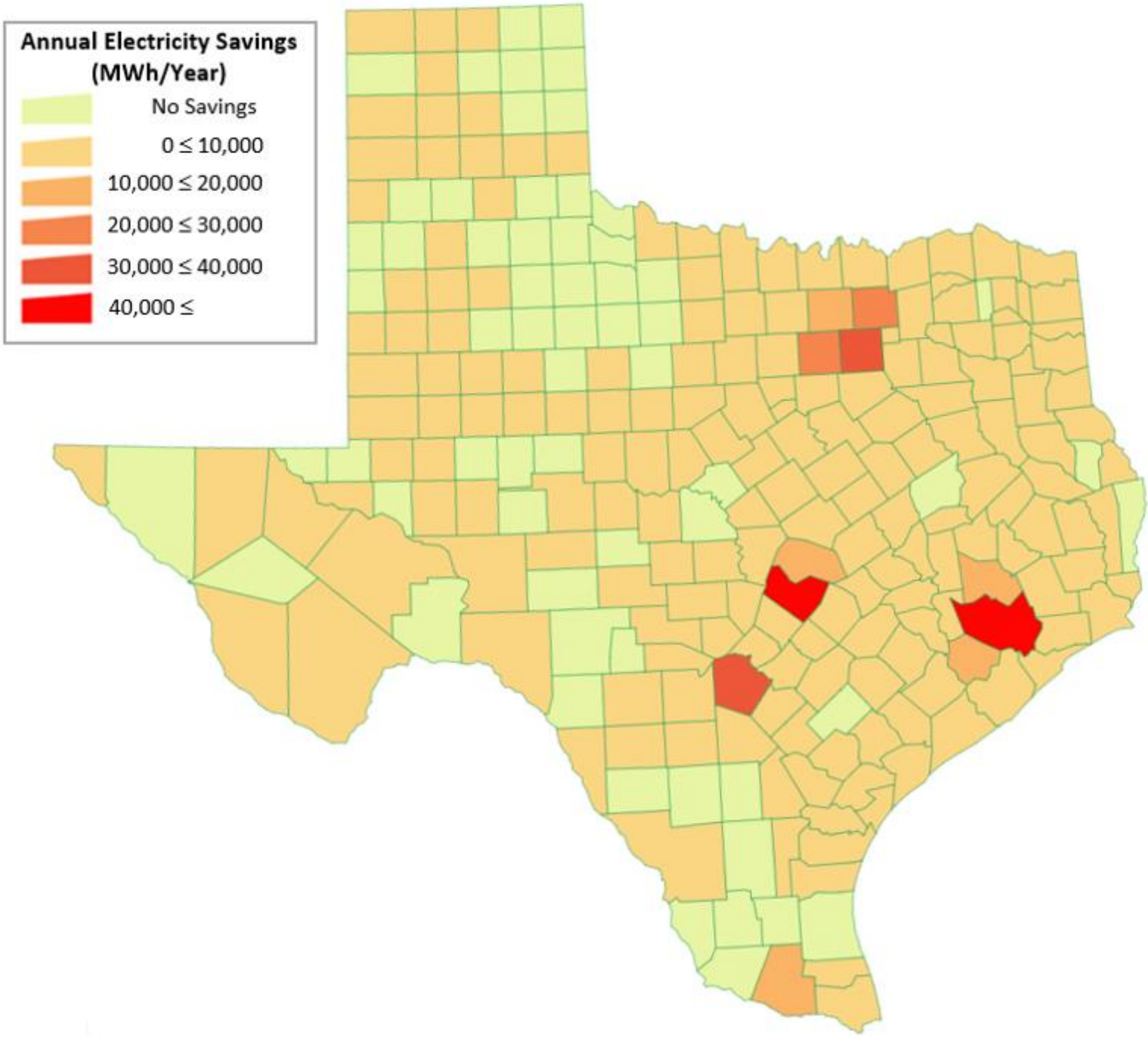


Figure 4-2: Map of 2022 Annual Electricity Savings by County from New Single-family and Multi-family Residences

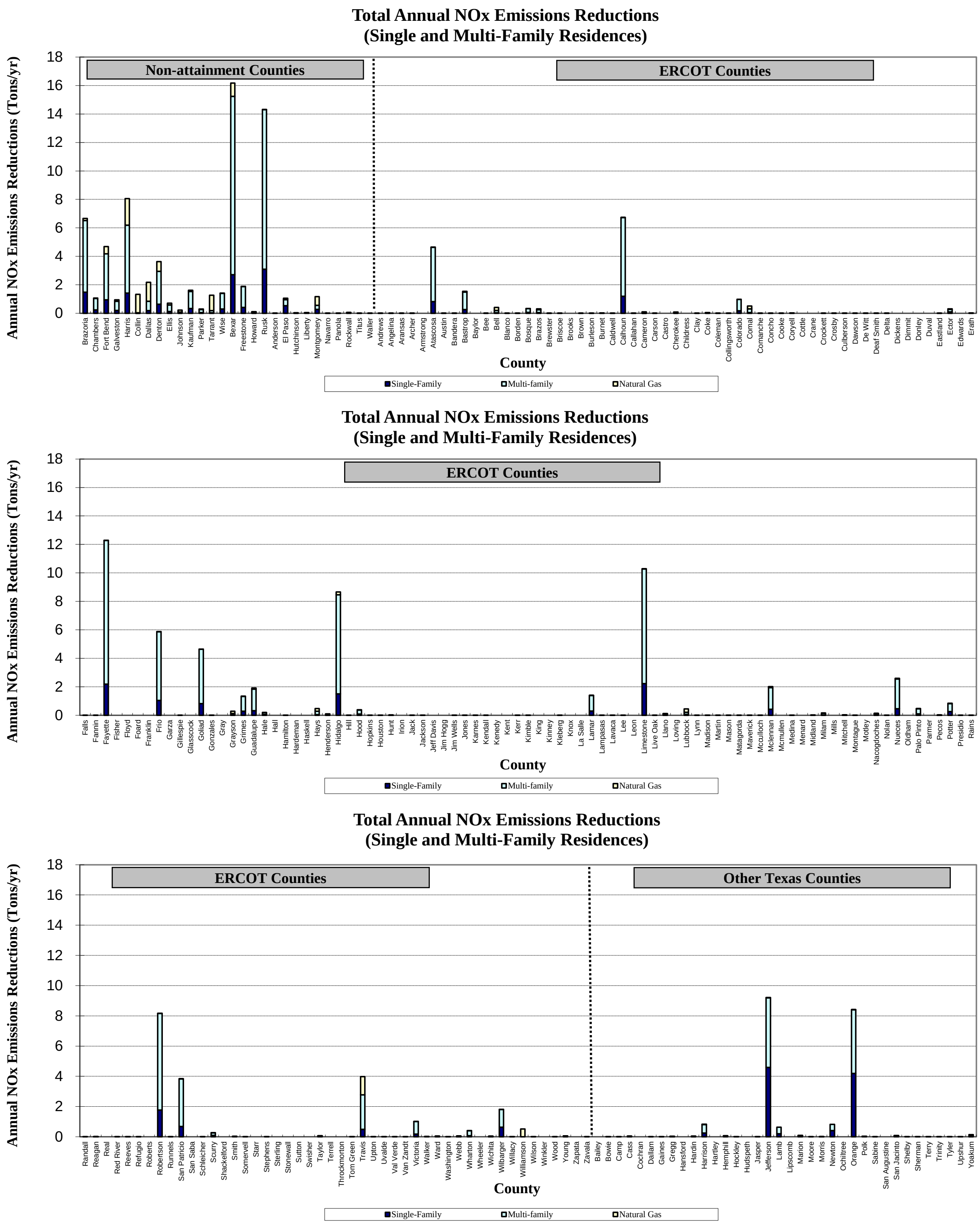


Figure 4-3: 2022 Annual NOx Reductions by County from New Single-family and Multi-family Residences

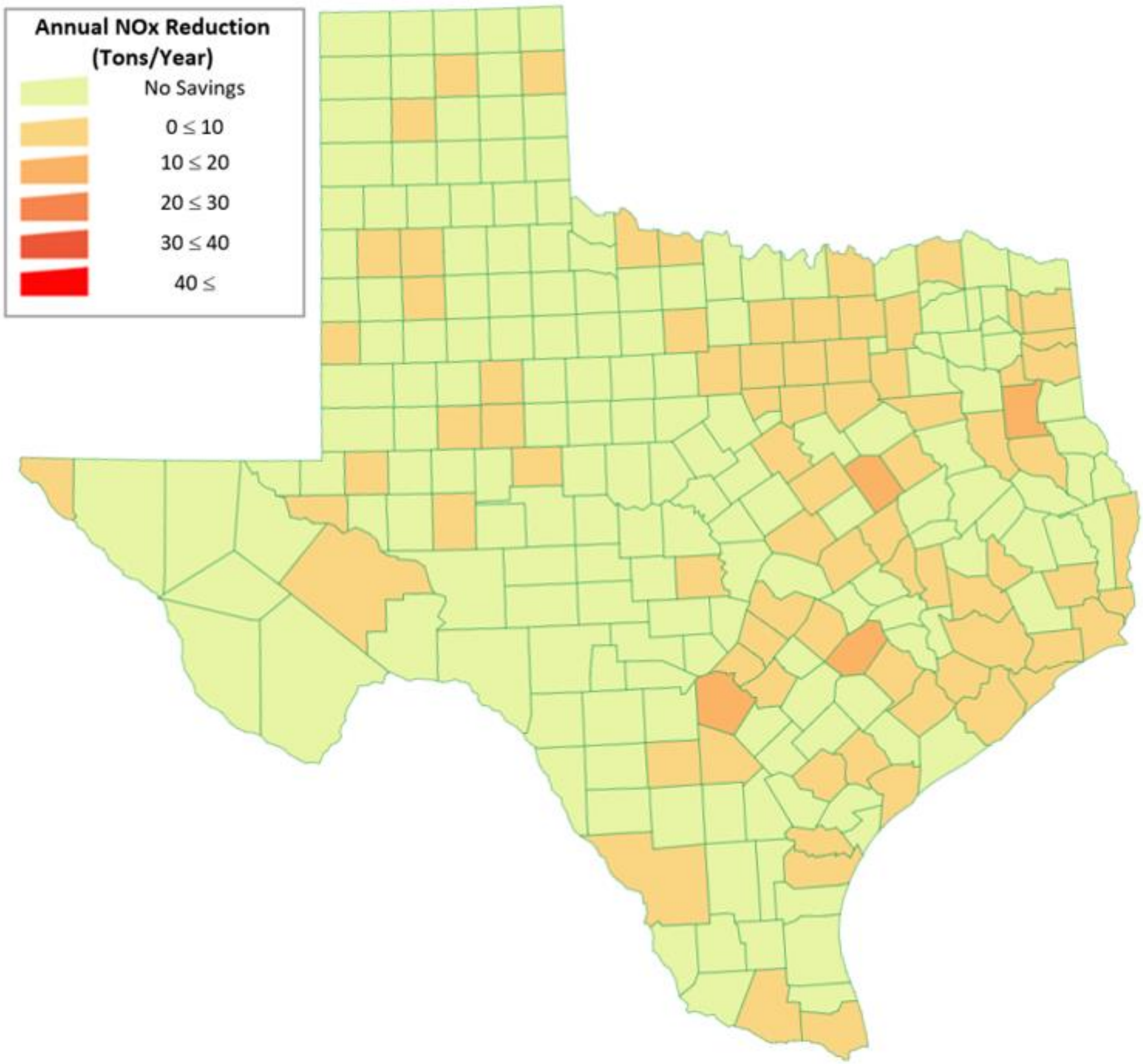


Figure 4-4: Map of 2022 Annual NOx Reductions from Electricity by County from New Single-family and Multi-family Residences

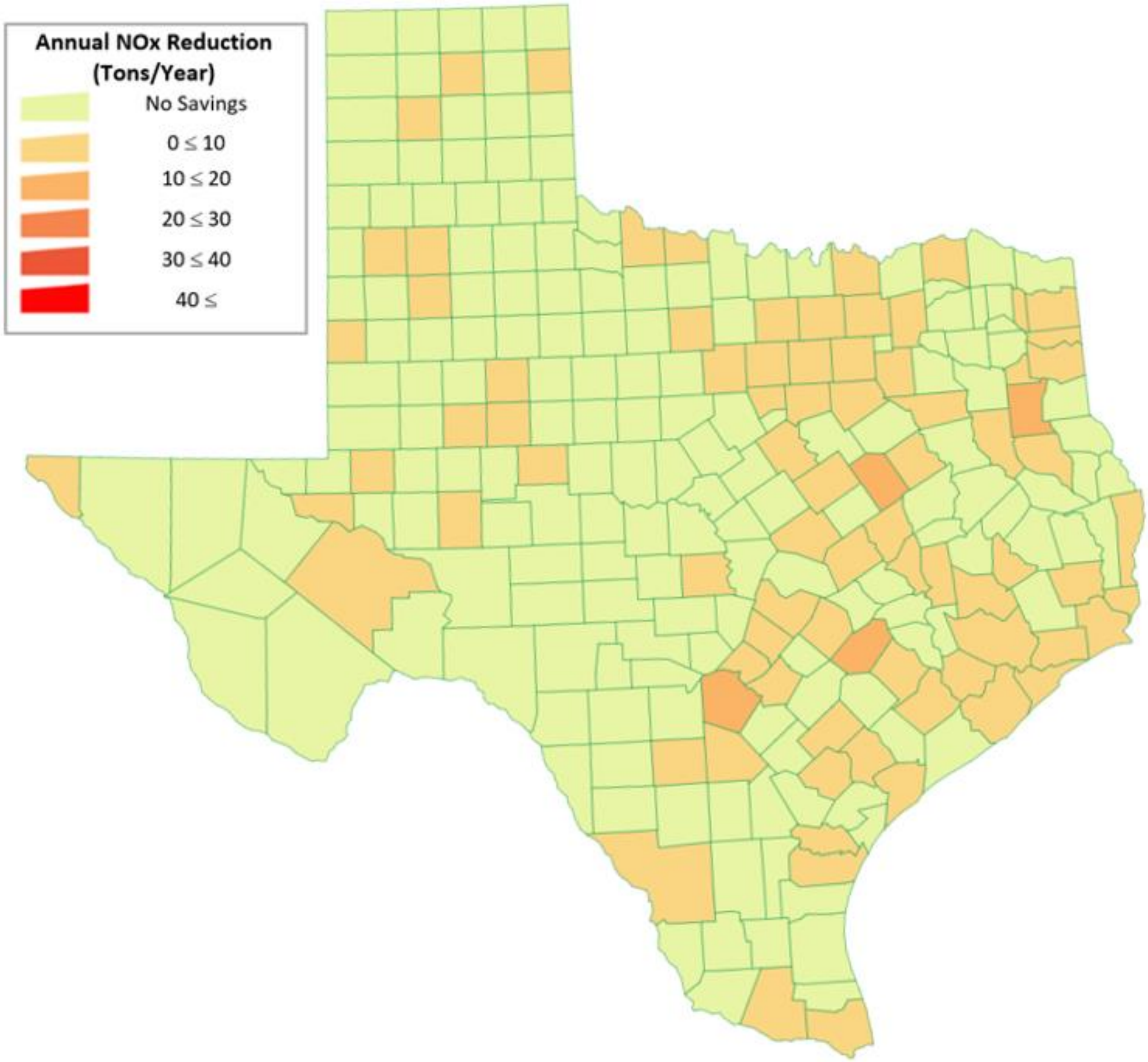


Figure 4-5: Map of 2022 Annual NOx Reductions from Electricity and Natural Gas by County from New Single-family and Multi-family Residences

4.4 2022 Results for Commercial Construction

This section reports the calculated energy savings and emissions reductions from new commercial construction in 2022 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 28 non-attainment counties, data from two sources (i.e., Dodge and USDOE) were merged into one analysis as shown in Figure 4-6. Beginning in the upper left of Figure 4-6, the Dodge database of the square footage of new commercial construction per county in Texas 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 4-6 and Table 16 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 17 (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.

In the next step, the annual energy savings from commercial construction 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 90.1-2013, 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 of seven building types were calculated. The commercial energy savings for 2022 were estimated against the baseline year of 2018. Therefore, the annual energy savings for new commercial construction in 2022 were not generated as shown in Table 18 since Texas has been complying with the ASHRAE Standard 90.1-2013 as the commercial code in both the 2018 and 2022.

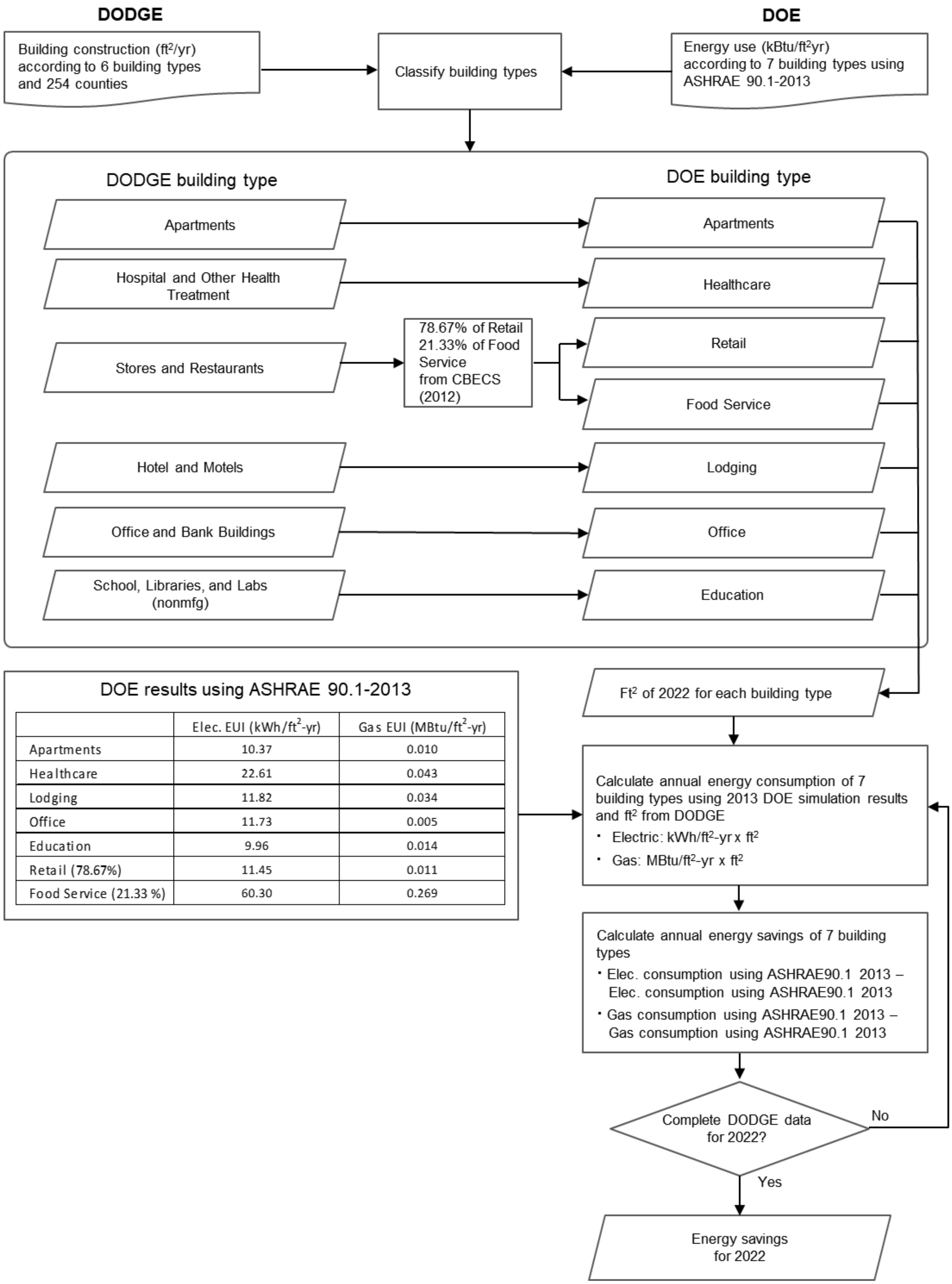


Figure 4-6: Calculation Method for 2022 Energy Savings from New Commercial Buildings

Table 16: 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 17: 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	

Table 18: 2022 Totalized Annual Electricity Savings by CL Zone from New Commercial Construction

Electric Power Market	CL Zone	Total Electricity Savings by CL Zone (MWh) [2022-TRY 2018]
ERCOT	Houston (H)	0
	North (N)	0
	West (W)	0
	South (S)	0
SPP	-	0
SERC	-	0
WECC	-	0
Total		0

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

5.1 Background

In January 2005, the Laboratory was asked by the Texas Commission on Environmental Quality (TCEQ) to develop a method by which the NOx emissions reductions from the energy-efficiency programs from multiple Texas State Agencies working under Senate Bill 5 and Senate Bill 7 could be reported in a uniform format to allow the TCEQ to consider the combined savings for Texas' State Implementation Plan (SIP) planning purposes. This required that the analysis should include the integrated savings estimation from all projects projected through 2027 for both the annual and Ozone Season Period (OSP) NOx reductions. The NOx emissions reductions from all these programs were calculated using estimated emissions factors for 2018 from the US Environmental Protection Agency (US EPA) eGRID database, which had been specially prepared for this purpose. The different programs included in this 2022 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 14 upgrades to Single-family and Multi-family residences

The Laboratory's single-family and multi-family programs include the energy savings attained by the construction of new residences in Texas. To estimate energy savings, the published data on residential construction characteristics provided by the Home Innovation Research Labs (HIRL) is used as a baseline as well as the adopted energy code in 2018 (i.e., the 2015 IECC). Annual electricity savings (MWh) are obtained from the Laboratory's Annual Reports to the TCEQ (Haberl et al., 2002 - 2018) (Baltazar et al., 2019 - 2022).

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 2021).

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 2022.

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 2020 reporting year SECO submitted annual energy savings values for projects funded by SECO (SECO 2022) and by Energy Service projects.

The *Electric Reliability Council of Texas (ERCOT) electricity production from currently installed green power generation* in Texas is reported. In this report, the measured electricity productions for 2001 through 2020 were included. For projections to 2025, an annual growth factor was estimated using the last six years of installed power capacity.

Finally, NOx 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) NOx emissions reductions were calculated for 2022 and integrated through 2027 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 19 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% from 2018 to 2021 and 5.25% after 2021 (EIA 2023) 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 30% for the estimations. For the electricity from renewables, the discount factor was taken as 5%. In addition, the discount factor for SEER 13/SEER 14 single-family and multi-family program was 20%.

Growth factor: The growth factors shown in Table 19 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 2020 from the Public Utility Commission of Texas. No growth was assumed for PUC programs, SECO, and SEER 13/14 entries.

Figure 5-1 shows the overall information flow that was used to calculate the NOx 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[24]. The base case is taken as the average characteristics of single-family and multi-family residences for Texas published the Home Innovation Research Labs (HIRL) based on the performance path of the 2015 IECC. The annual electricity savings from PUC's energy efficiency programs were calculated using PUC approved demand savings calculations and verification methods (PUC 2023). The SECO electricity savings were submitted as annual savings by project[25]. The electricity production from renewables in Texas was from the on-site metered data recorded at 15-minute intervals except for non-utility scale solar photovoltaic (PV) projects. The OSP consumption is the average daily consumption for the period between May 1 and September 30.

Integration of the savings from the different programs into a uniform format allowed for creditable NOx emissions to be evaluated using different criteria as shown in Table 19. These include evaluation across programs, evaluation across individual counties by program, evaluation by SIP area, evaluation for all ERCOT counties except Houston/Galveston.

[24] These values are based on a performance analysis as defined by Chapter 4 of the 2006, 2009 and 2015 IECC, plus the corresponding NAHB and HIRL data.

[25] 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.

Table 19: Final Adjustment Factors used for the Calculation of the Annual and OSP NOx Savings for the Different Programs

	ESL-Single Family	**ESL-Multifamily**	**ESL-Commercial**	**PUC (SB7)**	**SECO**	**Renewables-ERCOT**	**SEER 14 Single Family**	**SEER 14 Multi Family**
Annual Degradation Factor	**2.0%**	**2.0%**	**2.0%**	**5.0%**	**5.0%**	**0.0%**	**5.0%**	**5.0%**
T&D Loss**	**5.25%**	**5.25%**	**5.25%**	**5.25%**	**5.25%**	**0.0%**	**5.25%**	**5.25%**
Initial Discount Factor	**20.0%**	**20.0%**	**20.0%**	**10.0%**	**30.0%**	**5.0%**	**20.0%**	**20.0%**
Growth Factor	**4.1%**	**6.1%**	**5.3%**	**0.0%**	**0.0%**	**8.5%***	**N.A.***	**N.A.***
Weather Normalized	**Yes**	**Yes**	**Yes**	**No**	**No**	**No**	**Yes**	**Yes**

Notes: ** T&D Loss set as 7% from 2018 to 2021, and it sets as 5.25% after 2021.
* SEER 14 growth is based on the past permits of the recent seventeen years. Renewable projects have different growth factor for each type.

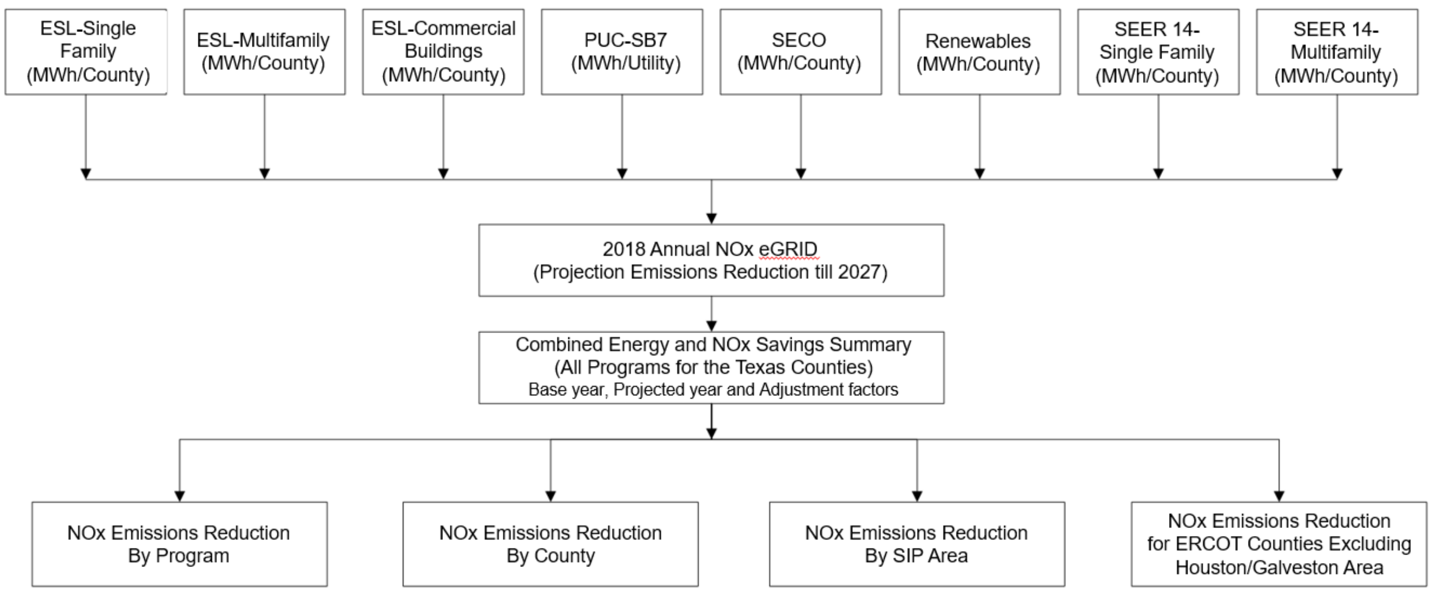


Figure 5-1: Process Flow Diagram of the NOx Emissions Reduction Calculations

5.3 Calculation Procedure

The electricity savings in this report were estimated based on the baseline year of 2018. In addition, the emissions estimation throughout this report was updated to include the 2018 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.

5.3.1 Single-Family, Multi-family, and Commercial Buildings

The calculation of the annual electricity savings for single- and multi-family residential construction included the savings from code-compliant housing in all the counties in ERCOT region as well as other counties in Texas, which includes the 28 non-attainment counties. From 2018 to 2022, based on year 2018, the annual electricity savings were calculated for new residential construction in all the counties in Texas. These savings were then tabulated by county and program. Using the calculated values through 2022, savings were then projected to 2027 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 2022 through 2027[26]. The projected energy savings through 2027, according to county, were then divided into the CL zones in the 2018 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 2019 annual report[27].

For the 2022 annual NOx emissions calculations, the US EPA's 2018 eGRID was used. The total electricity savings for each CL zone were used to calculate the NOx emissions reductions for each of the different counties using the emissions factors contained in eGRID. Similar calculations were performed for each year for which the analysis was required. Figure 5-2 and Figure 5-3 show annual and OSP electricity savings from new single-family residences from 2020 to 2027. Figure 5-4 and Figure 5-5 also show annual and OSP NOx reductions from new single-family residences from 2020 to 2027. In addition, Figure 5-6 and Figure 5-7 show annual and OSP electricity savings from new multi-family residences from 2020 to 2027. Figure 5-8 and Figure 5-9 also show annual and OSP NOx reductions from new multi-family residences from 2020 to 2027.

From 2018 to 2022, based on the year 2018, the annual electricity savings were calculated for new commercial construction by county. Using the calculated savings through 2022, savings were then projected to 2026 by incorporating the different adjustment factors mentioned above[28]. In the projected annual electricity savings, it was assumed that the same 2022 amount of electricity savings would be achieved for each year through 2027. Finally, the projected energy saving numbers through 2027, by county, were allocated into the appropriate CL zones.

[26] This would include the appropriate discount and degradation factors for each year.
[27] Haberl et al., 2020, Annual Report Volume I, pp. 60.
[28] This also includes the appropriate discount and degradation factors for each year.

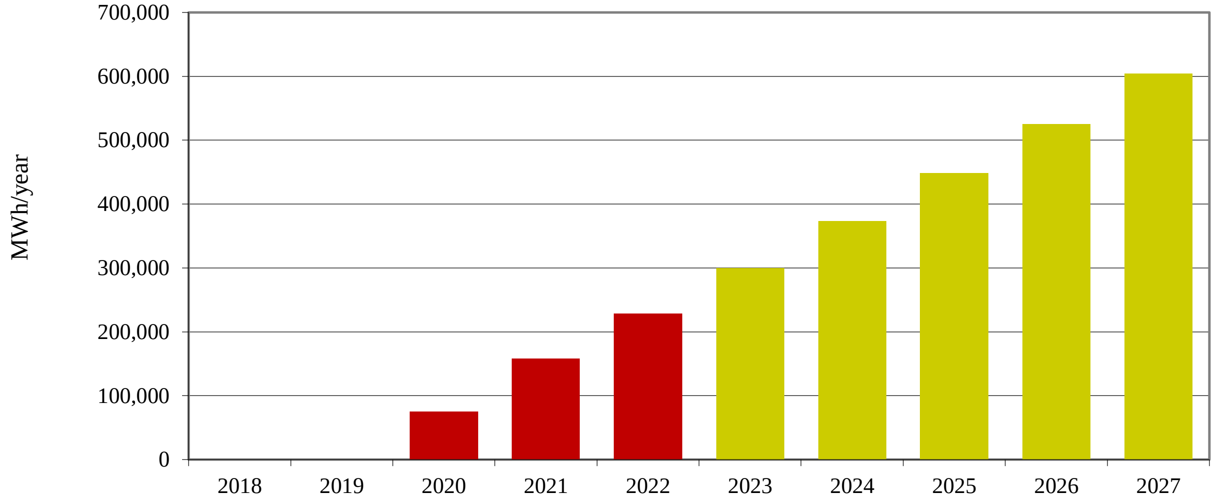


Figure 5-2: Actual and Projected Annual Savings from New Single-family Residences from 2020 to 2027 Based on the Year 2018.

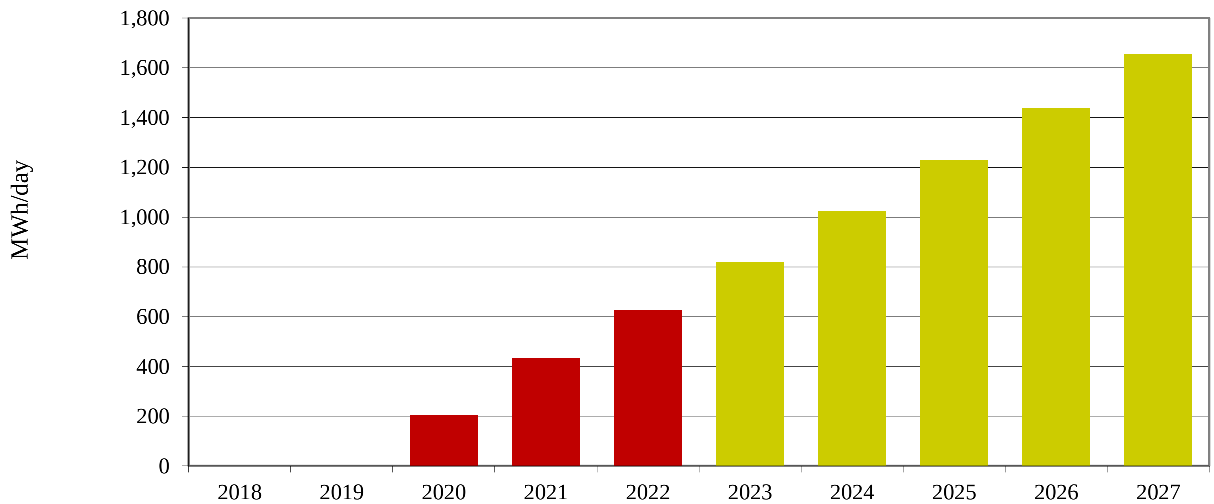


Figure 5-3: Actual and Projected OSP Daily Average Savings from New Single-family Residences from 2020 to 2027 Based on the Year 2018.

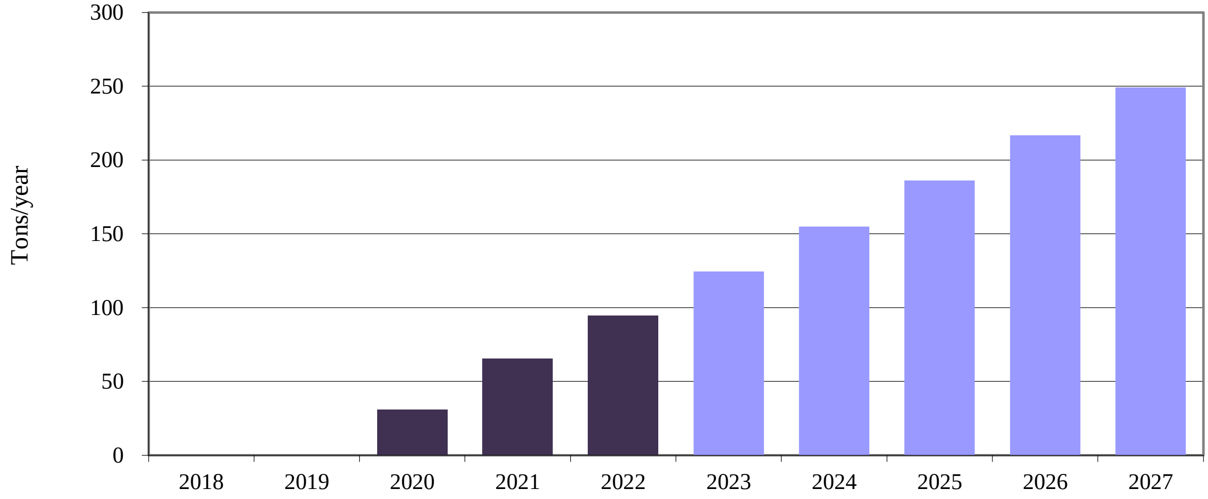


Figure 5-4: Actual and Projected Annual NOx Reduction from New Single-family Residences from 2020 to 2027 Based on the Year 2018.

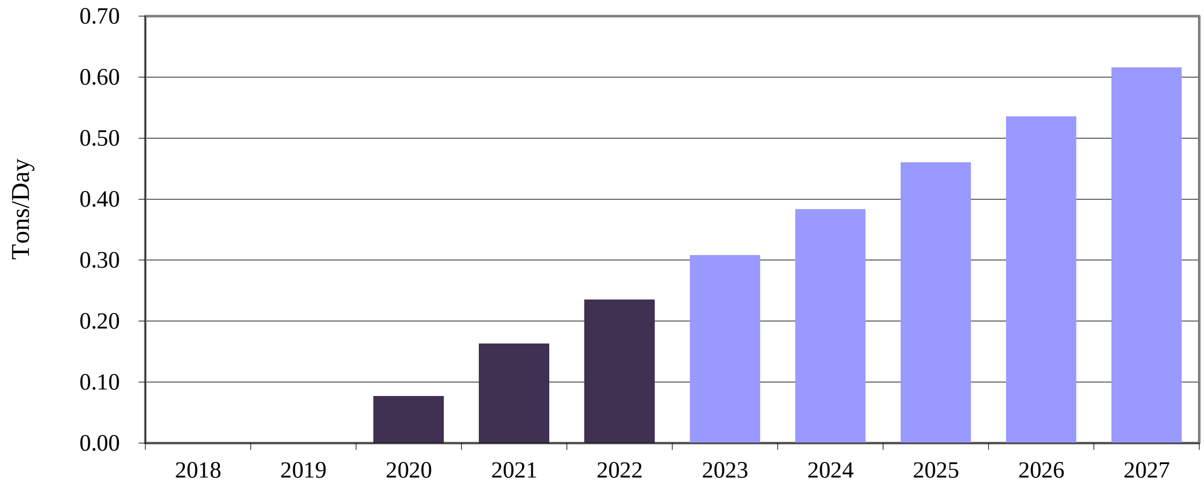


Figure 5-5: Actual and Projected OSP Average Daily NOx Reduction from New Single-family Residences from 2020 to 2027 Based on the Year 2018.

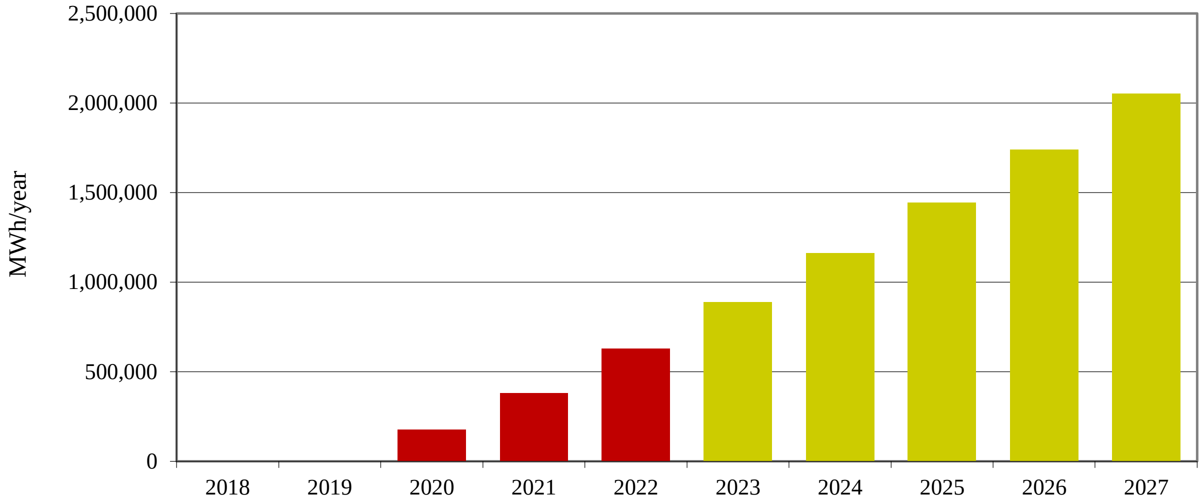


Figure 5-6: Actual and Projected Annual Savings from New Multi-family Residences from 2020 to 2027 Based on the Year 2018.

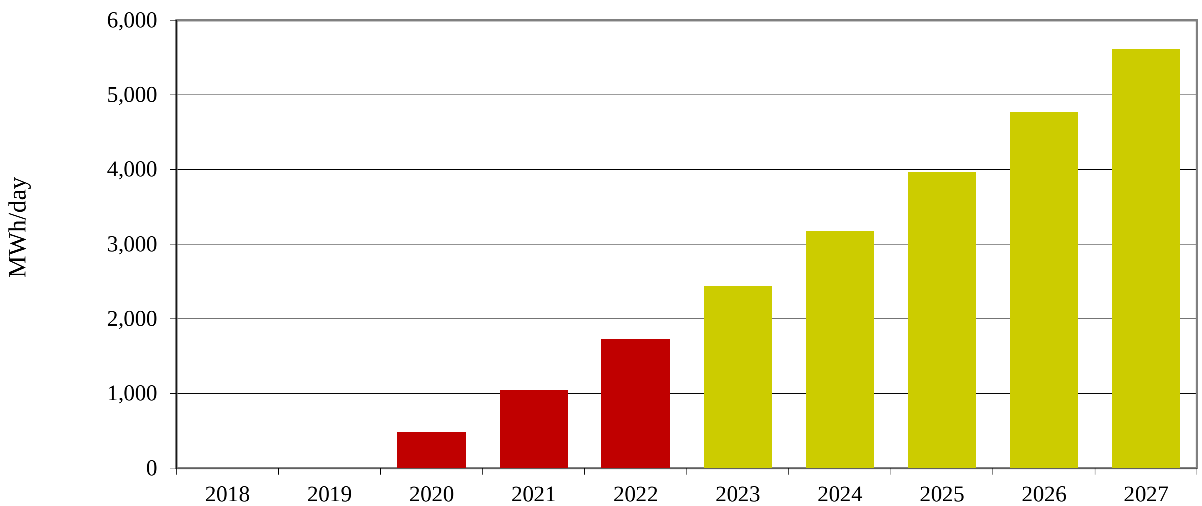


Figure 5-7: Actual and Projected OSP Daily Average Savings from New Multi-family Residences from 2020 to 2027 Based on the Year 2018.

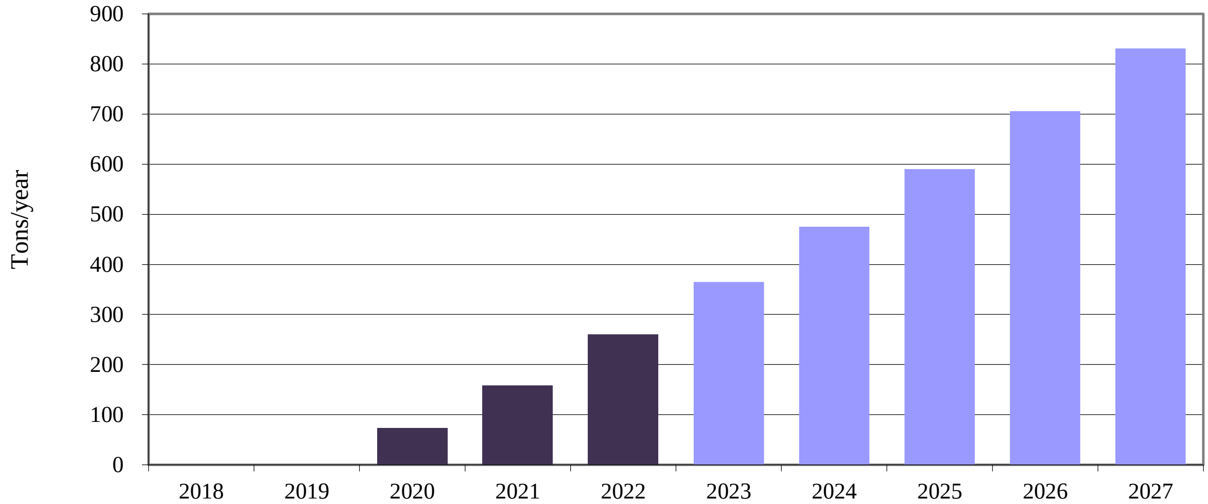


Figure 5-8: Actual and Projected Annual NOx Reduction from New Multi-family Residences from 2020 to 2027 Based on the Year 2018.

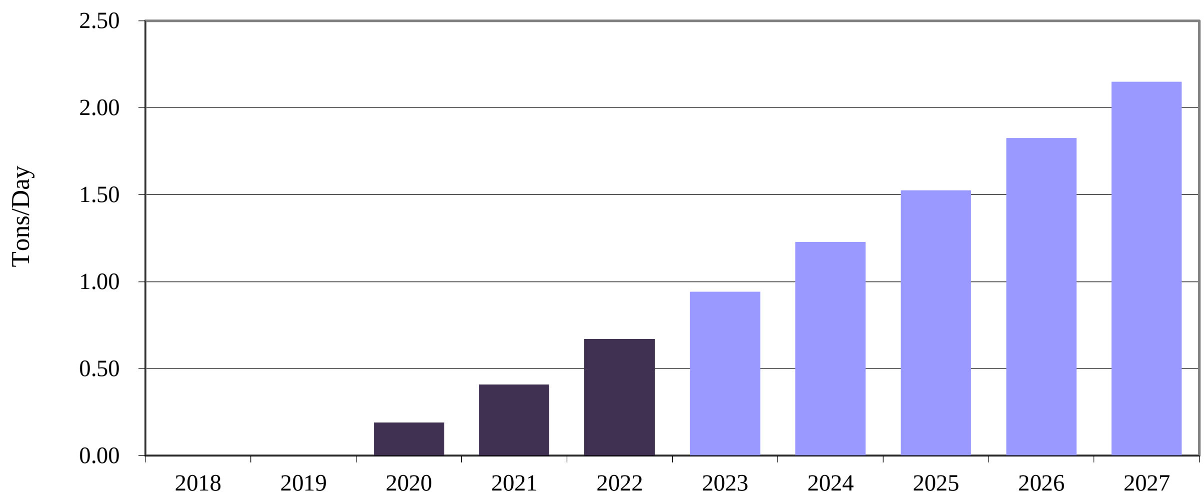


Figure 5-9: Actual and Projected OSP Average Daily NOx Reduction from New Multi-family Residences from 2020 to 2027 Based on the Year 2018.

5.3.2 PUC Calculation

PUC-Senate Bill 7. For the PUC Senate Bill 7 program savings, the annual electricity savings for 2022 were obtained from the Public Utility Commission of Texas (PUC 2023). The annual electricity savings from 2018 to 2022 listed in Table 20. Using these savings were projected through 2027 by incorporating the growth factor that listed in Table 19. The annual integrated saving from 2018 base year were calculated based on Table 20 with discount factor, T&D loss, and degradation factor that listed in Table 19. Similar savings were assumed for each year after 2022 until 2027. Figure 5-10 and Figure 5-11 list the annual savings from 2019 to 2027. The 2018 annual eGRID was used to calculate the NOx emissions savings for the PUC-Senate Bill 7 program. The total electricity savings for each CL zone were used to calculate the NOx emissions reductions for each county using the emissions factors contained in the US EPA's eGRID spreadsheet, which then were used to estimate the integrated NOx emissions reductions for each county. Figure 5-12 and Figure 5-13 list the integrated annual and OSP NOx reduction from 2019 to 2027.

Table 20: 2019 to 2021 Verified Savings by Utility (PUC 2019, 2020, 2021, 2022, 2023)

County	Annual Energy Savings 2018		Annual Energy Savings 2019		Annual Energy Savings 2020		Annual Energy Savings 2021		Annual Energy Savings 2022	
	Electric		Electric		Electric		Electric		Electric	
	MWh	MWh/ ozone season day	MWh	MWh/ ozone season day	MWh	MWh/ ozone season day	MWh	MWh/ ozone season day	MWh	MWh/ ozone season day
AEP-North	12,669	34.7	11,968	32.8	12,785	35.0	14,853	40.7	14,891	40.8
AEP-Central	62,417	171.0	58,398	160.0	59,265	162.4	68,848	188.6	69,025	189.1
SWEPCO	17,017	46.6	16,233	44.5	16,246	44.5	17,402	47.7	14,012	38.4
CenterPoint	162,440	445.0	215,620	590.7	189,588	519.4	235,257	644.5	226,351	620.1
Oncor	218,304	598.1	243,152	666.2	295,496	809.6	309,859	848.9	302,293	828.2
TNMP	17,204	47.1	15,624	42.8	16,802	46.0	18,924	51.8	18,057	49.5
Entergy	48,100	131.8	44,554	122.1	44,885	123.0	57,477	157.5	50,138	137.4
SPS	18,906	51.8	23,328	63.9	25,663	70.3	25,411	69.6	18,883	51.7
El Paso Electric	20,726	56.8	24,826	68.0	30,704	84.1	27,952	76.6	22,499	61.6

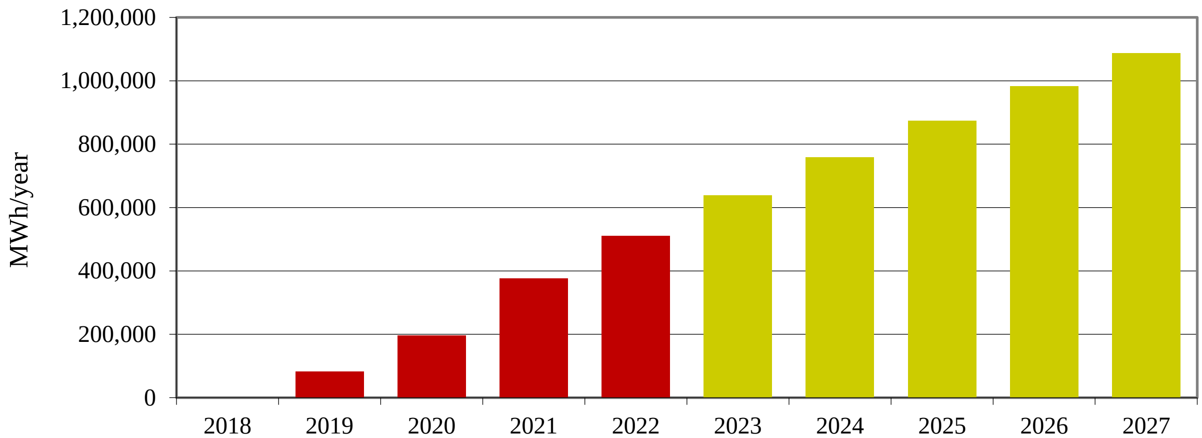


Figure 5-10: Actual and Projected Annual Savings from PUC from 2019 to 2027 Based on the Year 2018.

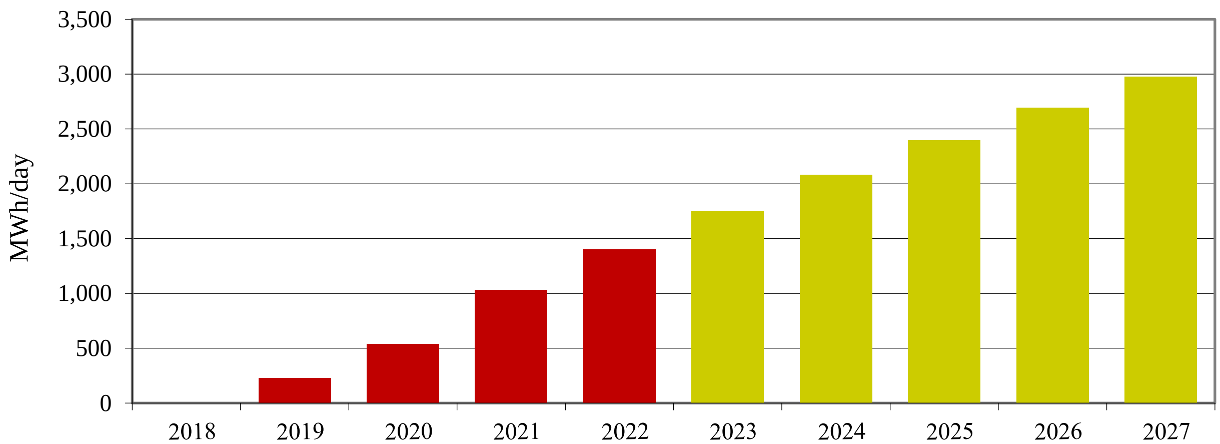


Figure 5-11: Actual and Projected OSP Daily Average Savings from PUC from 2019 to 2027 Based on the Year 2018.

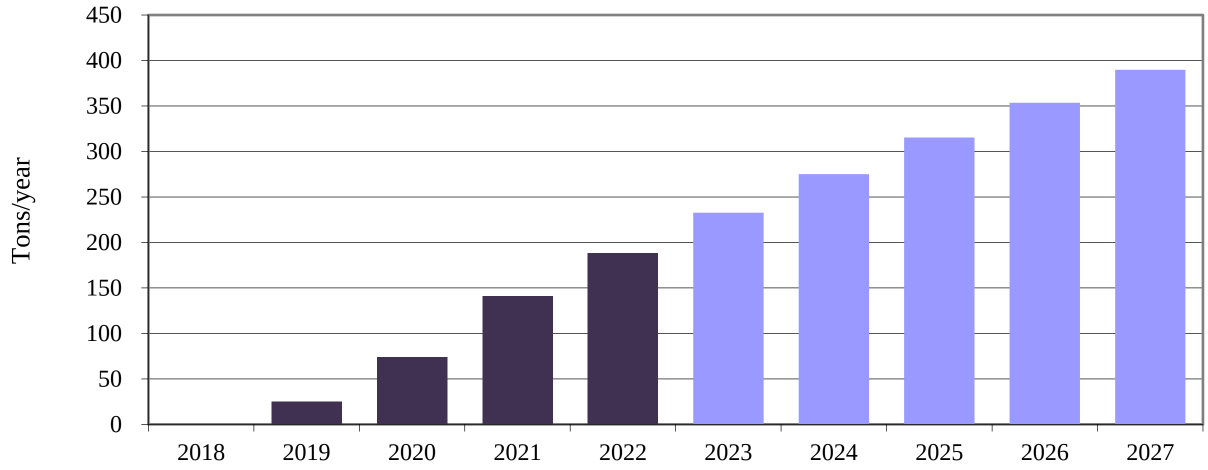


Figure 5-12: Actual and Projected Annual NOx reduction from PUC from 2019 to 2027 Based on the Year 2018.

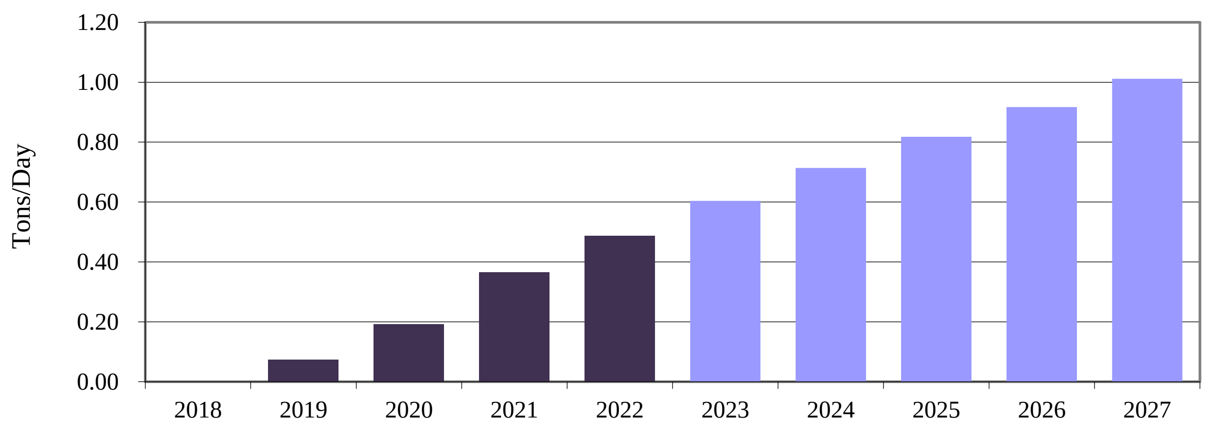


Figure 5-13: Actual and Projected OSP Average Daily NOx reduction from PUC from 2019 to 2027 Based on the Year 2018.

5.3.3 SECO Calculation

This section provides the potential electricity savings and the associated NOx emissions reductions in 2022 using the 2018 base year which is reported by political subdivisions for 2022 was obtained from the State Energy Conservation Office (SECO), including 225 valid entities in 44 surveyed counties in Texas. To calculate the NOx emissions reductions, the following procedures were adopted. First, total annual electricity consumption and total building areas were determined by county. To accomplish this, the 12-month calendar year (January 1st, 2021 – December 31st, 2021), the 12-month physical year (September 1st, 2020 – August 31st, 2021), and 12-month period (October 1st, 2021 – September 30th, 2022) data were calculated. Next, the annual energy use intensity (EUI) for each county was estimated and the county's energy savings for 2022 against the baseline year of 2018 were calculated. Using the reported consumption, the annual and OSP electricity savings resulted from energy conservation projects were then calculated. The NOx reductions potential from the electricity savings in each county was calculated using the US EPA's 2018 eGRID database (USEPA 2018)[29].

The electricity savings reported by SECO are shown in Table 21, including 264 entities in 44 counties, and 225 entities are valid for the electricity savings and NOx reduction calculation. The standard for the valid entities selection is based on the 12-month data report. Three reported date methods are included: first method is to start from January 1st, 2021, and end on December 31st, 2022; second method is to start from September 1st, 2021, and end on August 31st, 2022; three method is to start from October 1st, 2021, and end on September 30th, 2022. In Table 21, the rows are first sorted by counties, and then by entities names. Next, the third column and the fourth column show the start report date and the end report date. In addition, the fifth column, the 12-month data classification is listed. The sixth through seventh columns show the building electricity consumption and the building area.

In Table 22, the potential electricity savings and the EUIs are shown for each county. The second column shows the 2021 total building areas by counties. The third column shows the total annual electricity consumptions are calculated based on all entities in each county. In the fourth column, it shows the EUIs in 2022. In the fifth column, the potential electricity savings in 2022 are shown for each county. A 7% transmission and distribution loss were used through the 2019 to 2021 reports, which represented a fixed 1.07 multiplier for the electricity use. However, in the 2022 report, a 5.25%[30] transmission and distribution loss are used, which represents a fixed 1.05 multiplier for the electricity use. In addition, the 2022 total annual electricity savings are in MWh unit, therefore, it requests to divide 1,000 to convert kWh to MWh in calculation progress.

Figure 5-14 and Figure 5-15 list the annual savings from 2019 to 2027. The 2018 annual eGRID was used to calculate the NOx emissions savings for the SECO Senate Bill 5 Program. The total electricity savings for each CL zone were used to calculate the NOx emissions reductions for each county using the emissions factors contained in the US EPA's eGRID spreadsheet, which then were used to estimate the integrated NOx emissions reductions for each county. Figure 5-16 and Figure 5-17 list the integrated annual and OSP NOx reduction from 2019 to 2027.

[29] 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.
[30] EIA. 2023. Texas Electricity Profile. Table 10. Supply and disposition of electricity, 1990 through 2021. Accessed: September 28, 2023. available at: https://www.eia.gov/electricity/state/texas/

Table 21: 2022 SECO Report

County of Origin	SECO Entity Name	Start Date	End Date	12 months	Bulding Consumption (kWh/yr)	Entity Square Footage (ft^2)	County of Origin	SECO Entity Name	Start Date	End Date	12 months	Bulding Consumption (kWh/yr)	Entity Square Footage (ft^2)
Bastrop	City of Bastrop	1/1/2022	12/31/2022	Y	5,446,846	123,384	Denton	City of Krum	1/1/2022	12/31/2022	Y	1,965,025	41,219
Bastrop	Txdot	09/01/2021	08/31/2022	Y	-	-	Denton	City of Lake Dallas	1/1/2022	12/31/2022	Y	885,419	27,084
Bexar	Alamo Area Council of Governments	1/1/2022	12/31/2022	Y	3,238,450	117,838	Denton	City of Lewisville	1/1/2022	12/31/2022	Y	30,906,425	643,843
Bexar	Alamo Colleges District	09/01/2021	08/31/2022	Y	74,367,925	5,641,841	Denton	City of Oak Point	1/1/2022	12/31/2022	Y	203,428	12,278
Bexar	Bexar Apprisal	1/1/2022	12/31/2022	Y	720,000	51,712	Denton	City of Pilot Point	1/1/2022	12/31/2022	Y	2,595,638	48,508
Bexar	City of Fair Oaks Ranch, Texas	10/01/2021	09/30/2022	Y	2,487,029	38,216	Denton	City of Roanoke	1/1/2022	12/31/2022	Y	4,000,987	155,812
Bexar	City of San Antonio	1/1/2022	12/31/2022	Y	224,665,774	18,139,845	Denton	Hhsc - Denton State Supported Living Center	09/01/2021	08/31/2022	Y	8,392,803	485,984
Bexar	Hhsc - San Antonio State Hospital	09/01/2021	08/31/2022	Y	10,655,970	581,453	Denton	Lake Cities Municipal Utility Authority	01/12/2021	01/11/2022	Y	-	-
Bexar	Hhsc ??? San Antonio State Supported Living Center	09/01/2021	08/31/2022	Y	6,174,000	219,929	Denton	Town of Argyle	1/1/2022	12/31/2022	Y	368,921	21,000
Bexar	Hhsc ??? Texas Center For Infectious Diseases	09/01/2021	08/31/2022	Y	5,481,600	193,924	Denton	Town of Bartonville	1/1/2022	12/31/2022	Y	46,690	3,329
Bexar	Texas A&M University - San Antonio	09/01/2021	08/31/2022	Y	11,560,308	577,757	Denton	Town of Double Oak	1/1/2022	12/31/2022	Y	46,784	6,590
Bexar	Texas Lottery Commission	09/01/2021	08/31/2022	Y	-	-	Denton	Town of Lakewood Village	1/1/2022	12/31/2022	Y	465,101	3,000
Bexar	Txdot	09/01/2021	08/31/2022	Y	302,266	271,386	Denton	Town of Little Elm	1/1/2022	12/31/2022	Y	14,981,428	220,000
Brazoria	City of Iowa Colony	1/1/2022	12/31/2022	Y	81,502	7,200	Denton	Town of Northlake	1/1/2022	12/31/2022	Y	3,816,514	18,000
Brazoria	Iowa Colony	1/1/2022	12/31/2022	Y	74,183	7,200	Denton	Trophy Club Municipal Utility District No. 1	1/1/2022	12/31/2022	Y	4,788,572	8,600
Brazoria	Txdot	09/01/2021	08/31/2022	Y	227,400	40,839	Denton	University of North Texas	09/01/2021	08/31/2022	Y	120,592,105	7,889,238
Caldwell	Txdot	09/01/2021	08/31/2022	Y	-	-	El Paso	Eighth Court of Appeals	1/1/2022	12/31/2022	Y	-	-
Chambers	Txdot	09/01/2021	08/31/2022	Y	58,998	1,835	El Paso	Hhsc ??? El Paso Psychiatric Center	09/01/2021	08/31/2022	Y	1,298,700	107,883
Collin	City of Allen	1/1/2022	12/31/2022	Y	30,867,710	709,425	El Paso	Hhsc ??? El Paso State Supported Living Center	09/01/2021	08/31/2022	Y	2,367,750	118,465
Collin	City of Frisco	1/1/2022	12/31/2022	Y	39,031,066	2,026,998	El Paso	Texas Lottery Commission	09/01/2021	08/31/2022	Y	-	-
Collin	City of Josephine	1/1/2022	12/31/2022	Y	78,692	5,000	El Paso	Txdot	09/01/2021	08/31/2022	Y	264,859	85
Collin	City of Lavon	1/1/2022	12/31/2022	Y	966,348	19,919	Ellis	City of Maypearl	1/1/2022	12/31/2022	Y	456,071	3,000
Collin	City of Lowry Crossing	1/1/2022	12/31/2022	Y	7,200	1,800	Ellis	City of Oak Leaf	1/1/2022	12/31/2022	Y	28,973	4,555
Collin	City of Lucas	1/1/2022	12/31/2022	Y	-	-	Ellis	City of Ovilla	1/1/2022	12/31/2022	Y	563,160	19,242
Collin	City of Mckinney	1/1/2022	12/31/2022	Y	6,258,089	982,648	Ellis	City of Waxahachie	10/01/2021	09/30/2022	Y	-	-
Collin	City of Murphy	1/1/2022	12/31/2022	Y	4,433,306	97,426	Ellis	City of Waxahachie	1/1/2022	12/31/2022	Y	611,800	165,601
Collin	City of Parker	1/1/2022	12/31/2022	Y	1,121,648	34,700	Ellis	Txdot	09/01/2021	08/31/2022	Y	226,053	34
Collin	City of Plano	1/1/2022	12/31/2022	Y	61,883,606	1,709,119	Ellis	Txdot	09/01/2021	08/31/2022	Y	226,053	38,838
Collin	City of Wylie	1/1/2022	12/31/2022	Y	3,564,626	180,263	Fort Bend	City of Sugar Land	1/1/2022	12/31/2022	Y	7,999,552	651,499
Collin	Collin Central Appraisal District	1/1/2022	12/31/2022	Y	777	60,000	Fort Bend	Fort Bend County	1/1/2022	12/31/2022	Y	36,431,413	2,618,014
Collin	Collin County Community College District	1/1/2022	12/31/2022	Y	33,376,490	3,017,953	Fort Bend	Hhsc ??? Richmond State Supported Living Center	09/01/2021	08/31/2022	Y	8,214,768	469,752
Collin	North Texas Municipal Water District	10/01/2021	09/30/2022	Y	-	-	Fort Bend	Txdot	09/01/2021	08/31/2022	Y	352,040	2,675
Collin	North Texas Tollway Authority - Ntta	1/1/2022	12/31/2022	Y	22,117,500	354,000	Fort Bend	Village of Pleak	1/1/2022	12/31/2022	Y	48,905	6,000
Collin	Town of New Hope	1/1/2022	12/31/2022	Y	6,407	1,288	Galveston	City of Dickinson	1/1/2022	12/31/2022	Y	1,577,335	7,395
Collin	Town of Prosper	1/1/2022	12/31/2022	Y	8,336,371	116,751	Galveston	City of Friendswood	1/1/2022	12/31/2022	Y	6,237,037	185,249
Collin	Town of St Paul	1/1/2022	12/31/2022	Y	35,360	3,064	Galveston	City of Kemah	1/1/2022	12/31/2022	Y	596,380	60,000
Collin	Txdot	09/01/2021	08/31/2022	Y	22,304	26,498	Galveston	Texas A&M University - Galveston	09/01/2021	08/31/2022	Y	1,020,845	1,020,845
Comal	Comal County	1/1/2022	12/31/2022	Y	8,697,910	614,294	Galveston	Txdot	09/01/2021	08/31/2022	Y	378,911	44
Comal	Txdot	09/01/2021	08/31/2022	Y	198,338	14	Gregg	Gregg County	1/1/2022	12/31/2022	Y	8,846,783	467,074
Dallas	City of Cedar Hill	1/1/2022	12/31/2022	Y	10,330,128	254,365	Gregg	Railroad Commission of Texas	09/08/2021	09/07/2022	Y	44,716	8,890
Dallas	City of Coppell	1/1/2022	12/31/2022	Y	44,000	300,000	Gregg	Txdot	09/01/2021	08/31/2022	Y	378,911	5,123
Dallas	City of Dallas	1/1/2022	12/31/2022	Y	647,065,723	10,780,990	Hansford	City of Spearman	10/01/2021	09/30/2022	Y	35,485	32,965
Dallas	City of Desoto	1/1/2022	12/31/2022	Y	3,753,626	250,060	Hardin	Hardin County Appraisal District	1/1/2022	12/31/2022	Y	52,301	3,312
Dallas	City of Farmers Branch	1/1/2022	12/31/2022	Y	9,937,405	340,983	Hardin	Txdot	09/01/2021	08/31/2022	Y	43,664	12,487
Dallas	City of Glenn Heights	1/1/2022	12/31/2022	Y	1,106,500	72,354	Harris	City of Hilshire Village	1/1/2022	12/31/2022	Y	47,133	1,625
Dallas	City of Grand Prairie	1/1/2022	12/31/2022	Y	40,562,714	1,628,124	Harris	City of Houston	1/1/2022	12/31/2022	Y	1,066,267,804	28,342,781
Dallas	City of Irving	1/1/2022	12/31/2022	Y	56,690,674	1,520,948	Harris	City of Jacinto City	1/1/2022	12/31/2022	Y	9,151,228	87,988
Dallas	City of Lancaster	1/1/2022	12/31/2022	Y	8,916,640	230,726	Harris	City of Taylor Lake Village	1/1/2022	12/31/2022	Y	247,802	4,500
Dallas	City of Mesquite	1/1/2022	12/31/2022	Y	26,103,832	736,868	Harris	Harris Central Appraisal District	1/1/2022	12/31/2022	Y	3,785,625	449,127
Dallas	City of Richardson	1/1/2022	12/31/2022	Y	30,566,680	1,108,710	Harris	Hedwig Village, City Of	1/1/2022	12/31/2022	Y	439,921	366,935
Dallas	City of Rowlett	10/01/2021	09/30/2022	Y	10,257,090	207,146	Harris	Houston Community College	09/01/2021	08/31/2022	Y	75,042,831	4,342,463
Dallas	City of Sachse	1/1/2022	12/31/2022	Y	173,924,538	96,800	Harris	Texas Lottery Commission	09/01/2021	08/31/2022	Y	-	-
Dallas	Dallas Central Appraisal District	1/1/2022	12/31/2022	Y	2,287,814	95,692	Harris	Txdot	09/01/2021	08/31/2022	Y	200,860	34,382
Dallas	Dallas College	09/01/2021	08/31/2022	Y	66,998,530	4,978,691	Harris	University of Houston	09/01/2021	08/31/2022	Y	273,971,809	16,255,000
Dallas	Dallas County Hospital District Dba Parkland Health	1/1/2022	12/31/2022	Y	127,480,087	8,463,019	Harrison	City of Waskom	1/1/2022	12/31/2022	Y	750,336	20,000
Dallas	Dfw Airport	10/01/2021	09/30/2022	Y	271,103,618	49,860,000	Harrison	Txdot	09/01/2021	08/31/2022	Y	200,860	34,882
Dallas	Garland Power & Light	10/01/2021	09/30/2022	Y	33,685,243	1,684,508	Hays	City of San Marcos	1/1/2022	12/31/2022	Y	172,681,752	575,027
Dallas	Garland Power & Light	1/1/2022	12/31/2022	Y	51,642,648	1,684,508	Hays	Texas State University	09/01/2021	08/31/2022	Y	117,010,719	7,051,837
Dallas	Texas Lottery Commission	09/01/2021	08/31/2022	Y	-	-	Henderson	Txdot	09/01/2021	08/31/2022	Y	143,200	119,255
Dallas	Town of Addison	1/1/2022	12/31/2022	Y	9,459,363	597,700	Hood	Acton Municipal Utility District	1/1/2022	12/31/2022	Y	5,838,637	13,965
Dallas	Town of Highland Park	1/1/2022	12/31/2022	Y	2,080,868	67,250	Hunt	City of Quinlan	1/1/2022	12/31/2022	Y	583,507	8,500
Dallas	Ttu Health Sciences Center	09/01/2021	08/31/2022	Y	2,008,147	72,075	Hunt	Texas A&M University - Commerce	09/01/2021	08/31/2022	Y	37,325,520	2,833,881
Denton	City of Aubrey	1/1/2022	12/31/2022	Y	1,440,539	21,368	Hunt	Txdot	09/01/2021	08/31/2022	Y	8,873	40,895
Denton	City of Corinth	1/1/2022	12/31/2022	Y	3,513,453	98,716	Jefferson	City of Port Neches	1/1/2022	12/31/2022	Y	4,218,566	56,658
Denton	City of Denton	1/1/2022	12/31/2022	Y	48,066,678	1,137,566	Jefferson	Ninth Court of Appeals	1/1/2022	12/31/2022	Y	-	-
Denton	City of Krugerville	1/1/2022	12/31/2022	Y	210,665	5,635	Jefferson	Texas Lottery Commission	09/01/2021	08/31/2022	Y	-	-

Table 21: 2022 SECO Report (Continued)

County of Origin	SECO Entity Name	Start Date	End Date	12 months	Bulding Consumption (kWh/yr)	Entity Square Footage (ft^2)	County of Origin	SECO Entity Name	Start Date	End Date	12 months	Bulding Consumption (kWh/yr)	Entity Square Footage (ft^2)
Jefferson	Txdot	09/01/2021	08/31/2022	Y	286,990	169,213	Tarrant	City of Euless	1/1/2022	12/31/2022	Y	10,508,395	222,592
Johnson	Central Appraisal District of Johnson County	1/1/2022	12/31/2022	Y	136,765	12,667	Tarrant	City of Fort Worth	1/1/2022	12/31/2022	Y	335,479,537	12,858,061
Johnson	City of Alvarado	1/1/2022	12/31/2022	Y	1,672,592	39,000	Tarrant	City of Grapevine	1/1/2022	12/31/2022	Y	27,883,997	735,094
Johnson	City of Alvarado	1/1/2022	12/31/2022	Y	1,672,592	39,000	Tarrant	City of Haslet	1/1/2022	12/31/2022	Y	805,873	21,145
Johnson	City of Cleburne	1/1/2022	12/31/2022	Y	15,025,793	619,062	Tarrant	City of Hurst	1/1/2022	12/31/2022	Y	10,455,489	385,469
Johnson	City of Grandview	1/1/2022	12/31/2022	Y	534,485	7,393	Tarrant	City of Lake Worth	1/1/2022	12/31/2022	Y	1,633,871	47,855
Johnson	City of Joshua	1/1/2022	12/31/2022	Y	473,163	35,182	Tarrant	City of North Richland Hills	1/1/2022	12/31/2022	Y	10,327,911	555,008
Johnson	Johnson County Special Utility District	1/1/2022	12/31/2022	Y	207,000	25,000	Tarrant	City of Richland Hills	1/1/2022	12/31/2022	Y	2,289,460	74,749
Johnson	Town of Cross Timber	10/01/2021	09/30/2022	Y	33	400	Tarrant	City of River Oaks	1/1/2022	12/31/2022	Y	901,730	46,999
Johnson	Txdot	09/01/2021	08/31/2022	Y	183,723	24,051	Tarrant	City of River Oaks	1/1/2022	12/31/2022	Y	901,730	46,999
Kaufman	City of Combine	10/01/2021	09/30/2022	Y	47,805	9,496	Tarrant	City of Sansom Park	1/1/2022	12/31/2022	Y	1,753,956	15,000
Kaufman	City of Forney	1/1/2022	12/31/2022	Y	3,880,062	80,226	Tarrant	City of Watauga	1/1/2022	12/31/2022	Y	2,134,540	116,308
Kaufman	City of Kemp	1/1/2022	12/31/2022	Y	594,040	44,852	Tarrant	City of White Settlement	1/1/2022	12/31/2022	Y	-	-
Kaufman	City of Mabank	1/1/2022	12/31/2022	Y	3,238,450	50,000	Tarrant	Tarrant Appraisal District	1/1/2022	12/31/2022	Y	716,000	45,816
Kaufman	City of Oak Ridge	1/1/2022	12/31/2022	Y	25,389	2,400	Tarrant	Tarrant County College District	09/01/2021	08/31/2022	Y	55,471,364	3,878,107
Kaufman	Hhsc - Terrell State Hospital	09/01/2021	08/31/2022	Y	8,794,276	769,456	Tarrant	Tarrant Regional Water District (Trwd)	1/1/2022	12/31/2022	Y	206,818,559	216,436
Liberty	City of Liberty	10/01/2021	09/30/2022	Y	1,134,760	44,196	Tarrant	Texas Lottery Commission	09/01/2021	08/31/2022	Y	-	-
Liberty	Txdot	09/01/2021	08/31/2022	Y	68,192	19,715	Tarrant	Town of Trophy Club	1/1/2022	12/31/2022	Y	1,971,036	40,000
Montgomery	Montgomery County Esd8	1/1/2022	12/31/2022	Y	1,095,577	90,891	Tarrant	Town of Westlake	1/1/2022	12/31/2022	Y	2,791,285	186,050
Montgomery	Txdot	09/01/2021	08/31/2022	Y	5,588	31,290	Tarrant	Txdot	09/01/2021	08/31/2022	Y	1,187,386	303,517
Montgomery	Txdot	09/01/2021	08/31/2022	Y	216,800	31,290	Tarrant	University of North Texas Health Science Center	09/01/2021	08/31/2022	Y	30,562,404	1,364,776
Nueces	City of Bishop	1/1/2022	12/31/2022	Y	567,405	6,813	Travis	City of Austin Office of Sustainability	1/1/2022	12/31/2022	Y	312,750,126	14,000,000
Nueces	Corpus Christi Regional Transportation Authority	1/1/2022	12/31/2022	Y	4,822,073	154,500	Travis	City of Bee Cave	1/1/2022	12/31/2022	Y	778,864	42,107
Nueces	Hhsc ??? Corpus Christi State Supported Living Center	09/01/2021	08/31/2022	Y	5,667,774	261,595	Travis	City of Lakeway	1/1/2022	12/31/2022	Y	1,258,309	82,695
Nueces	Texas A&M University - Corpus Christi	09/01/2021	08/31/2022	Y	36,860,298	3,306,077	Travis	City of Pflugerville	1/1/2022	12/31/2022	Y	76,062,659	184,549
Nueces	Texas Lottery Commission	09/01/2021	08/31/2022	Y	-	-	Travis	Credit Union Department	09/01/2021	08/31/2022	Y	36,960	4,182
Nueces	Txdot	09/01/2021	08/31/2022	Y	1,843,246	172,406	Travis	Employees Retirement System of Texas	09/01/2021	08/31/2022	Y	1,443,500	122,862
Orange	Orange County Navigation And Port District	1/1/2022	12/31/2022	Y	134,568	7,000	Travis	Hhsc - Austin State Hospital	09/01/2021	08/31/2022	Y	10,256,076	755,908
Orange	Txdot	09/01/2021	08/31/2022	Y	123,200	36,067	Travis	Hhsc - Austin State Supported Living Center	09/01/2021	08/31/2022	Y	6,928,200	6,088,500
Orange	Txdot	09/01/2021	08/31/2022	Y	123,200	36,067	Travis	State Commission On Judicial Conduct	1/1/2022	12/31/2022	Y	-	-
Palo Pinto	City of Mineral Wells	1/1/2022	12/31/2022	Y	-	-	Travis	State Office of Administrative Hearings	09/01/2021	08/31/2022	Y	-	-
Parker	Annetta North	1/1/2022	12/31/2022	Y	-	-	Travis	Texas Behavioral Health Executive Council	1/1/2022	12/31/2022	Y	-	-
Parker	Azle	1/1/2022	12/31/2022	Y	6,708,957	156,436	Travis	Texas Board of Chiropractic Examiners	09/01/2021	08/31/2022	Y	-	-
Parker	City of Aledo	1/1/2022	12/31/2022	Y	1,298,000	7,362	Travis	Texas Board of Professional Engineers And Land Surveyors	09/01/2021	08/31/2022	Y	106,500	9,246
Parker	City of Annetta South	1/1/2022	12/31/2022	Y	-	-	Travis	Texas Department of Public Safety	09/01/2021	08/31/2022	Y	47,447,583	2,513,238
Parker	City of Millsap	1/1/2022	12/31/2022	Y	7,448	1,000	Travis	Texas Division of Emergency Management	09/01/2021	08/31/2022	Y	163,968	258,715
Parker	City of Springtown	1/1/2022	12/31/2022	Y	1,963,819	41,316	Travis	Texas Facilities Commission	09/01/2021	08/31/2022	Y	162,080,513	11,184,469
Parker	City of Weatherford	09/01/2021	08/31/2022	Y	22,203,926	266,355	Travis	Texas Lottery Commission	09/01/2021	08/31/2022	Y	-	-
Parker	City of Willow Park	1/1/2022	12/31/2022	Y	1,428,713	380,396	Travis	Texas Water Development Board	09/01/2021	08/31/2022	Y	21,773	7,827
Parker	Town of Annetta	10/01/2021	09/30/2022	Y	1,235,150	1,400	Travis	Texas Workforce Commission	09/01/2021	08/31/2022	Y	10,106,207	669,106
Parker	Town of Annetta	1/1/2022	12/31/2022	Y	20,044	1,400	Travis	Travis County, Facilities Management Department	1/1/2022	12/31/2022	Y	46,301,356	3,225,123
Parker	Txdot	09/01/2021	08/31/2022	Y	213,398	29,823	Travis	Txdot	09/01/2021	08/31/2022	Y	3,204,469	2,692,917
Rockwall	City of Fate	1/1/2022	12/31/2022	Y	2,017,621	44,442	Upshur	Txdot	09/01/2021	08/31/2022	Y	136,633	21,410
Rockwall	City of Rockwall	1/1/2022	12/31/2022	Y	-	-	Walker	Texas Department of Criminal Justice	09/01/2021	08/31/2022	Y	129,154,398	6,993,315
Rockwall	City of Rockwall	1/1/2022	12/31/2022	Y	-	-	Walker	Texas Department of Criminal Justice	09/01/2021	08/31/2022	Y	129,154,398	6,993,315
Rockwall	Rockwall Central Appraisal District	1/1/2022	12/31/2022	Y	76,600	6,068	Walker	Txdot	09/01/2021	08/31/2022	Y	199,517	18,409
Rusk	City of New London	1/1/2022	12/31/2022	Y	539,526	10,917	Waller	Prairie View A&M University	09/01/2021	08/31/2022	Y	46,178,722	2,874,676
Rusk	Txdot	09/01/2021	08/31/2022	Y	329,271	20,754	Waller	Txdot	09/01/2021	08/31/2022	Y	86,190	18,409
San Patricio	San Patricio County	1/1/2022	12/31/2022	Y	4,525,244	590,408	Williamson	City of Cedar Park	1/1/2022	12/31/2022	Y	26,659,957	283,781
San Patricio	San Patricio County Appraisal District	1/1/2022	12/31/2022	Y	95,781	10,248	Williamson	City of Florence	1/1/2022	12/31/2022	Y	937,945	11,390
San Patricio	Txdot	09/01/2021	08/31/2022	Y	99,072	16,659	Williamson	City of Round Rock	1/1/2022	12/31/2022	Y	65,156,153	1,131,494
Smith	Texas Lottery Commission	09/01/2021	08/31/2022	Y	-	-	Williamson	City of Taylor	1/1/2022	12/31/2022	Y	4,539,628	97,854
Smith	The University of Texas At Tyler	09/01/2021	08/31/2022	Y	29,763,660	2,022,255	Williamson	City of Test	1/1/2022	12/31/2022	Y	10,000,000	1,000,000
Smith	Txdot	09/01/2021	08/31/2022	Y	822,251	152,094	Williamson	Txdot	09/01/2021	08/31/2022	Y	199,517	450,051
Tarrant	Benbrook Water Authority	1/1/2022	12/31/2022	Y	3,770,004	18,582	Williamson	Williamson Central Appraisal District	1/1/2022	12/31/2022	Y	550,200	33,000
Tarrant	City of Benbrook	1/1/2022	12/31/2022	Y	2,072,774	61,610	Wilson	City of Poth	1/1/2022	12/31/2022	Y	496,361	2,400
Tarrant	City of Blue Mound	1/1/2022	12/31/2022	Y	376,236	13,000	Wilson	City of Testing	1/1/2022	12/31/2022	Y	500,000,000	5,000,000
Tarrant	City of Colleyville	1/1/2022	12/31/2022	Y	4,847,515	179,796	Wise	City of Alvord	1/1/2022	12/31/2022	Y	480,199	15,840
Tarrant	City of Crowley	1/1/2022	12/31/2022	Y	1,496,163	122,739	Wise	City of Decatur	1/1/2022	12/31/2022	Y	-	-
Tarrant	City of Dalworthington Gardens	1/1/2022	12/31/2022	Y	364,942	15,762	Wise	Txdot	09/01/2021	08/31/2022	Y	153,241	41,565

Table 22: 2021 SECO Electricity Savings and EUIs

County	2022 Total Building Area (ft^2)	2022 Total Annual Eletricity Consumption (kWh/yr)	2022 EUI (kWh/ft^2-yr)	2018 EUI (kWh/ft^2-yr))	2022 Total Annual Electricity Savings (with 5.25% T&D Losses) (MWh)	County	2022 Total Building Area (ft^2)	2022 Total Annual Eletricity Consumption (kWh/yr)	2022 EUI (kWh/ft^2-yr)	2018 EUI (kWh/ft^2-yr))	2022 Total Annual Electricity Savings (with 5.25% T&D Losses) (MWh)
Bastrop	123,384	5,446,846	44.15	-	-	Hunt	2,883,276	37,917,900	13.15	-	-
Bexar	25,833,901	339,653,322	13.15	13.54	7,498	Jefferson	225,871	4,505,556	19.95	18.79	-
Brazoria	55,239	383,085	6.94	0.75	-	Jefferson	801,755	19,906,146	24.83	14.40	-
Caldwell	-	-	-	-	-	Kaufman	956,430	16,580,022	17.34	-	-
Chambers	1,835	58,998	32.15	-	-	Liberty	63,911	1,202,952	18.82	-	-
Collin	9,346,852	212,107,500	22.69	28.10	37,221	Mclennan	-	-	-	-	-
Comal	614,308	8,896,248	14.48	-	-	Montgomery	153,471	1,317,965	8.59	-	-
Coryell	-	-	-	-	-	Naacogdoches	-	-	-	-	-
Dallas	85,031,517	1,586,005,868	18.65	2.20	-	Nueces	3,901,391	49,760,796	12.75	17.18	12,719
Denton	10,847,770	247,287,175	22.80	15.37	-	Orange	79,134	380,968	4.81	20.42	910
El Paso	226,433	3,931,309	17.36	-	-	Palo Pinto	-	-	-	-	-
Ellis	231,270	2,112,110	9.13	-	-	Parker	885,488	35,079,455	39.62	11.92	-
Fort Bend	3,747,940	53,046,678	14.15	14.24	246	Rockwall	50,510	2,094,221	41.46	-	-
Fort Worth	-	-	-	-	-	Rusk	31,671	868,797	27.43	-	-
Galveston	1,273,533	9,810,508	7.70	-	-	San Patricio	617,315	4,720,097	7.65	8.54	407
Grayson	-	-	-	-	-	Smith	2,174,349	30,585,911	14.07	-	-
Gregg	481,087	9,270,410	19.27	18.67	-	Tarrant	21,571,470	717,522,157	33.26	12.62	-
Guadalupe	-	-	-	-	-	Travis	41,841,444	678,947,064	16.23	25.77	294,239
Hardin	15,799	95,965	6.07	-	-	Upshur	21,410	136,633	6.38	-	-
Harris	49,884,801	1,429,155,013	28.65	22.95	-	Uvalde	-	-	-	-	-
Harrison	54,882	951,196	17.33	-	-	Victoria	-	-	-	13.18	-
Hays	7,626,864	289,692,471	37.98	14.91	-	Walker	2,893,085	304,773,225	104.74	-	-
Henderson	119,255	143,200	1.20	-	-	Williamson	3,007,570	108,043,400	21.60	14.84	-
Hood	13,965	5,838,637	418.09	-	-	Wilson	5,002,400	500,496,361	-	-	-

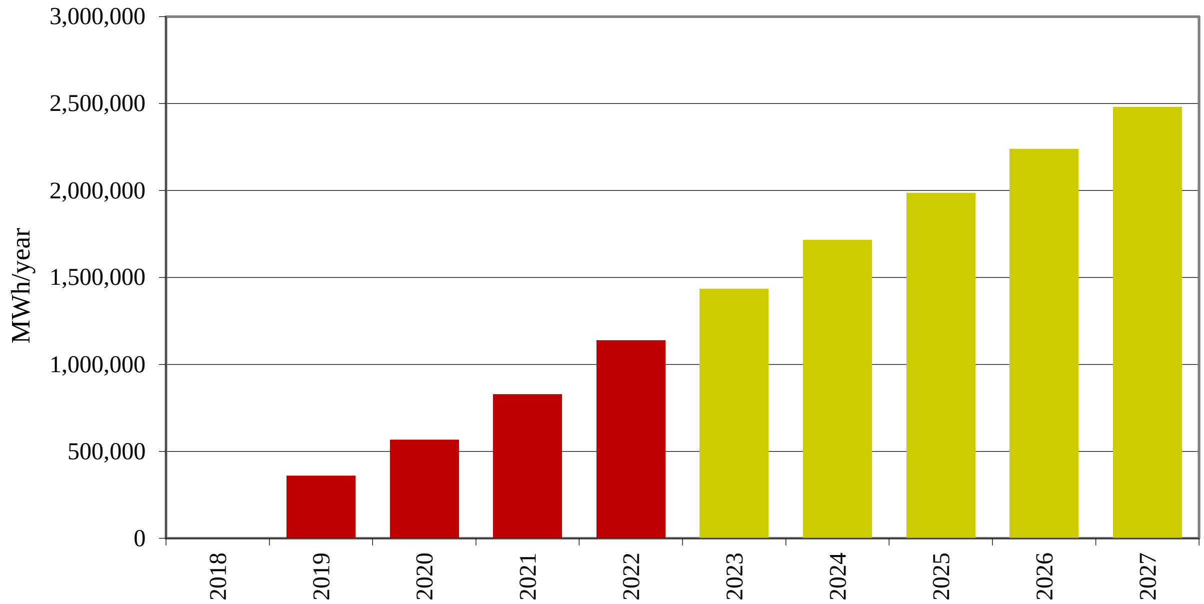


Figure 5-14: Actual and Projected Annual Savings from SECO from 2019 to 2027 Based on the Year 2018.

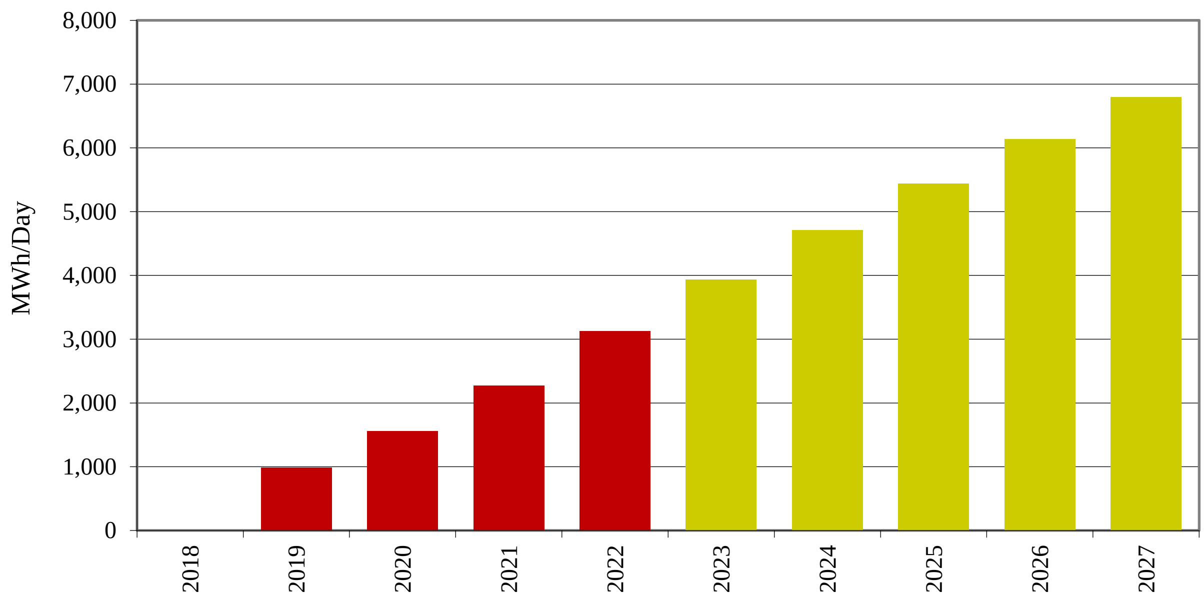


Figure 5-15: Actual and Projected OSP Daily Average Savings from SECO from 2019 to 2027 Based on the Year 2018.

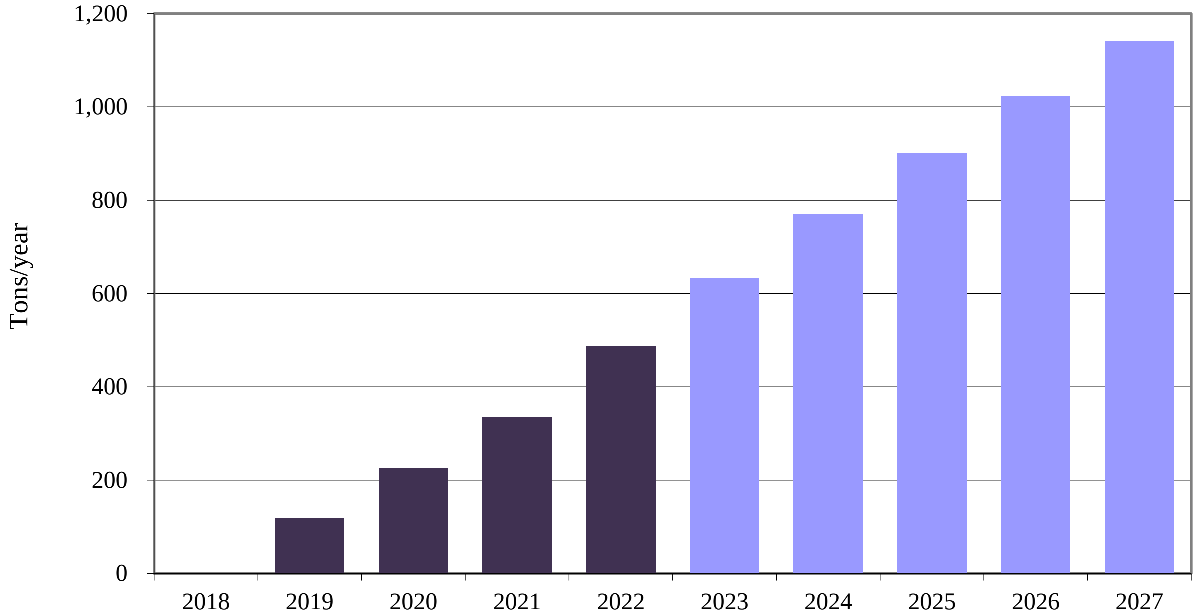


Figure 5-16: Actual and Projected Annual NOx reduction from SECO from 2019 to 2027 Based on the Year 2018.

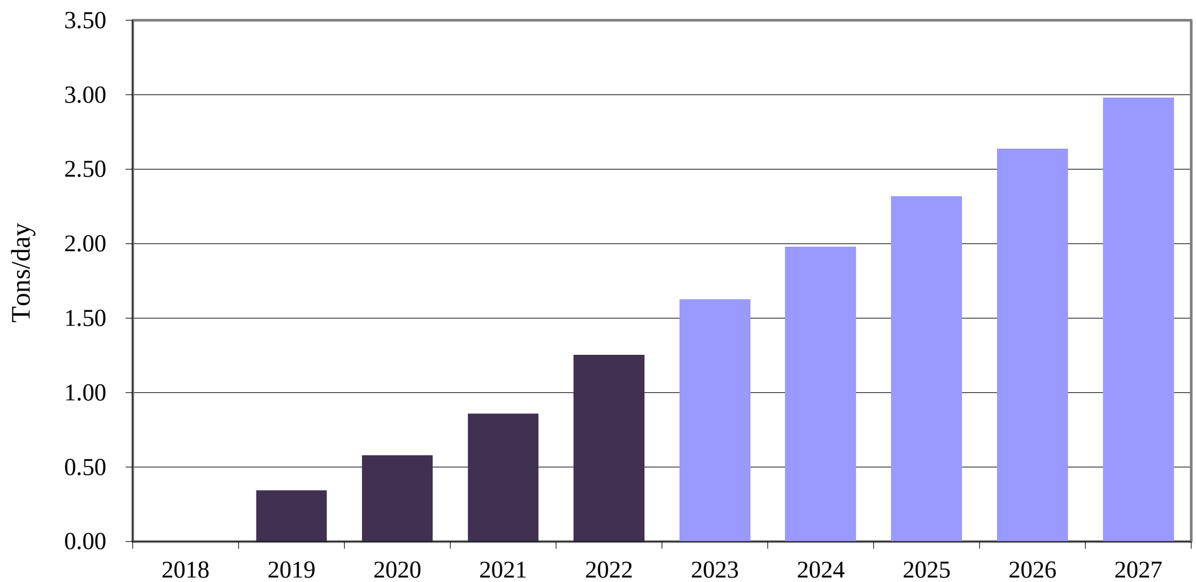


Figure 5-17: Actual and Projected OSP Average Daily NOx reduction from SECO from 2019 to 2027 Based on the Year 2018.

5.3.4 Electricity Generated by Renewables Calculation

The measured and estimated electricity production from renewables in Texas for 2018 through 2022 was obtained from the reports *Statewide Air Emissions Calculations from Wind and Other Renewables (2018-2023)* (Baltazar et al., 2019 - 2023). Using the reported numbers for 2022, savings through 2027 were projected incorporating the different adjustment factors mentioned above. Figure 5-18 and Figure 5-19 list the annual savings from 2019 to 2027. The 2016 eGRID was used for the 2019, and the 2018 eGRID was used for the period of 2020 through 2027 to calculate the NOx emissions reductions for the electricity generated by renewables in Texas. The total electricity savings for each CL zone were used to calculate the NOx emissions reductions for each of the different counties. Figure 5-20 and Figure 5-21 list the integrated annual and OSP NOx reduction from 2019 to 2027.

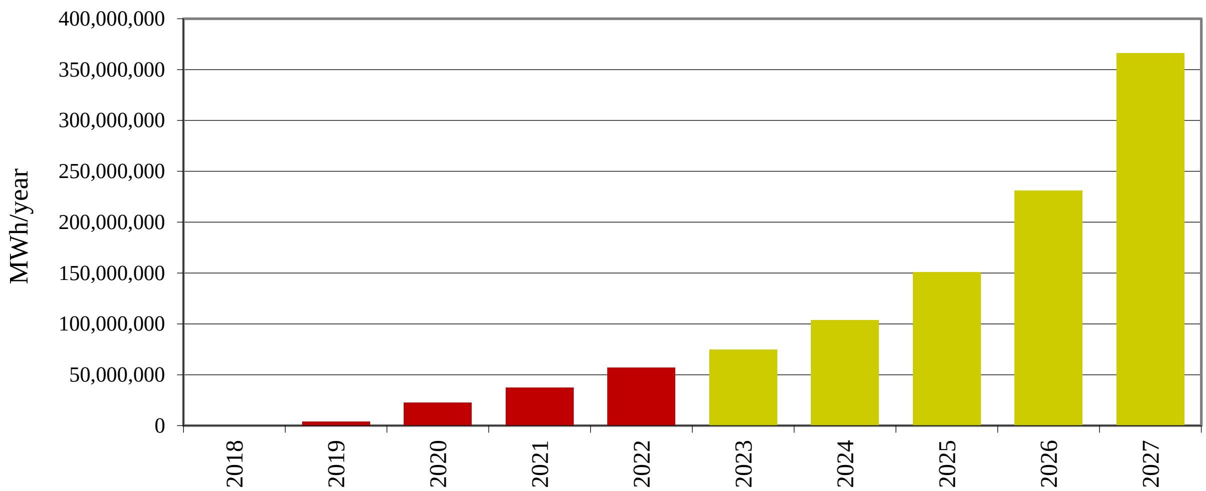


Figure 5-18: Actual and Projected Annual Savings from Renewable from 2019 to 2027 Based on the Year 2018.

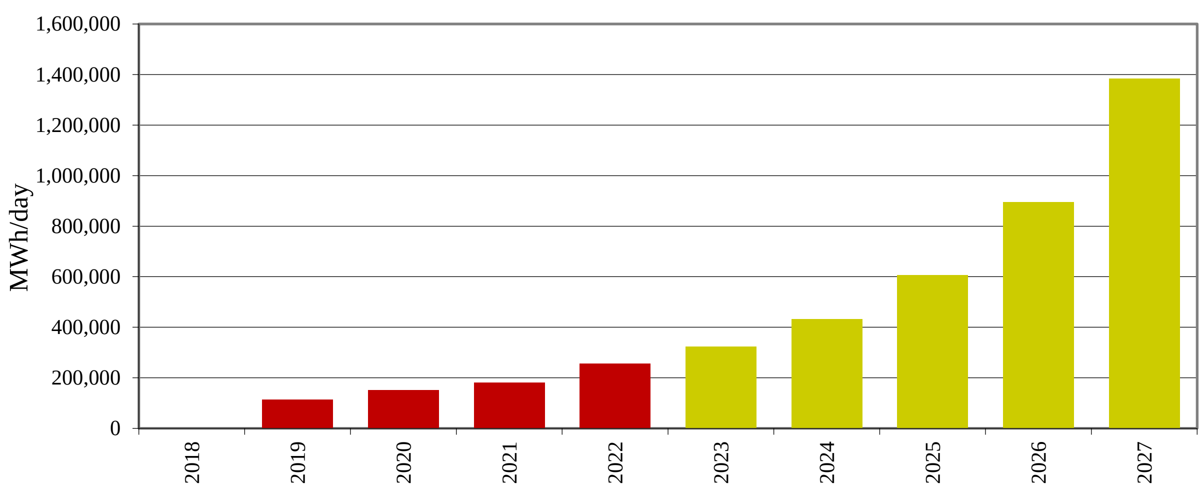


Figure 5-19: Actual and Projected OSP Daily Average Savings from Renewable from 2019 to 2027 Based on the Year 2018.

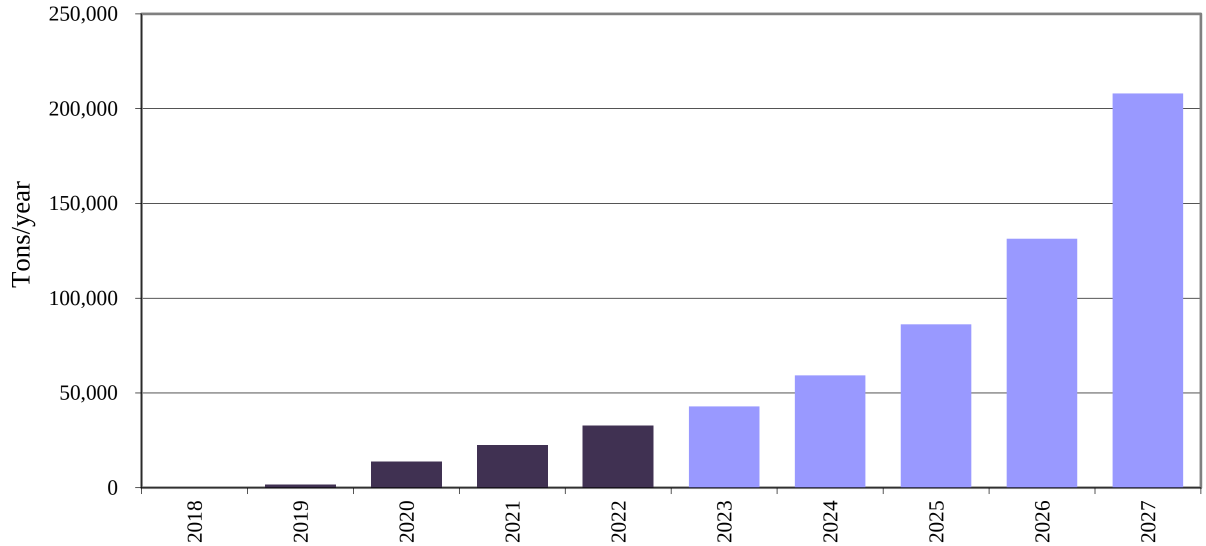


Figure 5-20: Actual and Projected Annual NOx reduction from Renewable from 2019 to 2027 Based on the Year 2018.

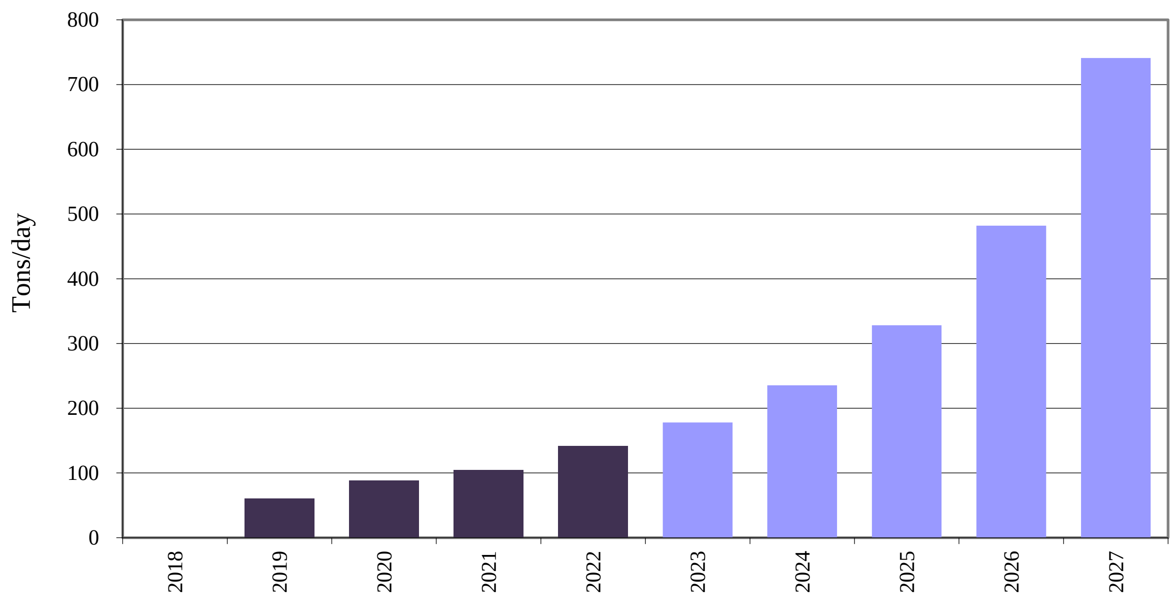


Figure 5-21: Actual and Projected OSP Average Daily NOx reduction from Renewable from 2019 to 2027 Based on the Year 2018.

5.3.5 SEER 14 Single-Family and Multi-Family Calculation

SEER 14 Single-Family and Multi-Family. Beginning in January 2015, Federal regulations mandated that the minimum efficiency for residential air conditioners be increased to SEER 14. According to the U.S. Department of Energy, the "lifespan" of a central air conditioner is about 15 to 20 years (average 17 years)[31]. Therefore, any existing residences built more than 17 years ago were assumed to have replaced their air conditioning with units with at least SEER 14 efficiency. In this report, 2018 is the base year for energy-saving calculations, and 2027 is the last projection year for analysis. Considering 17 years for air conditioning replacement, all households that were built from 2001 to 2010 are expected to replace their air conditioning units with at least SEER 14 efficiency. The number of single-family and multi-family units built during this period utilize the data from the Texas Real Estate Research Center.

This report estimates the annual cooling energy savings of a typical residential single-family and multi-family construction[32] from replacing air conditioning units (SEER 11 to SEER 14) in each climate zone inside ERCOT regions using DOE-2 hourly building simulation models. Therefore, the energy savings in each county are calculated from multiplying the number of new single-family and multi-family construction in each county (from 2001 to 2010) by the annual cooling energy savings for a typical residential building, considering adjustment factors (T&D Loss, Discount Factor). Since 2018 is the base year in this analysis, the actual and projected annual savings in each county are subtracted from energy saving of 2018. The corresponding OSP energy saving was calculated using an annual daily average. Also, the annual energy savings for all counties from 2019 to 2027 were calculated by incorporating the appropriate Degradation factor (see Table 19). The annual SEER14 electricity savings for each CL zone were used to calculate the NOx emissions reductions for each of the different counties using the emissions factors in the 2018 U.S. Environmental Protection Agency (US EPA) eGRID database (Figure *5-22* to Figure *5-29*).

[31] The "lifespan" of a central air conditioner is about 15 to 20 years (USDOE 2021).

[32] To estimate energy savings, the published data on typical residential construction characteristics provided by the NAHB (National Association of Home Builders) survey (NAHB 2003) was used for the base-code case single-family building. The code-compliant building envelope and system characteristics were determined from the general characteristics, for each climate zone as specified in the 2001 IECC. Also, the pre-code building envelope and system characteristics were determined based on the construction characteristics published by the NAHB (2000) for typical residential construction in East and West Texas for 1999. These buildings had SEER10 to SEER12 AC systems (AVG SEER11). For multi-family energy saving estimates, the 2001 IECC building code for both code-compliant and pre-code cases in multi-family calculation were used because there was no data for multi-family residences from NAHB report.

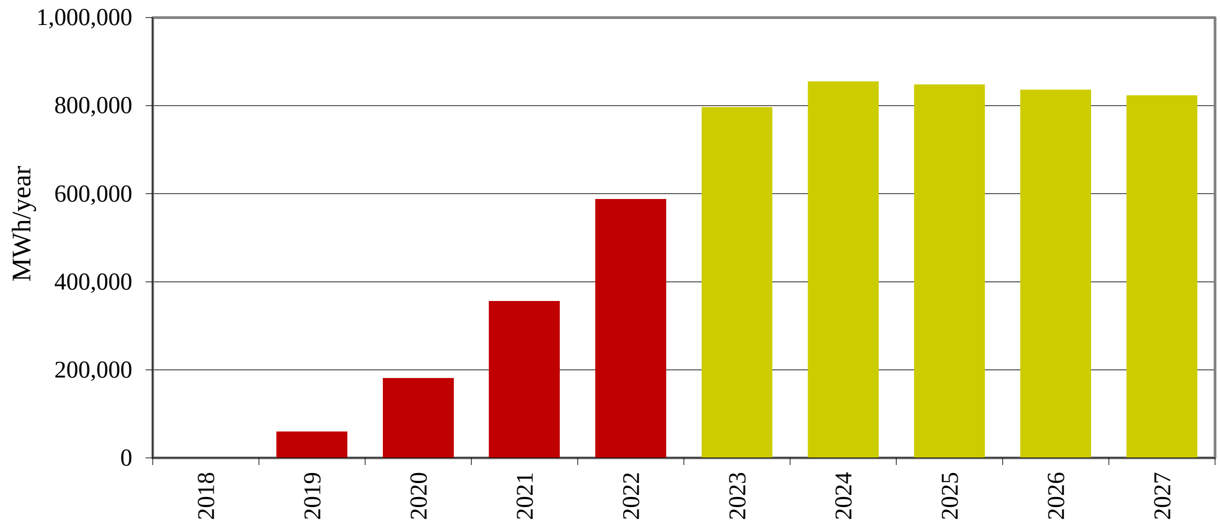


Figure 5-22: SEER 14 Single-Family Actual and Projected Annual Savings from 2019 to 2027 Based on the Year 2018.

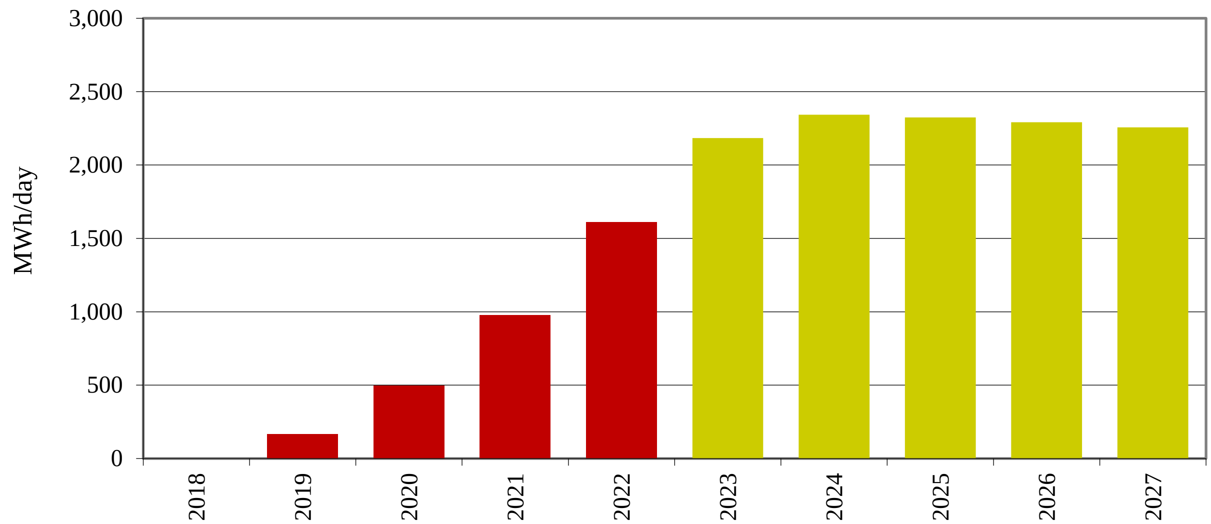


Figure 5-23: SEER 14 Single-Family Actual and Projected OSP Daily Average Savings from 2019 to 2027 Based on the Year 2018.

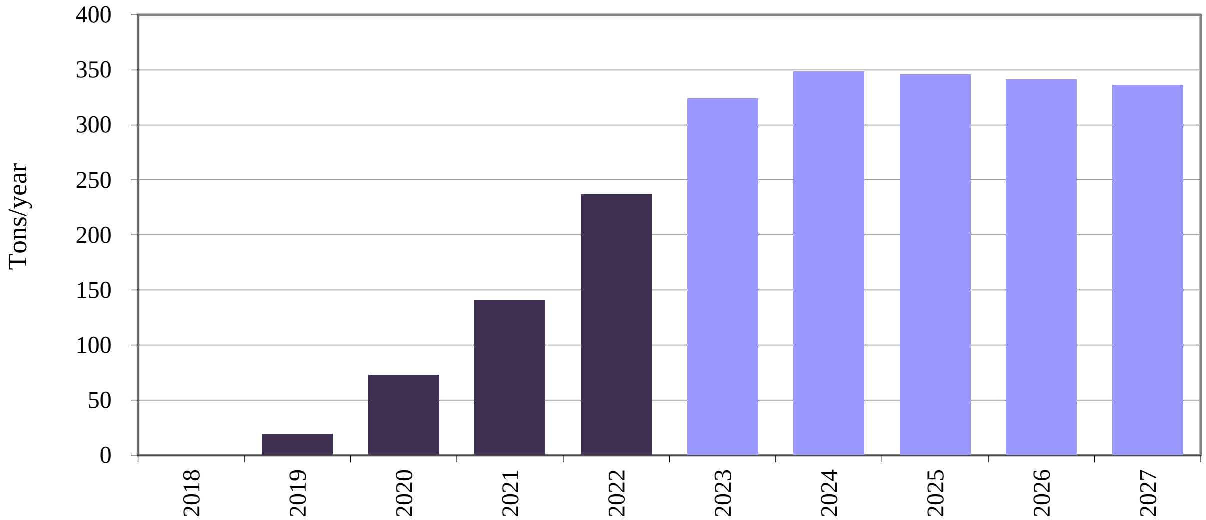


Figure 5-24: SEER 14 Single-Family Actual and Projected Annual NOx reduction from 2019 to 2027 Based on the Year 2018.

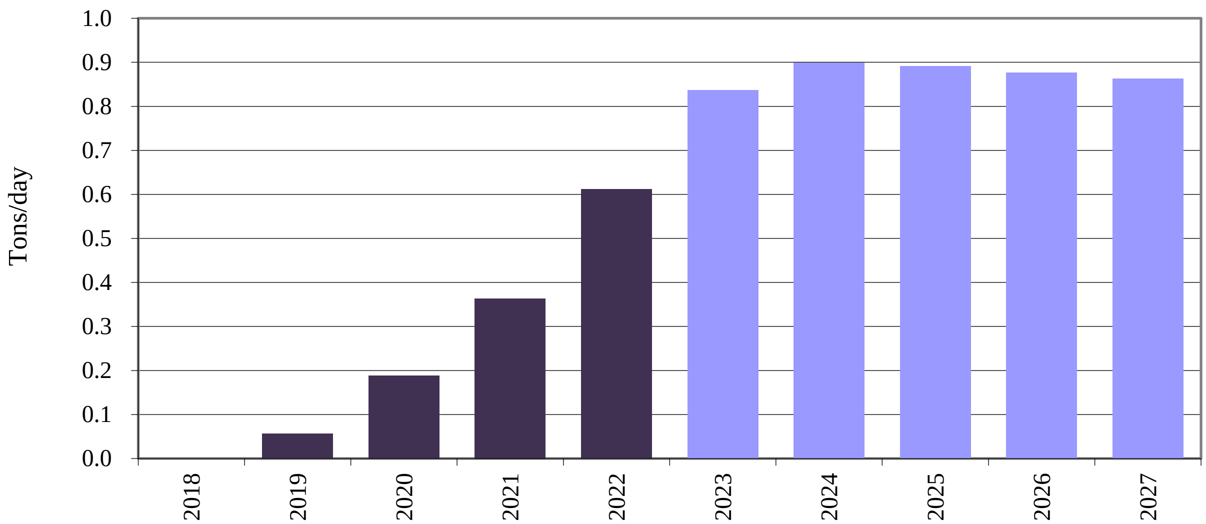


Figure 5-25: SEER 14 Single-Family Actual and Projected OSP Average Daily NOx reduction from 2019 to 2027 Based on the Year 2018.

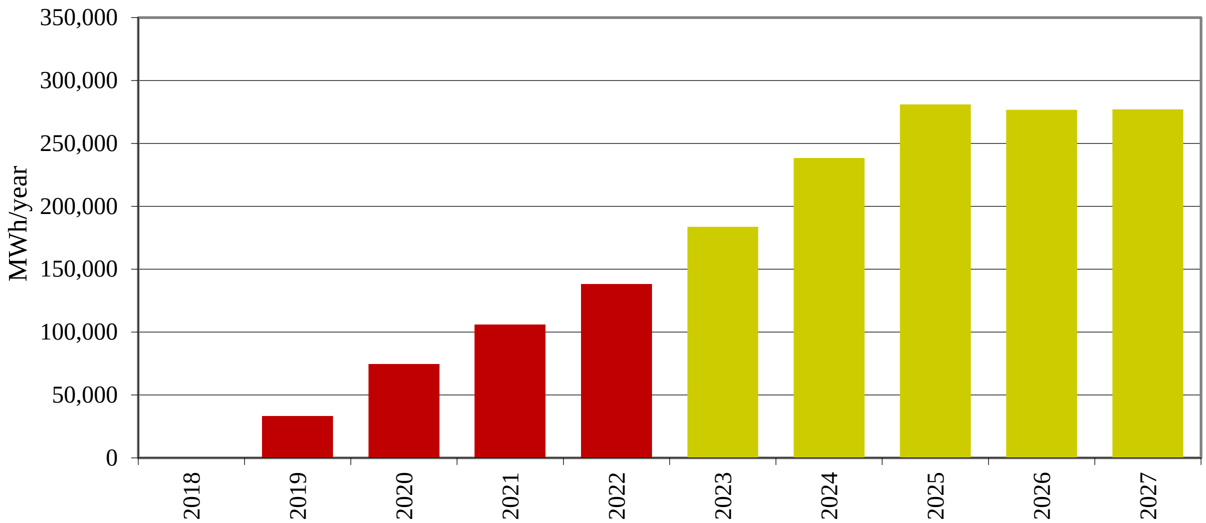


Figure 5-26: SEER 14 Multi-Family Actual and Projected Annual Savings from 2019 to 2027 Based on the Year 2018.

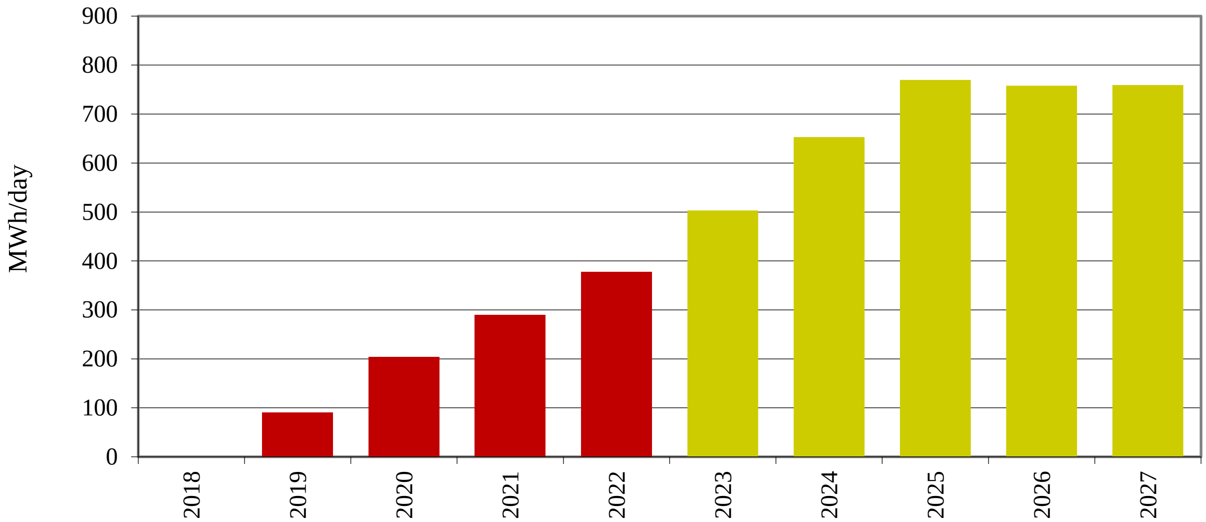


Figure 5-27: SEER 14 Multi-Family Actual and Projected OSP Daily Average Savings from 2019 to 2027 Based on the Year 2018.

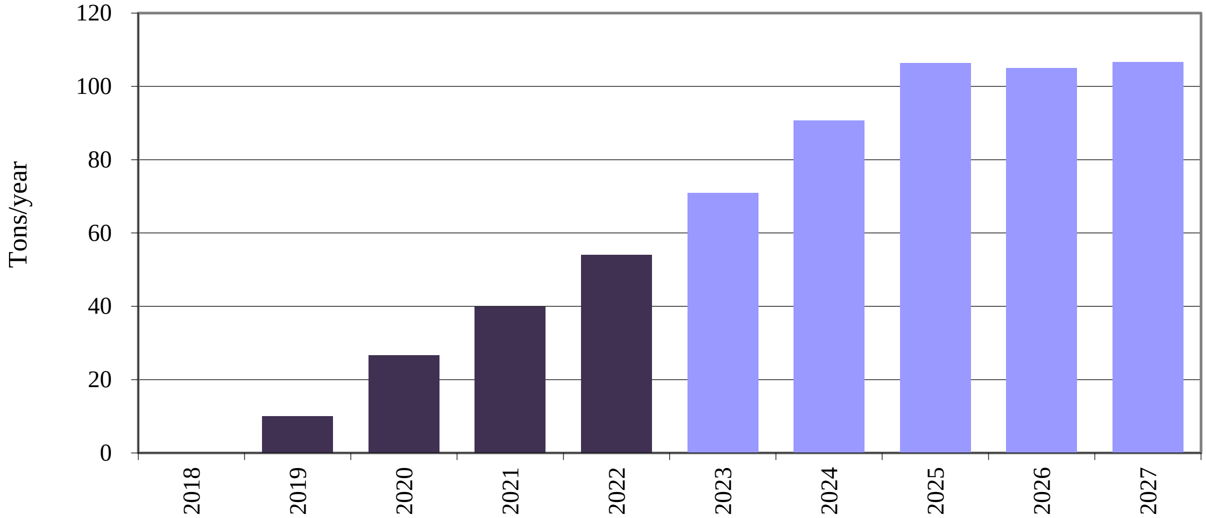


Figure 5-28: SEER 14 multi-Family Actual and Projected Annual NOx reduction from 2019 to 2027 Based on the Year 2018.

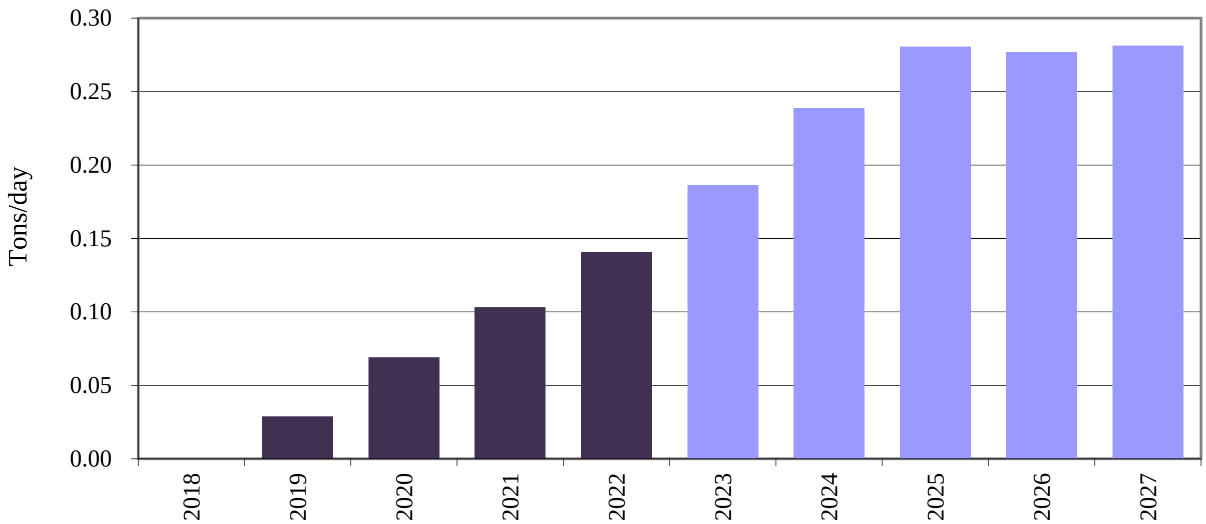


Figure 5-29: SEER 14 Multi-Family Actual and Projected OSP Average Daily NOx reduction from 2019 to 2027 Based on the Year 2018.

5.4 Results (Base year 2018)

The total integrated annual and OSP electricity savings for all the different programs in the integrated format were calculated for 2019 through 2027 as shown in Table 24, using the adjustment factors shown in Table 19. Annual and OSP NOx emissions reductions from the electricity savings (presented in Table 24) for all the programs in the integrated format were shown in Table 25. Integrated OSP NOx emissions reduction projection and integrated OSP individual programs NOx emissions reduction projection were presented in Figure 5-30 and Figure 5-31.

In 2022, the total integrated annual savings from all programs are 60,176,008 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 857,526 MWh/year (1.4% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program are 510,991 MWh/year (0.8%),
- Savings from SECO's Senate Bill 5 program are 1,140,211 MWh/year (1.9%),
- Electricity savings from renewable power generation are 56,941,742 MWh/year (94.6%), and
- Savings from residential air conditioner retrofits[33] are 725,539 MWh/year (1.2%).

In 2022, the total integrated OSP savings from all programs are 265,172 MWh/day, which would be 11,049 MW average hourly load reduction during the OSP period. The integrated OSP electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 2,349 MWh/day (0.9%),
- Savings from the PUC's Senate Bill 7 programs are 1,400 MWh/day (0.5%),
- Savings from SECO's Senate Bill 5 program are 3,122 MWh/day (1.2%),
- Electricity savings from renewable power generation are 256,313 MWh/day (96.7%), and
- Savings from residential air conditioner retrofits are 1,988 MWh/day (0.8%).

By 2027, the total integrated annual savings from all programs will be 373,481,128 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction will be 2,654,964 MWh/year (0.7% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program will be 1,087,084 MWh/year (0.3%),
- Savings from SECO's Senate Bill 5 program will be 2,480,463 MWh/year (0.7%),
- Electricity savings from renewable power generation will be 366,157,712 MWh/year (98.0%), and
- Savings from residential air conditioner retrofits will be 1,100,906 MWh/year (0.3%).

By 2027, the total integrated OSP savings from all programs will be 1,404,310 MWh/day, which would be 58,513 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 7,274 MWh/day (0.5%),
- Savings from the PUC's Senate Bill 7 programs will be 2,978 MWh/day (0.2%),
- Savings from SECO's Senate Bill 5 program will be 6,795 MWh/day (0.5%),
- Electricity savings from renewable power generation will be 1,384,247 MWh/day (98.6%), and
- Savings from residential air conditioner retrofits will be 3,016 MWh/day (0.2%).

In 2022 (Table 24 and Table 25), the total integrated annual NOx emissions reductions from all programs are 34,142 tons-NOx/year. The integrated annual NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction are 355 tons-NOx/year (1.0% of the total NOx savings),
- NOx emissions reductions from the PUC's Senate Bill 7 programs are 188 tons-NOx/year (0.6%),
- NOx emissions reductions from SECO's Senate Bill 5 program are 493 tons-NOx/year (1.4%),
- NOx emissions reductions from renewable power generation are 32,816 tons-NOx/year (96.1%), and

[33] This assumes air conditioners in existing homes are replaced with the more efficient 14 units, versus an average of SEER 11, which is slightly more efficient than the previous minimum standard of SEER 10.

- NOx emissions reductions from residential air conditioner retrofits are 290 tons-NOx/year (0.9%).

In 2022, the total integrated OSP NOx emissions reductions from all programs are 145.12 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 0.91 tons-NOx/day (0.6%),
- NOx emissions reductions from the PUC's Senate Bill 7 programs are 0.49 tons-NOx/day (0.3%),
- NOx emissions reductions from SECO's Senate Bill 5 program are 1.27 tons-NOx/day (0.9%),
- NOx emissions reductions from renewable power generation are 141.71 tons-NOx/day (97.7%), and
- NOx emissions reductions from residential air conditioner retrofits are 0.75 tons-NOx/day (0.5%).

By 2027, the total integrated annual NOx emissions reductions from all programs will be 211,074 tons-NOx/year. The integrated annual NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction will be 1,080 tons-NOx/year (0.5% of the total NOx savings),
- NOx emissions reductions from the PUC's Senate Bill 7 programs will be 390 tons-NOx/year (0.2%),
- NOx emissions reductions from SECO's Senate Bill 5 program will be 1,146 tons-NOx/year (0.5%),
- NOx emissions reductions from renewable power generation will be 208,019 tons-NOx/year (98.6%), and
- NOx emissions reductions from residential air conditioner retrofits will be 438 tons-NOx/year (0.2%).

By 2027, the total integrated OSP NOx emissions reductions from all programs will be 748.83 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 2.77 tons-NOx/day (0.4%),
- NOx emissions reductions from the PUC's Senate Bill 7 programs will be 1.01 tons-NOx/day (0.1%),
- NOx emissions reductions from SECO's Senate Bill 5 program will be 2.99 tons-NOx/day (0.4%),
- NOx emissions reductions from renewable power generation will be 740.94 tons-NOx/day (98.9%), and
- NOx emissions reductions from residential air conditioner retrofits will be 1.13 tons-NOx/day (0.2%).

Table 23: Example of NOx Emissions Reduction Calculations using 2018 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	0.1445243	3645.85	0.0000183	0.42	0.0000009	0.00	0.0013540	28.60	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	3674.87	1.84
	Chambers	0.0232302	586.02	0.0000029	0.07	0.0000001	0.00	0.0002176	4.60	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	590.68	0.30
	Fort Bend	0.0925360	2334.37	0.0000117	0.27	0.0000006	0.00	0.0008669	18.31	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	2352.95	1.18
	Galveston	0.0189140	477.14	0.0000024	0.06	0.0000001	0.00	0.0001772	3.74	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	480.93	0.24
	Harris	0.1374166	3466.55	0.0000174	0.40	0.0000008	0.00	0.0012874	27.19	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	3494.14	1.75
	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	0.0587430	105.69	0.0000000	0.00	105.69	0.05
	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
Beaumont/ Port Arthur Area	Hardin	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0027101	4.88	0.0000000	0.00	4.88	0.00
	Jefferson	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.9687861	1742.99	0.0000000	0.00	1742.99	0.87
	Orange	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.8865417	1595.02	0.0000000	0.00	1595.02	0.80
Dallas/ Fort Worth Area	Collin	0.0000743	1.87	0.0004556	10.48	0.0000220	0.04	0.0000046	0.10	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	12.49	0.01
	Dallas	0.0019090	48.16	0.0117105	269.33	0.0005656	0.99	0.0001195	2.52	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	321.00	0.16
	Denton	0.0066429	167.58	0.0407509	937.23	0.0019683	3.43	0.0004158	8.78	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1117.03	0.56
	Henderson	0.0001509	3.81	0.0009255	21.29	0.0000447	0.08	0.0000094	0.20	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	25.37	0.01
	Hood	0.0008451	21.32	0.0051842	119.23	0.0002504	0.44	0.0000529	1.12	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	142.10	0.07
	Hunt	0.0000043	0.11	0.0000263	0.61	0.0000013	0.00	0.0000003	0.01	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.72	0.00
	Tarrant	0.0004188	10.57	0.0025693	59.09	0.0001241	0.22	0.0000262	0.55	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	70.43	0.04
	Ellis	0.0013349	33.68	0.0081890	188.34	0.0003955	0.69	0.0000835	1.76	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	224.47	0.11
	Johnson	0.0002010	5.07	0.0012332	28.36	0.0000596	0.10	0.0000126	0.27	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	33.80	0.02
	Kaufman	0.0034596	87.27	0.0212228	488.11	0.0010251	1.79	0.0002165	4.57	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	581.74	0.29
	Parker	0.0005940	14.98	0.0036438	83.80	0.0001760	0.31	0.0000372	0.79	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	99.88	0.05
	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	0.0031300	78.96	0.0192012	441.61	0.0009275	1.62	0.0001959	4.14	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	526.33	0.26
El Paso Area	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	1006.31	1006.31	0.50
San Antonio Area	Bexar	0.0253670	639.92	0.0017108	39.35	0.0000826	0.14	0.2025905	4278.87	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	4958.29	2.48
	Comal	0.0005285	13.33	0.0000356	0.82	0.0000017	0.00	0.0042210	89.15	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	103.31	0.05
	Guadalupe	0.0030546	77.06	0.0002060	4.74	0.0000100	0.02	0.0243949	515.24	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	597.05	0.30
	Wilson	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
Austin Area	Bastrop	0.0024800	62.56	0.0001673	3.85	0.0000081	0.01	0.0198060	418.32	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	484.74	0.24
	Caldwell	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	0.0004731	11.93	0.0000319	0.73	0.0000015	0.00	0.0037782	79.80	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	92.47	0.05
	Travis	0.0046184	116.51	0.0003115	7.16	0.0000150	0.03	0.0368846	779.03	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	902.73	0.45
	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
North East Texas Area	Gregg	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0053705	6.10	0.0000000	0.00	0.0000000	0.00	6.10	0.00
	Harrison	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.2702671	306.85	0.0000000	0.00	0.0000000	0.00	306.85	0.15
	Rusk	0.0322708	814.08	0.1979648	4553.01	0.0095620	16.68	0.0020197	42.66	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	5426.43	2.71
	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
	Upshur	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
Corpus Christi Area	Nueces	0.0042426	107.03	0.0002861	6.58	0.0000138	0.02	0.0338828	715.63	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	829.26	0.41
	San Patricio	0.0063692	160.67	0.0004296	9.88	0.0000207	0.04	0.0508668	1074.35	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1244.94	0.62
Victoria Area	Victoria	0.0016730	42.20	0.0001128	2.60	0.0000054	0.01	0.0133614	282.20	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	327.01	0.16
Other ERCOT Counties	Anderson	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
	Angelina	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
	Atascosa	0.0077084	194.46	0.0005199	11.96	0.0000251	0.04	0.0615620	1300.24	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1506.70	0.75
	Bell	0.0004444	11.21	0.0027262	62.70	0.0001317	0.23	0.0000278	0.59	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	74.73	0.04
	Bosque	0.0007214	18.20	0.0044257	101.79	0.0002138	0.37	0.0000452	0.95	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	121.31	0.06
	Brazos	0.0005654	14.26	0.0034687	79.78	0.0001675	0.29	0.0000354	0.75	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	95.08	0.05
	Calhoun	0.0111852	282.16	0.0007544	17.35	0.0000364	0.06	0.0893292	1886.70	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	2186.28	1.09
	Cameron	0.0000231	0.58	0.0000016	0.04	0.0000001	0.00	0.0001843	3.89	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	4.51	0.00
	Cherokee	0.0001844	4.65	0.0011310	26.01	0.0000546	0.10	0.0000115	0.24	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	31.00	0.02
	Coke	0.0000223	0.56	0.0001365	3.14	0.0231815	40.43	0.0000014	0.03	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	44.16	0.02
	Colorado	0.0016158	40.76	0.0001090	2.51	0.0000053	0.01	0.0129041	272.54	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	315.82	0.16
	Ector	0.0001338	3.37	0.0008206	18.87	0.1393442	243.04	0.0000084	0.18	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	265.46	0.13
	Fayette	0.0204274	515.31	0.0013777	31.69	0.0000665	0.12	0.1631405	3445.66	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	3992.77	2.00
	Freestone	0.0042261	106.61	0.0259247	596.25	0.0012522	2.18	0.0002645	5.59	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	710.63	0.36
	Frio	0.0097614	246.25	0.0006583	15.14	0.0000318	0.06	0.0779581	1646.54	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1907.98	0.95
	Goliad	0.0077047	194.36	0.0005196	11.95	0.0000251	0.04	0.0615328	1299.62	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1505.98	0.75
	Grayson	0.0002857	7.21	0.0017525	40.31	0.0000846	0.15	0.0000179	0.38	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	48.04	0.02
	Grimes	0.0029942	75.53	0.0183678	422.44	0.0008872	1.55	0.0001874	3.96	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	503.48	0.25
	Hidalgo	0.0140830	355.27	0.0009498	21.84	0.0000459	0.08	0.1124720	2375.50	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	2752.69	1.38
	Hill	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
	Howard	0.0000467	1.18	0.0002865	6.59	0.0486558	84.86	0.0000029	0.06	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	92.69	0.05
	Lamar	0.0031379	79.16	0.0192492	442.72	0.0009298	1.62	0.0001964	4.15	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	527.64	0.26
	Limestone	0.0231674	584.43	0.1421203	3268.64	0.0068646	11.97	0.0014500	30.62	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	3895.67	1.95
	Llano	0.0001855	4.68	0.0000125	0.29	0.0000006	0.00	0.0014818	31.30	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	36.27	0.02
	McLennan	0.0043688	110.21	0.0268006	616.39	0.0012945	2.26	0.0002734	5.78	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	734.63	0.37
	Milam	0.0002486	6.27	0.0000168	0.39	0.0000008	0.00	0.0019850	41.93	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	48.58	0.02
	Mitchell	0.0000072	0.18	0.0000443	1.02	0.0075244	13.12	0.0000005	0.01	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	14.33	0.01
	Nacogdoches	0.0002714	6.85	0.0016647	38.29	0.0000804	0.14	0.0000170	0.36	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	45.63	0.02
	Nolan	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
	Palo Pinto	0.0010391	26.21	0.0063745	146.61	0.0003079	0.54	0.0000650	1.37	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	174.73	0.09
	Pecos	0.0000029	0.07	0.0000180	0.41	0.0030637	5.34	0.0000002	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	5.84	0.00
	Reagan	0.0000002	0.01	0.0000015	0.03	0.0002476	0.43	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.47	0.00
	Red River	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
	Robertson	0.0184177	464.61	0.1129830	2598.51	0.0054573	9.52	0.0011527	24.35	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	3096.98	1.55
	Scurry	0.0001246	3.14	0.0007646	17.58	0.1298311	226.45	0.0000078	0.16	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	247.34	0.12
	Titus	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
	Ward	0.0000206	0.52	0.0001265	2.91	0.0214790	37.46	0.0000013	0.03	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	40.92	0.02
	Webb	0.0000253	0.64	0.0000017	0.04	0.0000001	0.00	0.0002020	4.27	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	4.94	0.00
	Wharton	0.0006585	16.61	0.0000444	1.02	0.0000021	0.00	0.0052594	111.08	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	128.72	0.06
	Wichita	0.0000051	0.13	0.0000315	0.72	0.0053432	9.32	0.0000003	0.01	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	10.18	0.01
	Wilbarger	0.0008609	21.72	0.0052810	121.46	0.8967472	1564.07	0.0000539	1.14	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	1708.38	0.85
	Wood	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
	Young	0.0000257	0.65	0.0001578	3.63	0.0267892	46.72	0.0000016	0.03	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	51.04	0.03
Other SPP Counties	Cass	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0127595	14.49	0.0000000	0.00	0.0000000	0.00	14.49	0.01
	Gaines	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
	Gray	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
	Hale	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0616792	70.03	0.0000000	0.00	0.0000000	0.00	70.03	0.04
	Hemphill	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0246062	27.94	0.0000000	0.00	0.0000000	0.00	27.94	0.01
	Hutchinson	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0134856	15.31	0.0000000	0.00	0.0000000	0.00	15.31	0.01
	Lamb	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.2117054	240.36	0.0000000	0.00	0.0000000	0.00	240.36	0.12
	Lubbock	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0695988	79.02	0.0000000	0.00	0.0000000	0.00	79.02	0.04
	Marion	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0272898	30.98	0.0000000	0.00	0.0000000	0.00	30.98	0.02
	Moore	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
	Morris	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0002270	0.26	0.0000000	0.00	0.0000000	0.00	0.26	0.00
	Potter	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.2710995	307.79	0.0000000	0.00	0.0000000	0.00	307.79	0.15
	Titus	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
	Yoakum	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0438855	49.83	0.0000000	0.00	0.0000000	0.00	49.83	0.02
Other SERC Counties	Jasper	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
	Newton	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0870000	156.53	0.0000000	0.00	156.53	0.08
	San Jacinto	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0000000	0.00	0.0072219	12.99	0.0000000	0.00	12.99	0.01
	Tyler	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
	Total	**0.4927768**	**12431.07**	**0.6891868**	**15850.68**	**0.9589944**	**1672.64**	**0.7276081**	**15367.67**	**1.3340545**	**1514.61**	**0.4990937**	**897.94**	**1.2223686**	**1006.31**	**805950.57**	**402.98**

Energy Savings (MWh)		25,227		22,999		1,744		21,121		1,135		1,799		823	

Table 24: Integrated Annual and OSP Electricity Savings for the Different Programs (Base Year 2018)

PROGRAM	ANNUAL (MWh)									
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
ESL-Single Family	0	0	74,850	158,185	228,167	299,749	373,020	448,076	525,014	603,936
ESL-Multifamily	0	0	175,080	380,168	629,359	889,230	1,160,524	1,444,026	1,740,567	2,051,028
ESL-Commercial	0	0	0	0	0	0	0	0	0	0
PUC (SB7)	0	83,347	195,887	376,958	510,991	638,321	759,286	874,202	983,372	1,087,084
SECO	0	359,121	567,339	828,391	1,140,211	1,436,440	1,717,857	1,985,203	2,239,183	2,480,463
Renewables-ERCOT	0	4,091,723	22,537,959	37,278,263	56,941,742	74,737,111	103,482,550	150,992,668	230,770,375	366,157,712
SEER14-Single Family	0	60,071	181,188	356,259	587,566	796,865	855,307	848,191	836,377	823,784
SEER14-Multi Family	0	33,152	74,374	105,771	137,973	183,666	238,352	280,988	276,696	277,122
Total Annual (MWh)	**0**	**4,627,414**	**23,806,679**	**39,483,996**	**60,176,008**	**78,981,382**	**108,586,896**	**156,873,354**	**237,371,584**	**373,481,128**

PROGRAM	OZONE SEASON PERIOD - OSP (MWh/day)									
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
ESL-Single Family	0	0	205	433	625	821	1,022	1,228	1,438	1,655
ESL-Multifamily	0	0	480	1,042	1,724	2,436	3,180	3,956	4,769	5,619
ESL-Commercial	0	0	0	0	0	0	0	0	0	0
PUC (SB7)	0	228	537	1,033	1,400	1,749	2,080	2,395	2,694	2,978
SECO	0	984	1,553	2,268	3,122	3,934	4,705	5,438	6,134	6,795
Renewables-ERCOT	0	114,596	150,844	181,516	256,313	324,194	431,455	605,958	895,831	1,384,247
SEER14-Single Family	0	165	496	976	1,610	2,183	2,343	2,324	2,291	2,257
SEER14-Multi Family	0	91	204	290	378	503	653	770	758	759
Total OSP (MWh)	**0**	**116,063**	**154,318**	**187,558**	**265,172**	**335,821**	**445,438**	**622,068**	**913,915**	**1,404,310**

Table 25: Integrated Annual and OSP NOx Emissions Reduction Values for the Different Programs (Base Year 2018)

PROGRAM	ANNUAL (in tons NOx)									
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
ESL-Single Family	0	0	31	66	95	125	155	186	217	249
ESL-Multifamily	0	0	73	159	260	365	475	590	706	831
ESL-Commercial	0	0	0	0	0	0	0	0	0	0
PUC (SB7)	0	25	74	141	188	233	275	315	353	390
SECO	0	121	230	341	493	637	774	905	1,028	1,146
Renewables-ERCOT	0	1,800	13,849	22,385	32,816	42,929	59,240	86,170	131,361	208,019
SEER14-Single Family	0	20	74	143	236	320	343	341	336	331
SEER14-Multi Family	0	10	27	40	54	71	91	106	105	107
Total Annual (Tons NOx)	**0**	**1,975**	**14,358**	**23,275**	**34,142**	**44,680**	**61,353**	**88,614**	**134,107**	**211,074**

PROGRAM	OZONE SEASON PERIOD - OSP (in tons NOx/day)									
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
ESL-Single Family	0.00	0.00	0.08	0.16	0.23	0.31	0.38	0.46	0.54	0.62
ESL-Multifamily	0.00	0.00	0.19	0.41	0.67	0.94	1.23	1.53	1.83	2.15
ESL-Commercial	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PUC (SB7)	0.00	0.07	0.19	0.37	0.49	0.60	0.71	0.82	0.92	1.01
SECO	0.00	0.35	0.59	0.87	1.27	1.64	1.99	2.33	2.65	2.99
Renewables-ERCOT	0.00	60.45	88.21	104.65	141.71	178.12	235.38	328.23	482.09	740.94
SEER14-Single Family	0.00	0.06	0.19	0.37	0.61	0.83	0.89	0.88	0.86	0.85
SEER14-Multi Family	0.00	0.03	0.07	0.10	0.14	0.19	0.24	0.28	0.27	0.28
Total OSP (Tons NOx)	**0.00**	**60.96**	**89.52**	**106.93**	**145.12**	**182.62**	**240.82**	**334.52**	**489.16**	**748.83**

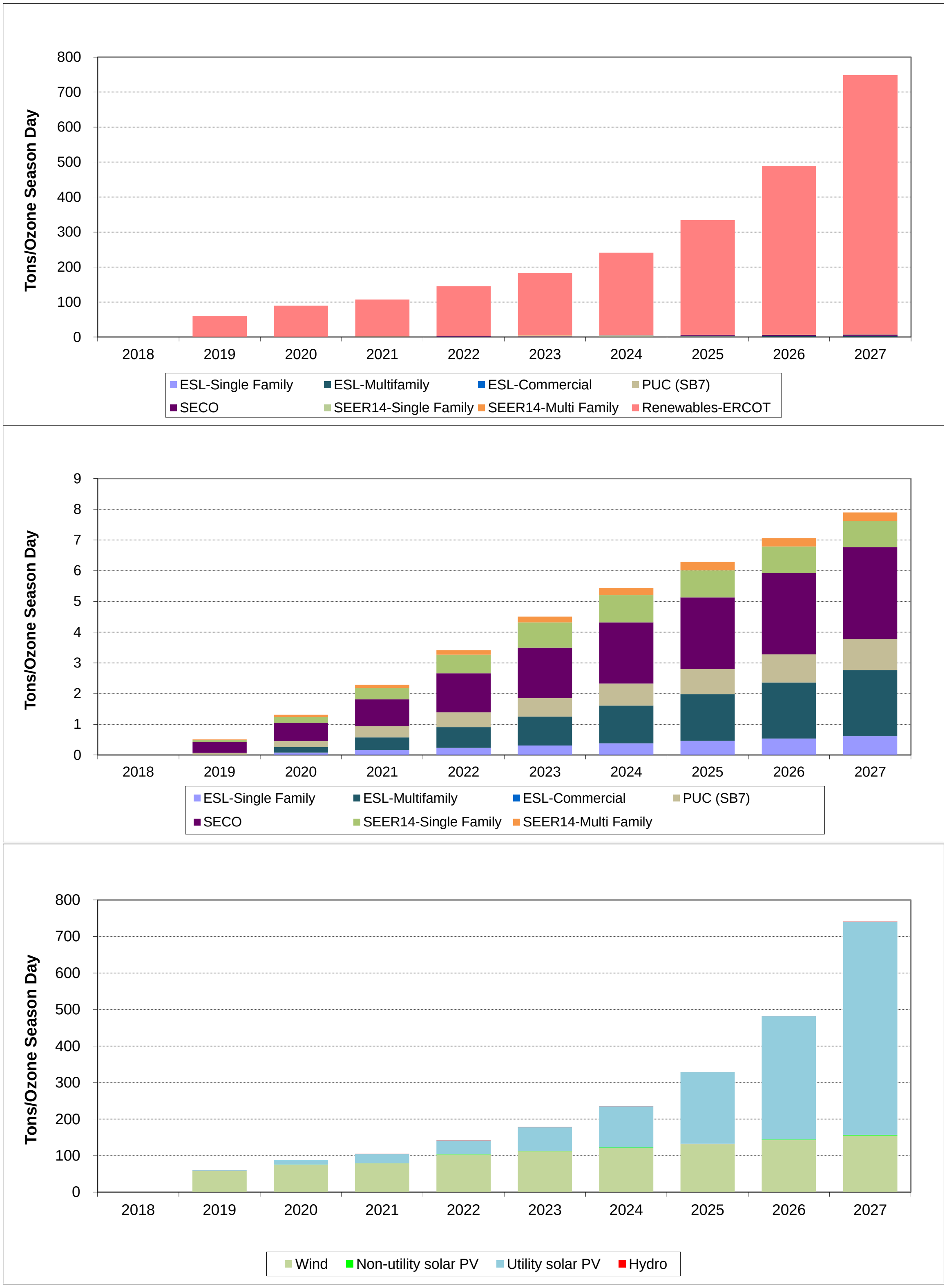


Figure 5-30: Integrated OSP NOx Emissions Reduction Projections through 2027. (Upper Plot) All Programs, (Middle Plot) All Programs Except Renewables, (Lower Plot) Renewables.

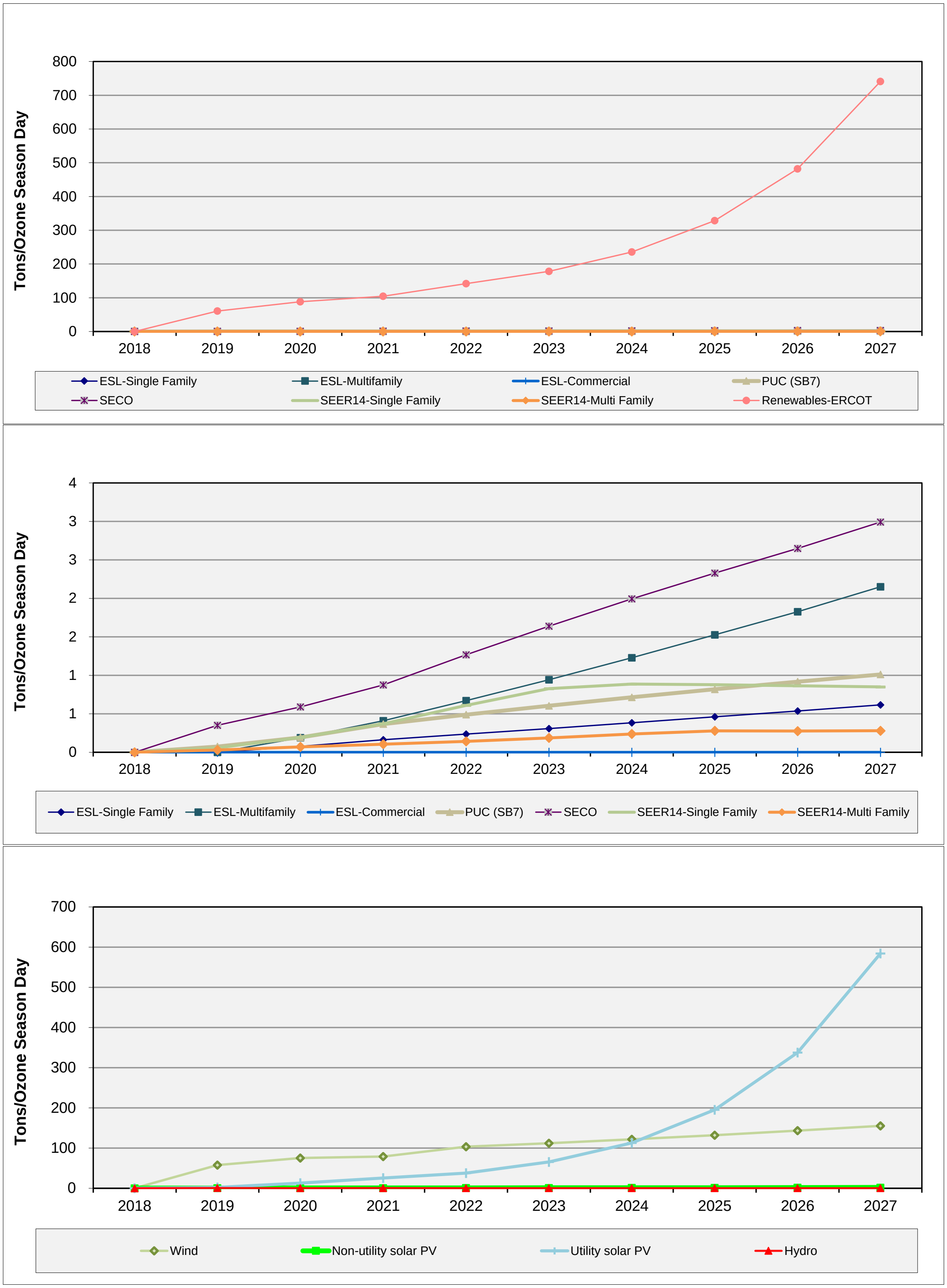


Figure 5-31: Integrated OSP Individual Programs NOx Emissions Reduction Projections through 2027. (Upper Plot) All Programs, (Middle Plot) All Programs Except Renewables, (Lower Plot) Renewables.

6 2021 Year Activities of Energy Systems Laboratory (ESL) for Texas Emissions Reduction Plan

6.1 IC3 Texas Building Registry (TBR)

6.1.1 Background

In 2008, the 81st Texas Legislature amended the Texas Administrative Code (TAC .§388.008, 2009) to develop a Registry of Above-Code homes. The ESL built the first version of the Registry in 2009. This preliminary version allowed to provide basic metrics on usage of the ESL's above code calculators, *IC3*[34] and *TCV*.[35] 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 2022, the reports continued, and numbers were gathered. Figure 6-1 shows the projects issued each month from January to December 2022. The projects are differentiated by the basic types, IECC performance path and ERI path. Figure 6-2 shows the cumulative users and projects through 2022. 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 6-3. Only counties with at least 10 new projects in 2022 are included in the chart. Figure 6-4 shows the certifications issued by city in 2022. Only those cities with at least 50 new projects are shown on the chart.

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

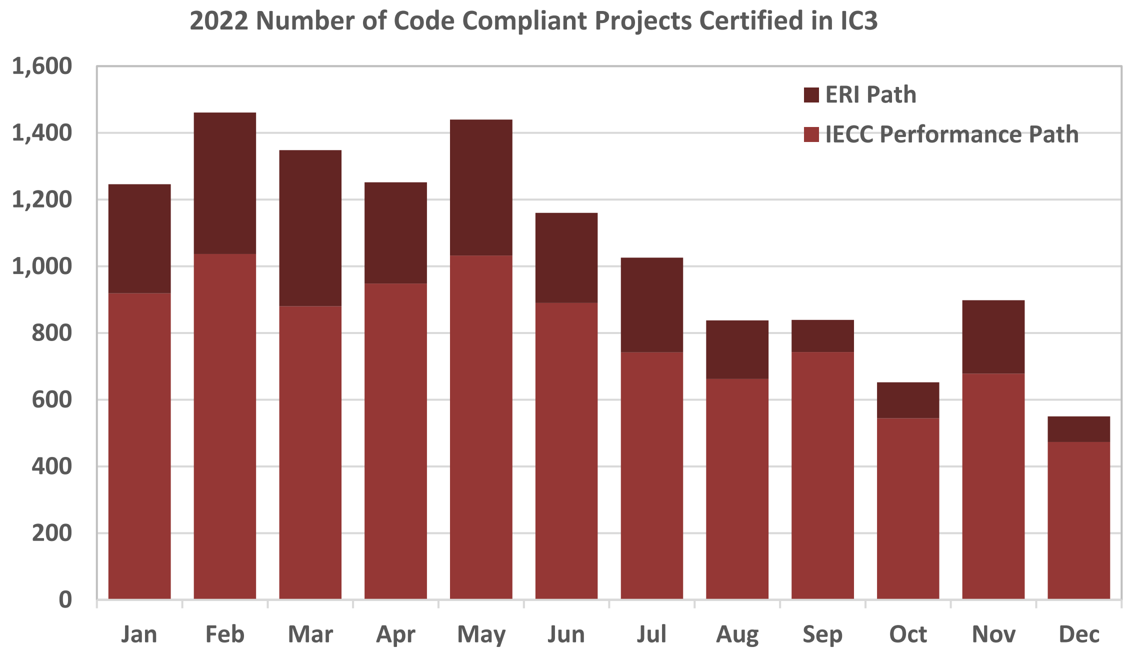


Figure 6-1: *IC3* 2022 Projects

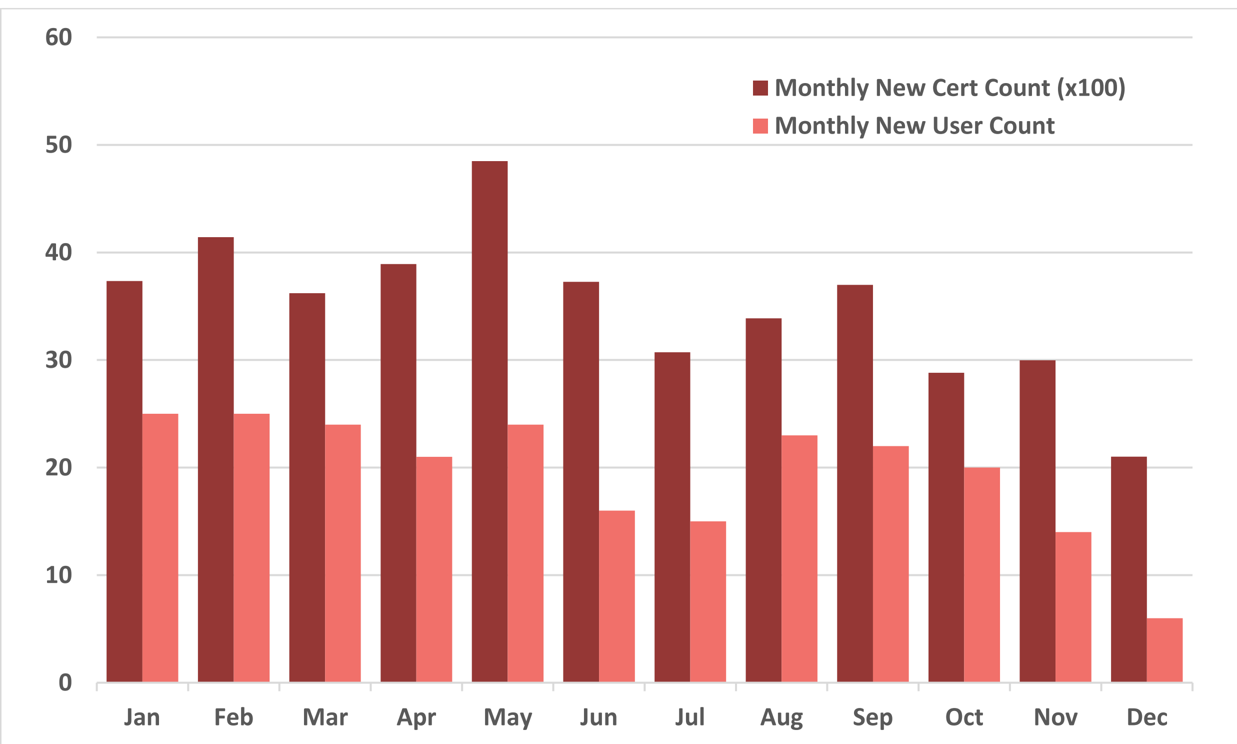


Figure 6-2: *IC3* 2022 New Users and New Certificates

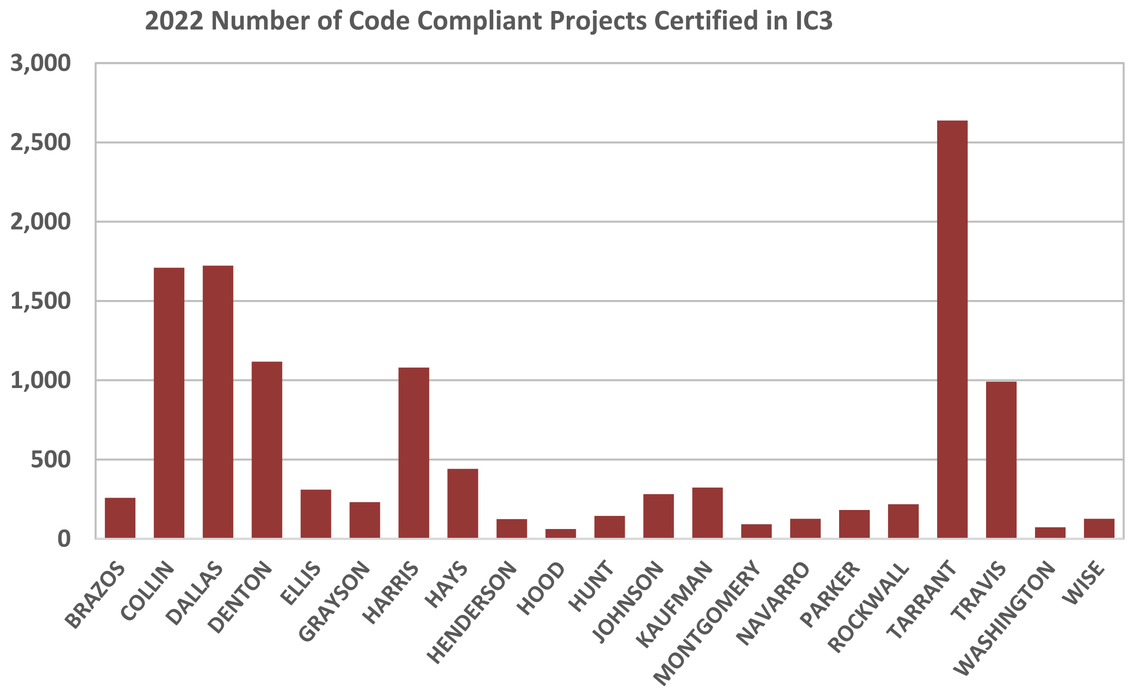


Figure 6-3: *IC3* 2022 Certificates – Counties with at least 50 Certificates

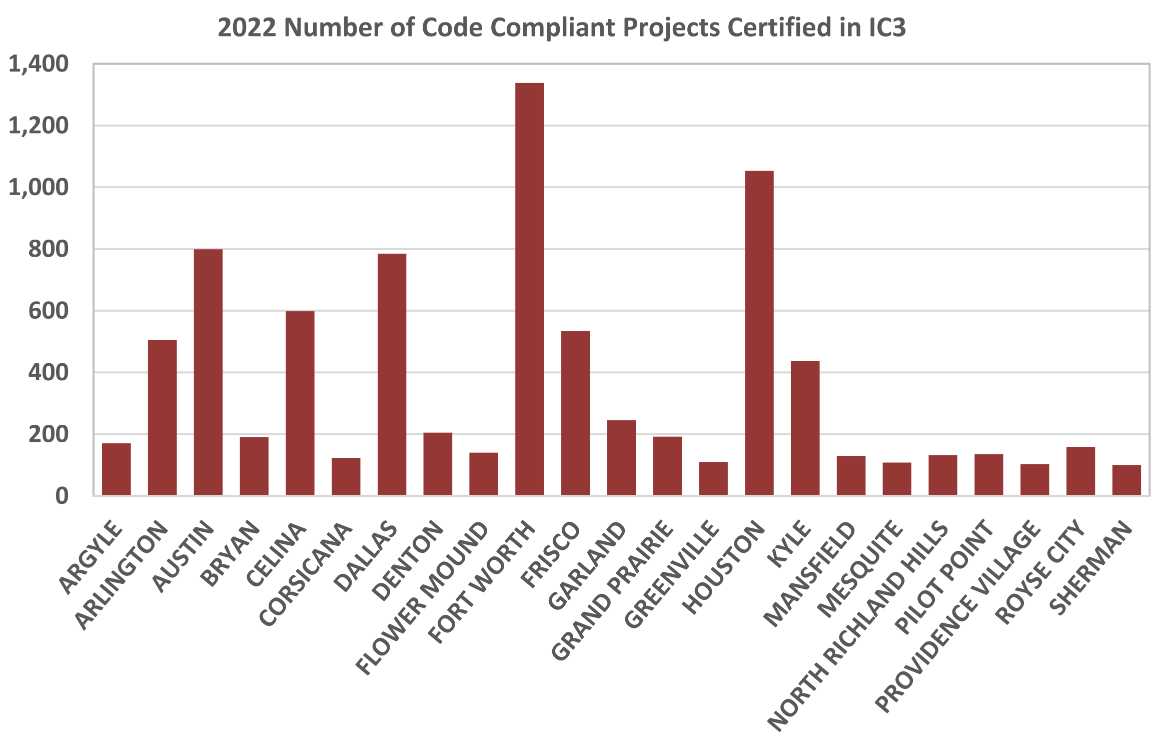


Figure 6-4: *IC3* 2022 Certificates – Cities with at least 100 Certificates

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, 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 6-5 shows the "layout" of the IC3 (v3.x and above) and TCV[36] (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.

[36] 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.

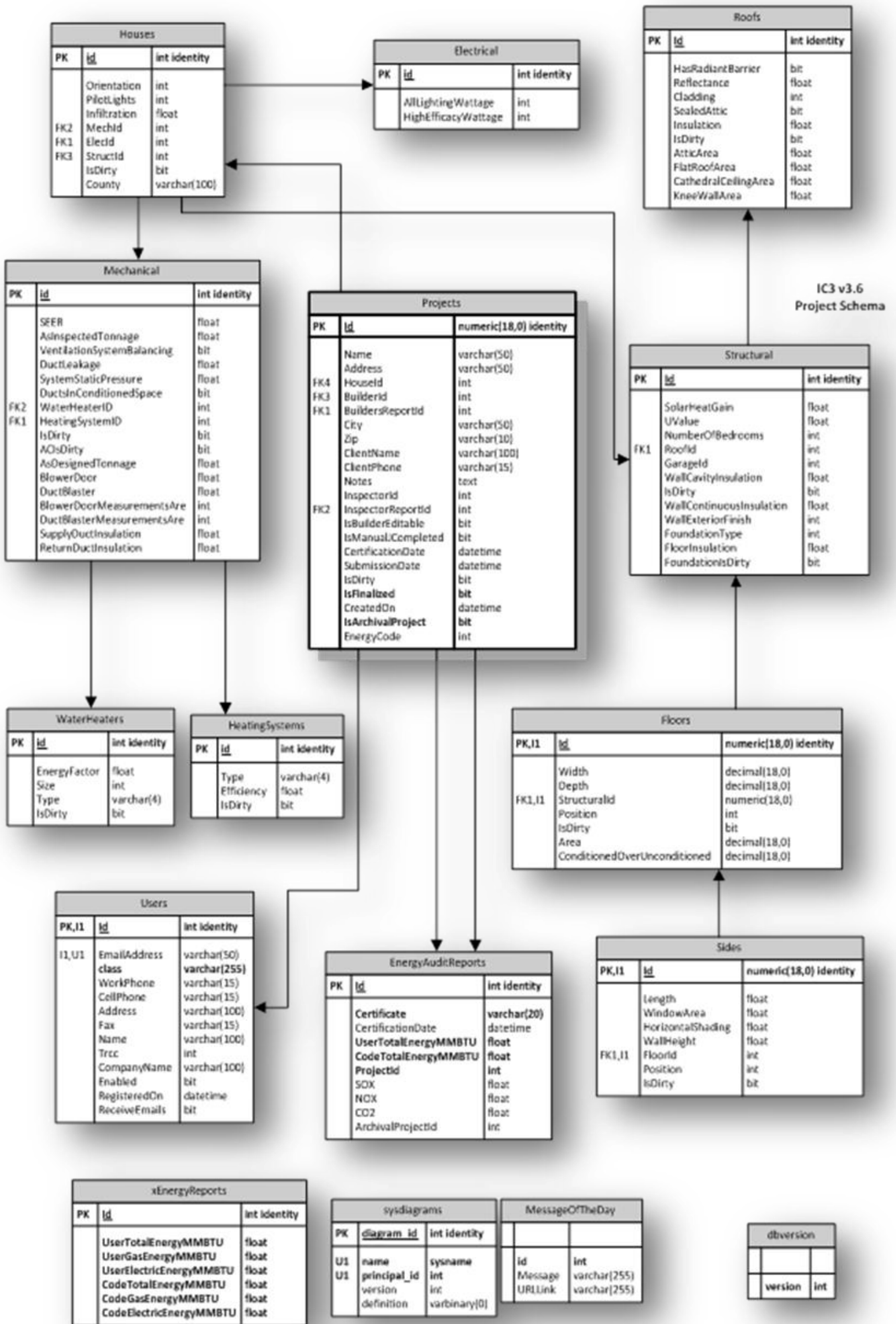


Figure 6-5: Database Schema

6.1.3 Usage Reports

Figure 6-2 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 26 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 2022.

Table 26 Counties Generating IC3 Certificates in 2022.

County Name	January	February	March	April	May	June	July	August	September	October	November	December
ANDERSON								1				
ARANSAS	1											
ATASCOSA	1											
AUSTIN						1						
BASTROP		1		5	1		1					
BELL								1				
BEXAR	1	3	3	9	2	6	15		1	2	4	1
BLANCO										1		
BRAZORIA						1			1	1	1	
BRAZOS	13	13	13	13	44	21	26	37	35	11	13	20
BURNET						2			1			2
CALDWELL	1		1		1							
COLLIN	109	185	198	146	265	126	152	93	69	57	212	98
COMAL	2	1	8	8	4	1	3		1			
COOKE	7	7	4			1	5	7	2	4	1	3
DALLAS	139	112	203	176	146	131	155	114	139	152	148	108
DENTON	164	136	99	115	136	88	81	54	67	30	92	55
ELLIS	18	23	25	22	21	26	31	48	22	37	26	11
FANNIN			1		2	1	2				6	
FORT BEND	2	1		3	1	1			1			26
FREESTONE	1											
FRIO									1			
GALVESTON	1	5	2	3	3	8	1	1	1	5	1	
GILLESPIE		3					1					
GRAYSON	18	30	16	10	37	44	35	1	21	8	7	4
GREGG						3		2	1	1	1	
GRIMES						17	2	11	4	1	1	
GUADALUPE	1	1	1		1	1						
HAMILTON				1								
HARRIS	73	131	106	169	123	73	49	129	86	35	70	36
HAYS	64	5	56	76	34	52	56	10	33	25	23	7
HENDERSON	6	9	23	11	32	9	4	9	8	8	2	3
HIDALGO									1			
HILL		1	1	4	2			1	5	5	3	
HOOD	3	5	10	4	10	8	3	4	2	2	11	
HOPKINS				1			3	2			1	
HOWARD			1									
HUNT	13	14	22	16	6	9	13	6	20	8	7	11
JEFFERSON							1					

Table 26 Counties Generating IC3 Certificates in 2022 (Continued).

County Name	January	February	March	April	May	June	July	August	September	October	November	December
JIM WELLS										1		
JOHNSON	23	40	58	30	27	34	14	12	17	9	8	10
KAUFMAN	42	58	37	24	34	46	4	13	23	23	11	8
LAMAR									1			
LIBERTY	2	3			2	2	5	13			1	3
LLANO	2	1	3	3	3	1	2					2
MADISON						1						
MCLENNAN			1	4		2		4	1			
MEDINA			2									
MIDLAND					1							
MONTAGUE	1	1		2	2							
MONTGOMERY	16	1	1	3	24	9	20	4	8	1	1	4
NAVARRO	5	1	4	26	29	38	3	7	8	3	1	2
ORANGE			1									
PALO PINTO		1							1			
PARKER	27	21	12	22	29	17	14	5	9	12	8	6
RAINS	3		1		1					1	1	
ROCKWALL	34	16	22	39	30	29	18	2	6	7	10	5
SMITH	1			2	1	1	1	1				
SOMERVELL			1	3								
TARRANT	290	354	282	209	246	261	175	193	180	150	200	98
TAYLOR						1						
TITUS		2		2	2		1			1		
TRAVIS	126	242	108	43	120	75	102	35	55	45	24	16
TYLER							1					
UPSHUR				1								
VAN ZANDT	4		2		4	2						2
WALLER		1							1			
WASHINGTON	24	8	12	14	6			8		1		
WILLIAMSON		2	1	3		1	16		1			
WISE	8	22	7	29	8	9	11	10	6	5	3	9
WOOD		1										
ZAPATA				1		1						

6.1.4 Parameter Reports

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

This report shows the yearly average wall cavity insulation distribution Texas for 2022 (Figure 6-6 - Figure 6-15).

The colors in the figure show the relevant insulation values.

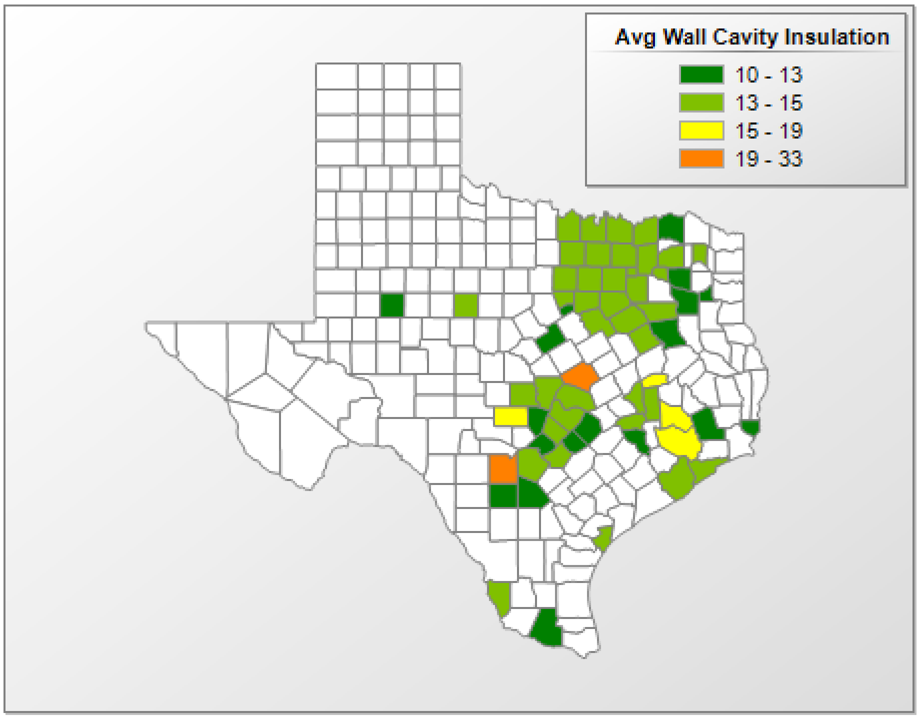


Figure 6-6: Yearly Average Wall Cavity Insulation Distribution by County in 2022

This report shows water heater efficiencies across Texas in 2022

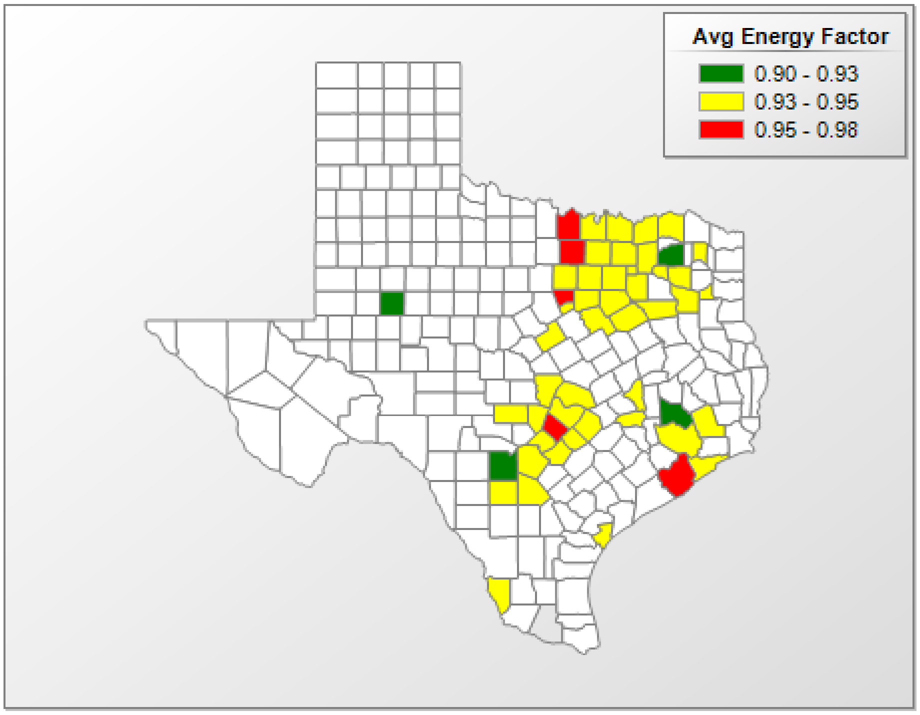


Figure 6-7: Yearly Average Electric Water Heater Energy Factor Distribution by County in 2022

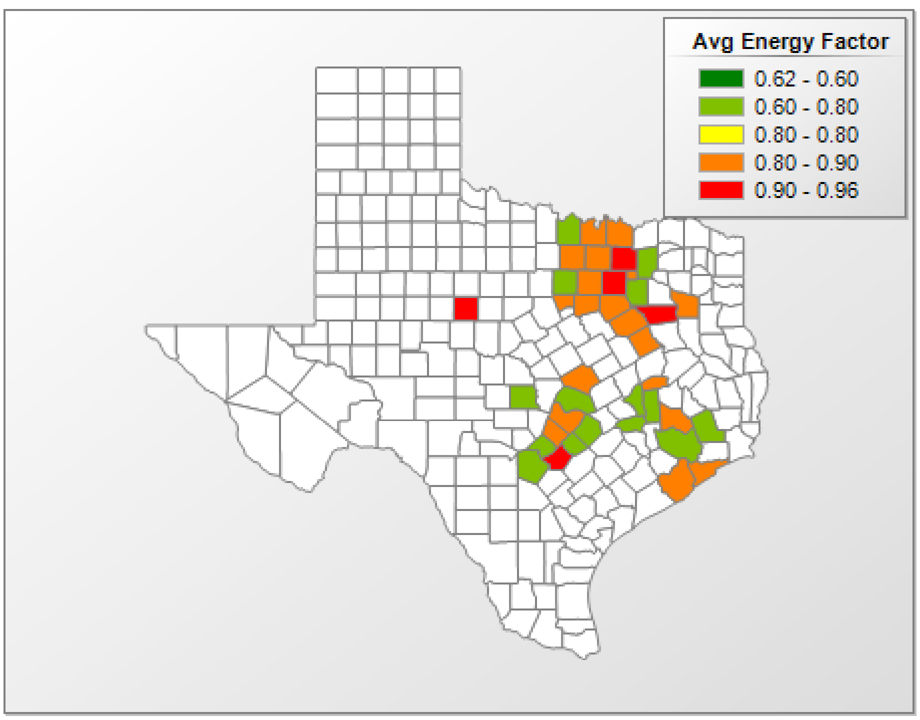


Figure 6-8: Yearly Average NG Water Heater Energy Factor Distribution by County in 2022

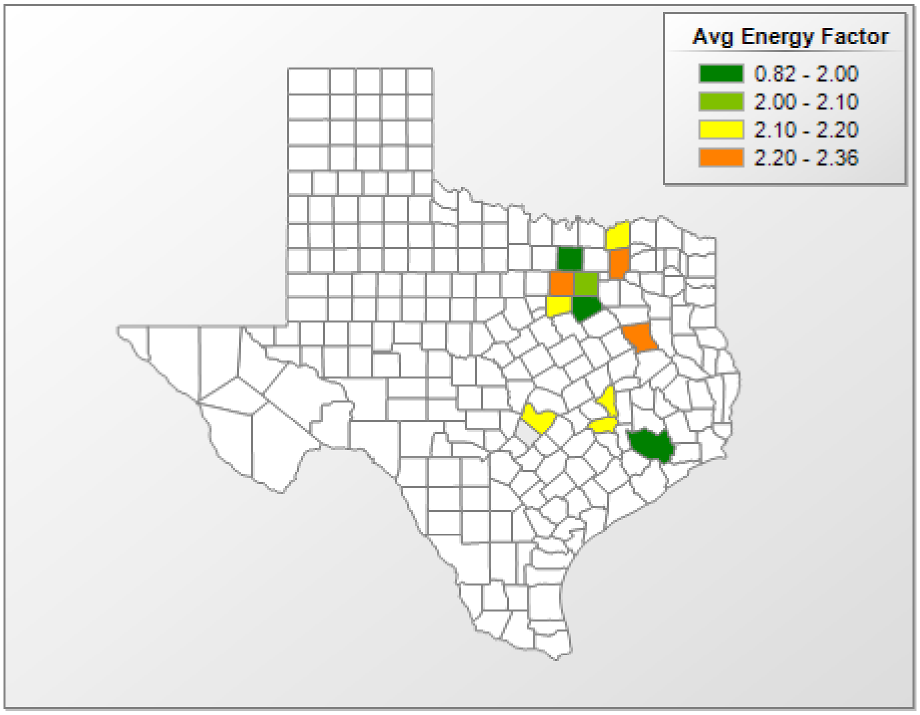


Figure 6-9: Yearly Average Heat Pump Water Heater Energy Factor Distribution by County in 2022

This report shows the average A/C SEER across Texas in 2022. The efficiency (and sizing) of air conditioning is a vital component of energy efficiency in Texas.

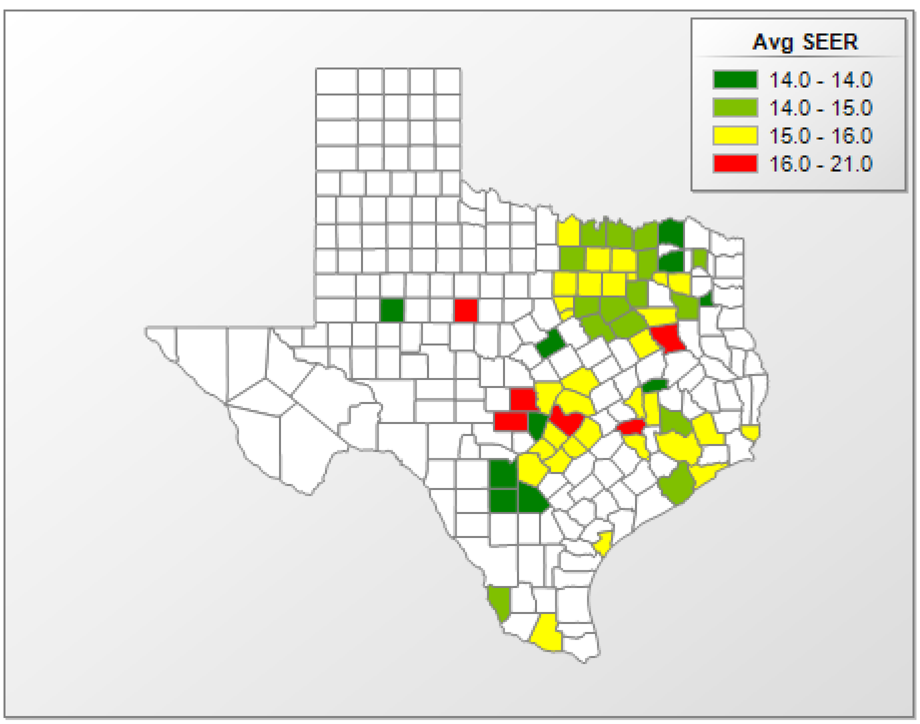


Figure 6-10: Average A/C SEER across Counties in 2022

This report shows the average ceiling insulation across Texas in 2022.

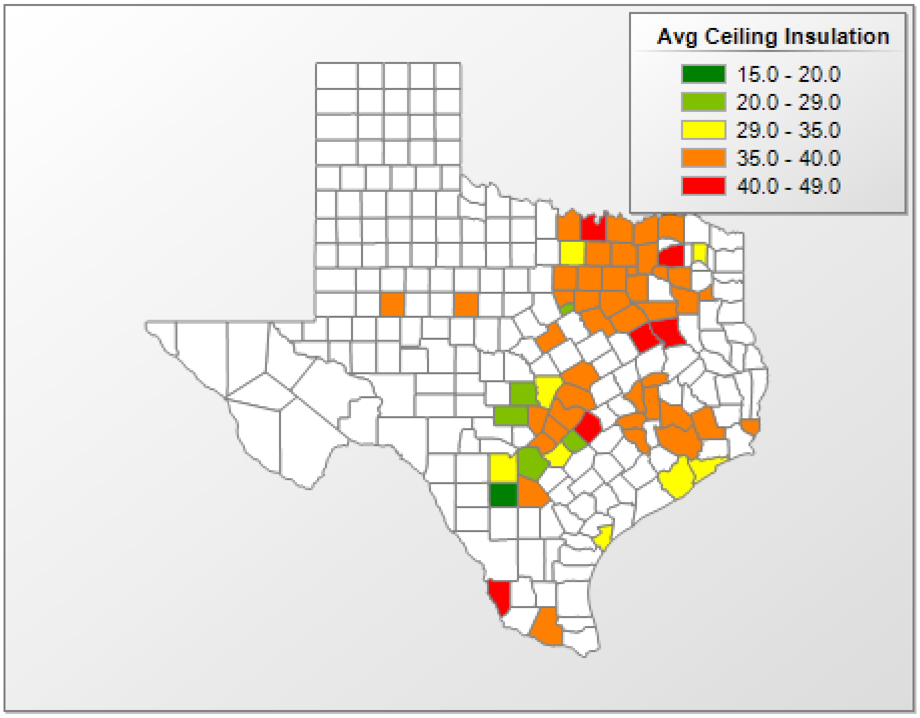


Figure 6-11: Average Ceiling Insulation across Counties in 2022

This report shows the average heating efficiency across Texas in 2022.

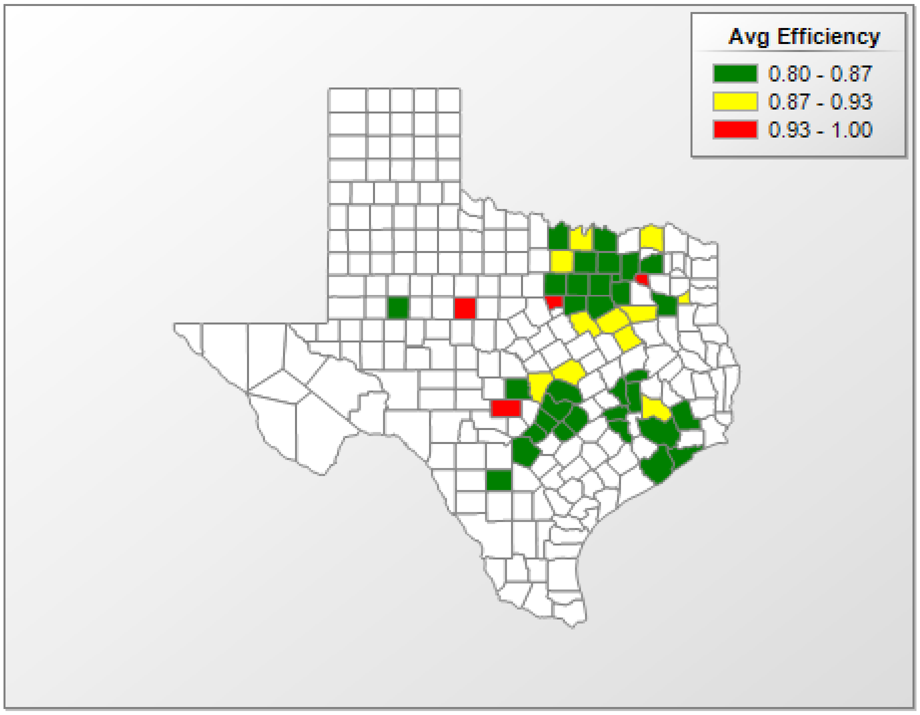


Figure 6-12: Average NG Heating Efficiency across Counties in 2022

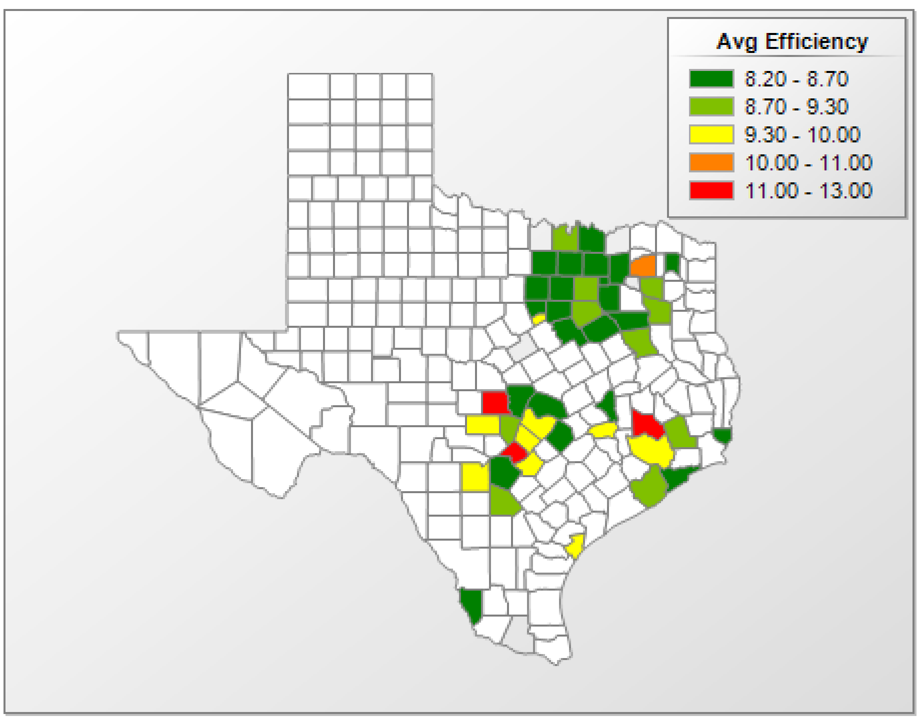


Figure 6-13: Average Heat Pump Heating Efficiency across Counties in 2022

This report shows the average SHGC across Texas in 2022.

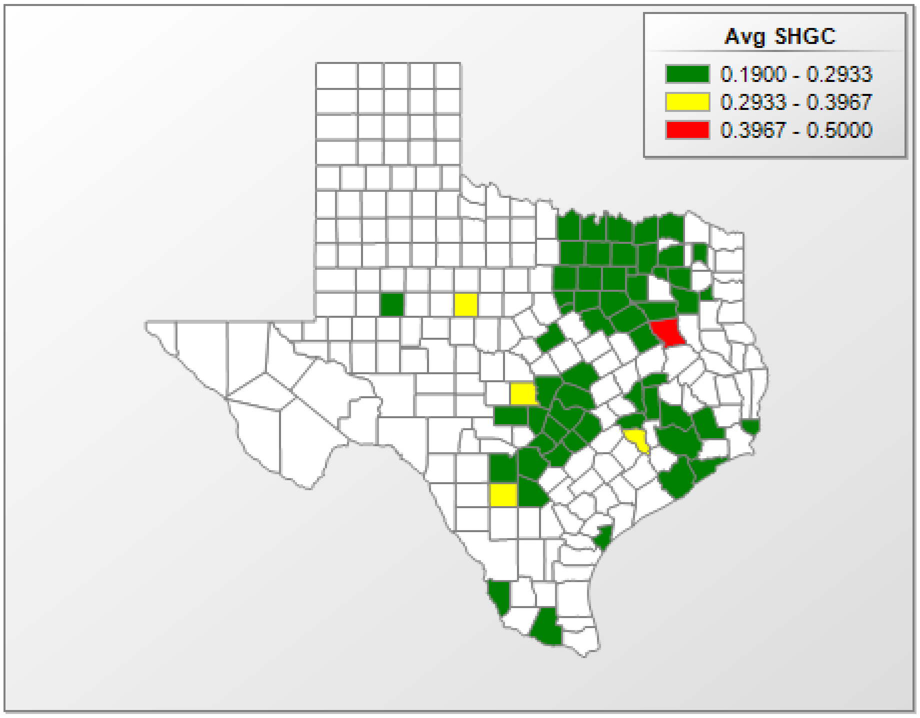


Figure 6-14: Average SHGC across Counties in 2022

This report shows the average U-Factor across Texas in 2022. The U-Factor applies to the heat transfer of a window caused by temperature, no direct solar radiation.

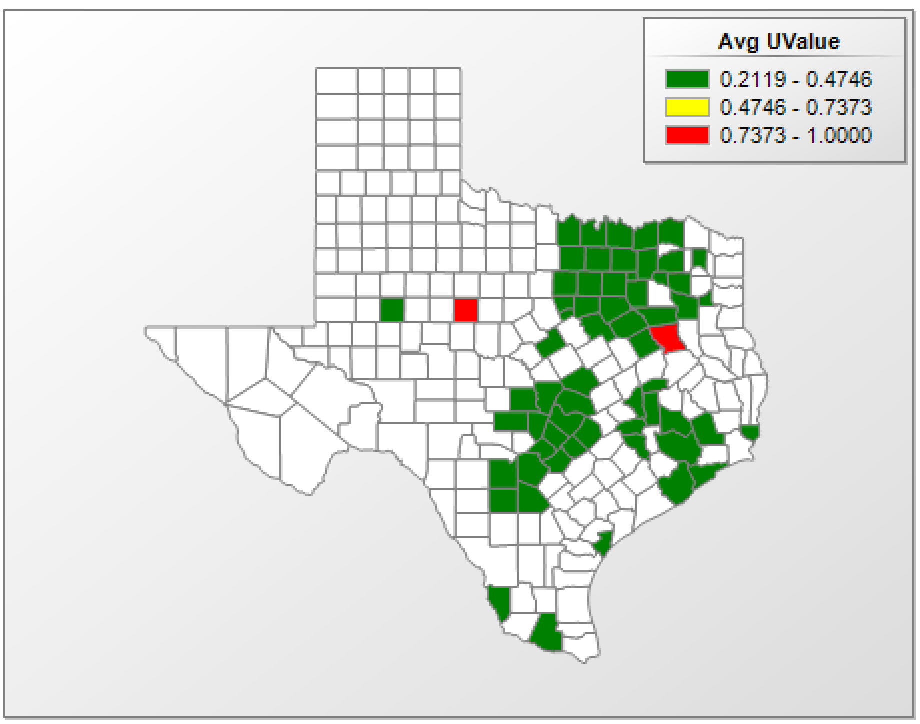


Figure 6-15: Average U-Factor across Counties for Single-Family Homes in 2022

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

In version 4.5.2 (September 2020)
- Revised IECC 2015 AE code

In version 4.5.3 (September 2020)
- Bug Fixes

In version 4.5.5 (September 19, 2022)
- IECC 2022 code supported
- IECC 2022 AE code supported
- In version 4.5.6 (December 10, 2022)

- IECC 2022 AE code added
- IECC 2022 code added
- New equipment: DHW UEF, New Duct System Interface

In version 4.5.7 (May 23, 2022)

- New search features added in project page
- Alterations made to 2022 Energy Option selection

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

Table 27 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
4.02.03	Added support for revised 2015 IECC AE code. Specifically, added 4th floor support.	

<u>*Added sensible and latent components for equipment heat gain*</u>
In order to incorporate the HERS Index calculations in IC3, it became necessary to elaborate the input for lighting, equipment and occupants.[37] 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.

[37] 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.[38]
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).[39]

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.

Added 4th floor support
In BDL Version 4.02.03 specifications for a fourth floor were added to the BDL.

[38] Email correspondence with Jeff Myron, EnergyGauge Technical Support (10/18/2013).
[39] 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 2022, the Laboratory redesigned its website to make navigation easier. On the navigation bar is a tab that links to the TERP homepage (Figure 6-16). 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 (Figure 6-16 - Figure 6-18)

- 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 2002-2022
  - Presentations
- Workshops
  - International Code Compliance Calculator
  - ASHRAE
  - IECC Commercial Energy Code Training

- IECC Residential Energy Code Training
- Continuous Commissioning

- TERP Links (Figure 6-18)
  - 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

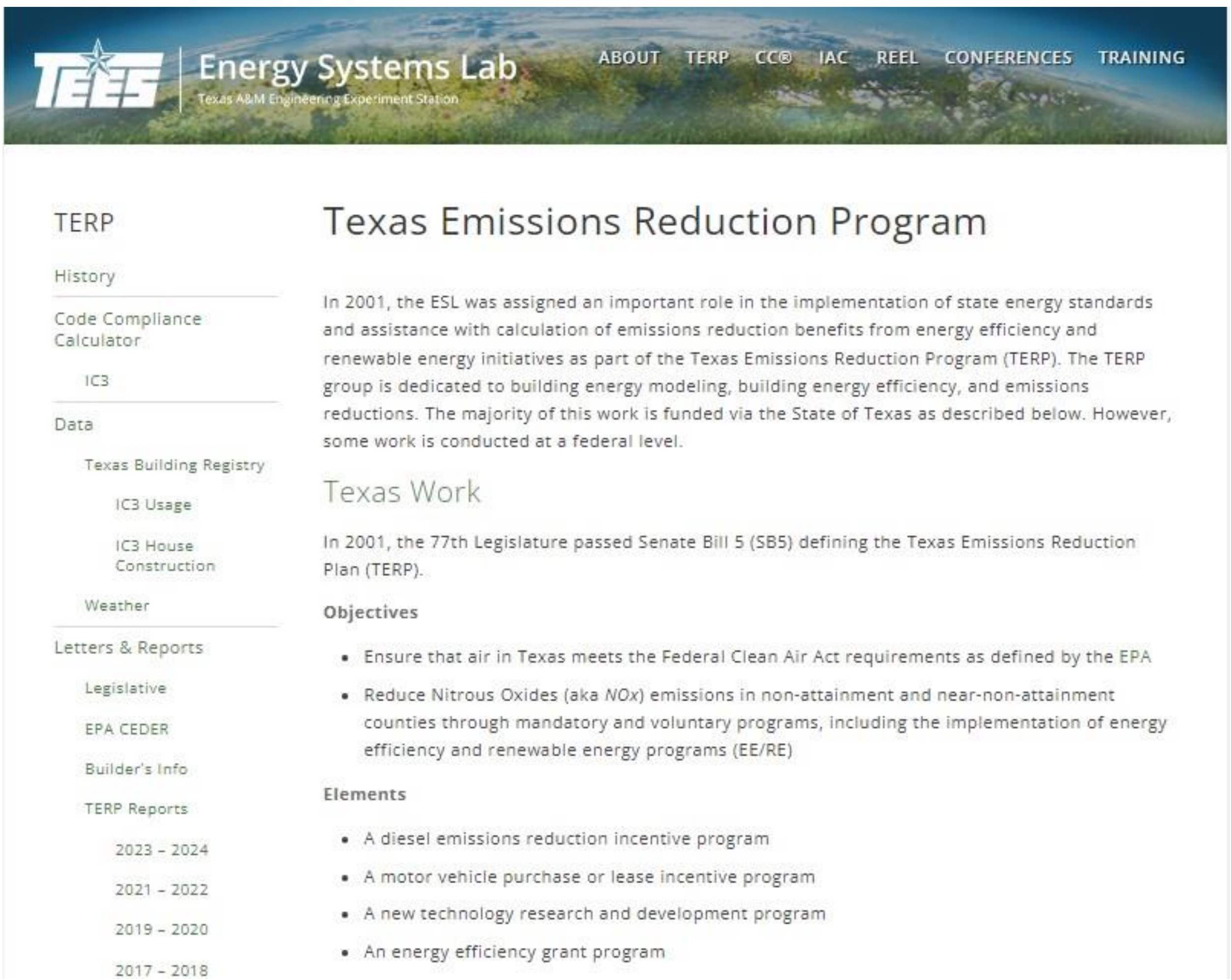


Figure 6-16. TERP Home Page

Energy Systems Lab
Texas A&M Engineering Experiment Station

ABOUT TERP CC® IAC REEL CONFERENCES TRAINING

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

2023 – 2024

2021 – 2022

2019 – 2020

2017 – 2018

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).

- **Aug 2021** ESL Stringency Analysis for Commercial and Residential Buildings Over 3 Stories – 2015 vs 2021 Aug 30 2021 [PDF] download
- **Aug 2021** ESL Stringency Analysis for SF Residential Buildings – 2015 vs 2021 IRC Aug 30 2021 [PDF] download
- **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

Figure 6-17: TERP –Legislative Documents

Figure 6-18: TERP Links (Accessed: 08/29/2022)

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. From 2005 to 2021, the Laboratory continued to work closely with the TCEQ to develop an integrated emissions calculation, which provided to the TCEQ with a creditable NOx emissions reduction from energy efficiency and renewable energy (EE/RE) programs. The integrated emission estimation includes data from 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. In 2021, due to COVID-19, there were no code training workshops.

6.4.3 Texas Energy Summit

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 from March 2 - 5, 2022.

TEXAS ENERGY SUMMIT **PROGRAM**

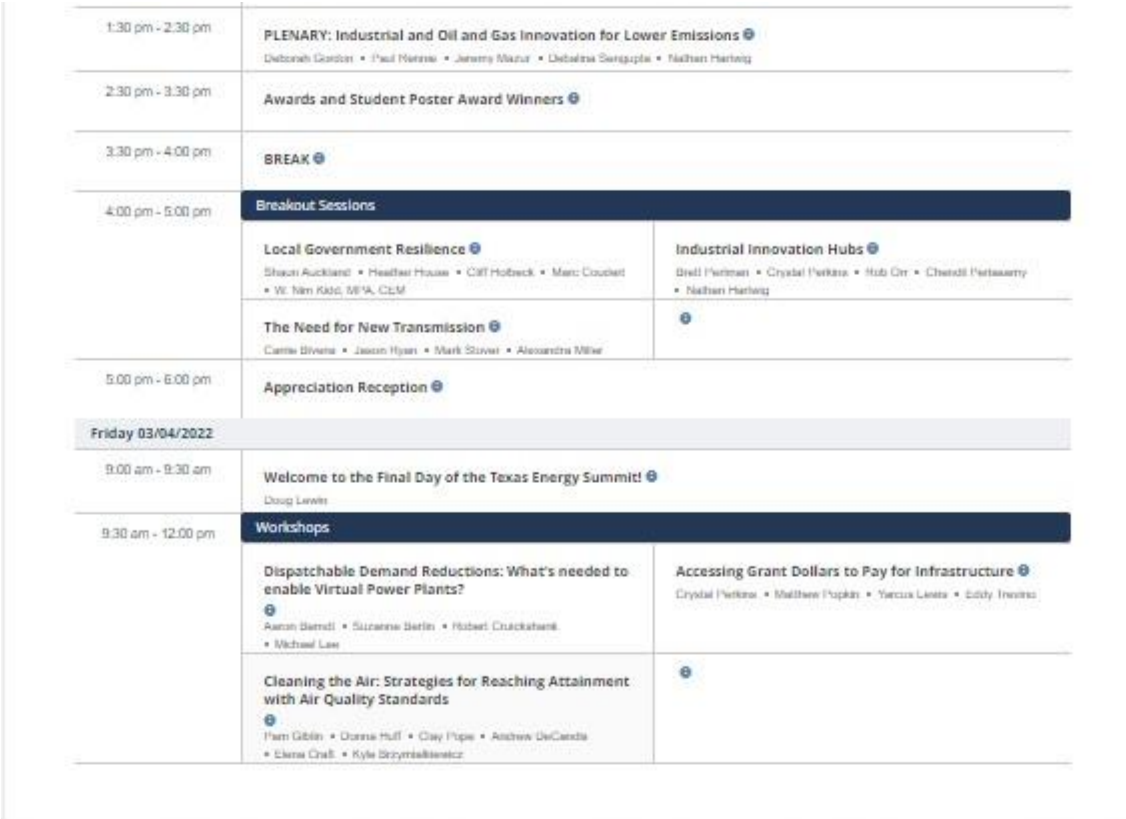
Texas Energy Summit Select Date WEDNESDAY 03/02/2022 Select List Order List by Date Filter Print

Wednesday 03/02/2022		
8:45 am - 9:00 am	**Welcome and Opening: Doug Lewin** Doug Lewin	
9:00 am - 9:30 am	**Keynote Address by Evan Smith** Evan Smith	
9:30 am - 9:45 am	**Keynote Address: Transitioning to a Clean Energy Economy** Kelly Speakes-Backman	
9:45 am - 10:30 am	**PLENARY: Increasing Resiliency Post-Uri** Virginia Palacios • Caitlin Smith • Senator Jose Menendez • Evan Smith	
10:30 am - 10:45 am	**BREAK**	
10:45 am - 11:45 am	**Breakout Sessions**	
	Speed and scale for "Baseload" Energy Efficiency: Addressing Inefficient Heat Alison Silverstein • Matt Burton • Kevin DeMaster • Pearl Cruz	**Batteries, Long Duration Storage and the Grid** Julia Matevosyan • Eric Goff • Molly Bales • Philip Jankowski
	The Intersection of Energy and Emergency Preparedness Vince Driering, P.E. • Marina Baldwin-Kritikos • Rep. Erin Zwiener • David Treichler • Maggie Glynn	
11:45 am - 1:15 pm	**LUNCH, sponsored by TEESI**	
1:15 pm - 1:30 pm	**State of the State's Air Quality** Jeff Haberl	
1:30 pm - 1:45 pm	**EPA Region 6 Priorities with RA Earthea Nance** Earthea Nance	
1:45 pm - 2:30 pm	**PLENARY: The Intersection of Air Quality, Public Health and Equity** Robert Bullard • Shelley Francis • Daniel Cohan • Emily Foxhall	
2:30 pm - 2:45 pm	**BREAK**	

Texas Energy Summit 2022

2:45 pm - 3:45 pm	**Breakout Sessions:**	
	Energy Codes in Texas Cyrus Reed • Jason Vandever • Shirley Ellis • Susan Alvarez • Patricia Chawla	**24/7 Clean Energy** Tim Latimer • Michael Jewell • Savannah Goodman • Michael McNamara
	Engaging Communities in Sustainability and Resiliency Shane Johnson • Elida Castillo • Nathan Shannon • Alanna Cisz • Andrenika Whitenton	
3:45 pm - 4:00 pm	**BREAK**	
4:00 pm - 5:00 pm	**Breakout Sessions**	
	Integrating EVs and EV Fleets into the Grid Tom "Smitty" Smith • Ann Xu • Mitch Ferman • Jeremy Adelman	**Large Building Energy Efficiency: Financing in both Public and Private Sectors** Steve Brown • Eddy Trevino • Tim Farkas • Cassidy Ellis
	Replacing the Highest Polluting Power Plants with Cleaner, More Reliable Sources Daniel Cohan • Elena Krieger • Mose Buchele • Keri Macklin	
5:00 pm - 6:30 pm	**Welcome Reception sponsored by METCO Engineering**	
Thursday 03/03/2022		
8:30 am - 9:00 am	**Welcome and Opening: Doug Lewin** Doug Lewin	
9:00 am - 9:15 am	**Keynote Address by Amy Myers-Jaffe** Amy Myers Jaffe	
9:30 am - 10:30 am	**PLENARY: The Future of Clean Energy in Texas** Rep. Drew Darby • Barry Smitherman • Amy Heart • Lynnae Willette	
10:30 am - 11:00 am	**BREAK**	
11:00 am - 12:00 pm	**Breakout Sessions**	
	Growing and Training the Clean Energy Workforce Jarrell Hills • Bo Delp • Patricia Zavala • Richard Froeschle	**Local Power, Microgrids, and Resiliency** Cliff Braddock • Gavin Dillingham • Darrell Thornley • Scott Hill
	Rural Opportunities for Economic Development from Clean Energy Laramie Stroud • Samuel Davis • Charlene Heydinger • Arlene Lewis	
12:00 pm - 1:30 pm	**LUNCH, sponsored by Google**	

Texas Energy Summit 2022



1:30 pm - 2:30 pm	PLENARY: Industrial and Oil and Gas Innovation for Lower Emissions Deborah Gordon • Paul Henne • Jeremy Mazur • Debalina Sengupta • Nathan Hartwig	
2:30 pm - 3:30 pm	Awards and Student Poster Award Winners	
3:30 pm - 4:00 pm	BREAK	
4:00 pm - 5:00 pm	Breakout Sessions	
	Local Government Resilience Shaun Auckland • Heather House • Cliff Holbeck • Marc Coudert • W. Nim Kidd, MPA, CEM	Industrial Innovation Hubs Brett Perlman • Crystal Perkins • Rob Orr • Chendil Periasamy • Nathan Hartwig
	The Need for New Transmission Carrie Bivens • Jason Ryan • Mark Stover • Alexandra Miller	
5:00 pm - 6:00 pm	Appreciation Reception	
Friday 03/04/2022		
9:00 am - 9:30 am	Welcome to the Final Day of the Texas Energy Summit! Doug Lewin	
9:30 am - 12:00 pm	Workshops	
	Dispatchable Demand Reductions: What's needed to enable Virtual Power Plants? Aaron Berndt • Suzanne Berlin • Robert Cruickshank • Michael Lee	Accessing Grant Dollars to Pay for Infrastructure Crystal Perkins • Matthew Popkin • Yarcus Lewis • Eddy Trevino
	Cleaning the Air: Strategies for Reaching Attainment with Air Quality Standards Pam Giblin • Donna Huff • Clay Pope • Andrew DeCandis • Elena Craft • Kyle Strzymkiewicz	

Texas Energy Summit 2022

6.4.4 Papers, Theses, etc.

6.4.4.1 Theses and Dissertations.

The following theses and dissertations were published in 2022 incorporating work related to the Texas Emissions Reduction Plan (TERP).

- Lu, X., "Development and Evaluation of Advanced Sequences of Operation for HVAC Systems" *Ph.D. Dissertation, Dept. of Mechanical Engineering, Texas A&M University, College Station, TX, Mar. 2022*

  Commercial buildings account for 35 percent of electricity consumption in the U.S., of which 30 percent is used by the heating, ventilation, and air conditioning (HVAC) system. Despite the significant role of the HVAC control systems in energy efficiency, its design, commissioning, and retrofit have long been an intricate and complicated issue, considering that only diffuse and fragmented information on system operation is available for decision making in most of the scenarios. Due to this limitation, designers and control contractors can only rely on ad-hoc control sequences for system operation in practice, which is one of the major reasons why buildings are operated sub-optimally. To provide standardized and high-performance rule-based HVAC control sequences, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) has developed the Guideline 36 (GDL36) High Performance Sequences of Operation (SOO) for HVAC Systems to maximize energy efficiency. Although GDL36 was considered the most advanced rule-based HVAC control sequences in this era, most of the proposed controls are still under development and its actual performance remains largely unknown. Up till now, only a few field studies have been conducted to verify the overall effectiveness of GDL36 after its publication, and these studies only focused on the energy saving potential. There is a practical need to benchmark the SOO in GDL36 in different aspects. To address these gaps, this research aims at enhancing the existing standardized high-performance control sequences (GDL36) by conducting a comprehensive evaluation in terms of energy efficiency, fault robustness, ventilation performance, and grid ancillary service compatibility. The target HVAC systems in this research are multi-zone variable air volume (VAV) systems, which are one of the most popular HVAC system configurations in U.S. commercial buildings. First, a Modelica model of a five-zone VAV system that follows both airside and waterside SOO was developed and verified. This building model serves as the virtual testbed for the following intelligent controller evaluation and comprehensive fault impact analysis. Second, the energy saving potential of the high-performance rule-based controls was compared with that of the state-of-the-art intelligent controls (deep reinforcement learning (DRL)-based control (DRLC) and optimization-based control (OBC)) in two typical cooling weeks. Two supervisory control loops in the airside GDL36 SOO (e.g., supply air temperature and duct static pressure) were replaced by DRL and OBC controller. The results show that the GDL36 has a comparable energy performance (within a 3% deviation) with DRLC in scenarios under both high and mild cooling loads. GDL36 also has a comparable energy performance (within a 3% deviation) with OBC in scenarios with high cooling load, but it consumed 7% more energy in the shoulder week. In terms of thermal comfort, the GDL36 was found to have slightly more zone air temperature violation in all scenarios compared to the other two intelligent controllers (i.e., DRLC and OBC). Third, a comprehensive fault impact analysis of the GDL36 was conducted to assess its fault robustness. How these sequences handle and adapt to various types of common faults was evaluated through a large-scale fault simulation. The results show that a vast majority (~90%) of fault scenarios have a fault impact ratio (FIR) of less than 6% for energy consumption and energy cost. Besides, the results of FIR distributions also indicate that GDL36 SOO only has limited influence on key performance indexes (KPIs) such as the supply air temperature control quality, thermal comfort, ventilation performance, and peak power load. Fourth, considering that the HVAC system configuration of multiple zone VAV systems with multiple recirculation paths has long been neglected in literature, a CO2-based demand control ventilation (DCV) was developed and quantitatively investigated in this study in terms of energy and ventilation performance. The proposed DCV control sequences were tested in four typical ASHRAE climate zones and proved to achieve considerable energy savings while maintaining an acceptable indoor air quality compliant with ASHRAE Standard 62.1. Lastly, an experimentally validated frequency regulation (FR) control scheme was integrated with the GDL36 SOO for air handling unit (AHU) fans from the perspective of the building providing ancillary service in the future. The impacts on the energy efficiency and thermal comfort were assessed and potential control conflict was identified when the VAV system provides frequency regulation using the GDL36 SOO. In summary, this dissertation developed a Modelica-based virtual testbed and evaluated the GDL36 SOO for multi-zone VAV systems in a holistic view. For energy efficiency, the GDL36 SOO achieved a comparable performance in terms of energy efficiency and thermal comfort with two intelligent supervisory controls in both high and mild cooling load conditions. For the fault robustness, it demonstrated that there were only minor fault impacts over different KPIs for the system with GDL36 SOO through a large fault simulation. From the ventilation aspect, the proposed DCV SOO for multi-zone recirculating path systems showed its energy efficiency and ventilation compliance and could be readily merged into GDL36. Lastly, when the AHU fan provides the FR service, the FR control could be integrated with GDL36 SOO with limited impacts on the HVAC system. Following prerequisites need to be met. First, the time-varying FR capacity must be correctly estimated. Second, an anti-saturation control scheme needs to be developed to avoid the fan power surge and ensure a smooth transition to post-FR operation.

- Vadali, P.A., “Impact Metrics for Residential HVAC Systems using Cloud-Based Smart Thermostat Data,” *M.S. Thesis, Dept. of Mechanical Engineering, Texas A&M University, College Station, TX, Mar. 2022*

The aggregation of data from connected smart thermostats installed in a huge number of residential buildings has expedited the remote detection and diagnosis of faults in Heating, Ventilation and Air-Conditioning (HVAC) systems. Upon identification of faults in air-conditioning systems, manufacturers and occupants are interested to know how severe the impact of the faults is on the energy consumption and the thermal comfort of the occupants. Several studies in literature have previously attempted to quantify an energy impact metric and a thermal comfort impact metric of faults in an HVAC system, but the metrics developed lack the ability to be used objectively to compare several systems at once. Furthermore, no study has yet tried to examine the coupled relationship between the energy consumption of the system and the thermal comfort of the occupants to estimate an aggregate fault severity index of a system. The current study attempts to provide a paradigm shift in the calculation of the energy impact metric. The thesis, firstly, proposes a methodology to model the energy consumption of the average system in a dataset comprising of similarly sized system operating in the same climate region. The performance of each air-conditioning system is compared to the performance of the average system to estimate the amount of impact faults have on their energy consumption. Additionally, the current study also estimates the level of thermal discomfort felt by occupants of the house using the Predicted Mean Vote (PMV) of the indoor environment. The average level of discomfort felt by the occupants living in the house is then compared with a baseline to estimate impact on the thermal comfort of occupants. The two impact metrics are then combined together into one index that represents the fault severity index of the system which can then be used to rank systems to prioritize them for repair. The severity index of the system is a representation of the relative energy consumption level of the system if it were to produce no thermal discomfort. Another metric that comes as a by-product of this derivation is the amount of change in energy consumed by the system in order to make the indoor environment comfortable. The coupled nature of the four metrics will be delineated so as to gain an insight into the characteristics of air-conditioning systems. Causes for faulty behavior of systems are examined and systems with mechanical faults are segregated from systems operating under ineffective operating conditions.

Papers

Published Papers in 2022

The following papers were published in 2022 incorporating work related to the Texas Emissions Reduction Plan (TERP).

- Shin, M., Haberl, J. 2022. "Development of a Procedure for Automated Thermal Zoning for Building Energy Simulation", Journal of Building Engineering, (January).

  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. In addition, the building energy standards and guidelines related to building energy simulation recommend that only a core and perimeter thermal zoning strategy be used to reduce the total number of thermal zones in a model. However, although this simplifies modeling, it can lead to too many thermal zones in the building energy model of a multi-story building, or in some cases too few zones, which can impact the model's accuracy. Therefore, the aim of this study is to develop a new thermal zoning process for building energy simulation called the "grid/cluster method." that can be applied automatically to whole-building energy simulations of multi-zone commercial structures. To verify this new thermal zoning method, the indoor temperature profiles of grid units were carefully analyzed in a case study simulation. In this study, three thermal zoning simulation models for a rectangular building were created and applied in heating- and cooling-dominant climates. The results show that for both climate conditions, the new grid/cluster method reduced heating/cooling loads by 11%–27% as compared to the single-zone model. In addition, the results significantly improved the simulated indoor comfort conditions.

Link: A procedure for automating thermal zoning for building energy simulation

- Oh, S., Baltazar, J-C., Haberl, J. 2022. “Assessment of the Impact of Using a Smart Thermostat and Smart Meter Data on a Whole Building Energy Simulation”, Sustainability (May).

This paper assesses the current level of the application of passive/natural and daylighting systems in the US by architects and engineers. Although an extensive list of publications about passive/natural and daylighting systems exists, there are very few studies addressing the degree of applying these systems in practice. This paper, through the application of a survey methodology, evaluates the level of the application of passive and daylighting systems in the US and discusses the survey findings and variables that may increase the application of these systems in practice. The findings indicate a low level of the application of passive systems that need complex designs. In this case, daylighting systems were more regularly applied, while the application of passive cooling in the US was more common than passive heating systems. To promote the application of passive systems, the clients' desire/collaboration, building code/rating systems, and simulation tools for passive design were the most influential factors according to the survey findings. The focus of this study was on the application of passive systems as a part of a larger research focused on the application, education, and best-practices of passive design in the US.

Link: Assessment of the Impact of Using a Smart Thermostat and Smart Meter Data on a Whole-Building Energy Simulation

7 References

ASHRAE 2013. ANSI/ASHRAE/IESNA Standard 90.1-2013, Energy Standards for Building Except Low-Rise Residential Buildings. American Society of Heating and Refrigerating and Air-conditioning Engineers, Inc., Atlanta, GA.

Baltazar, J.C, Haberl, J., Yazdani, B., Claridge, D., Jung, S., Kheiri, F., Kim, C., 2019, "Statewide Air Emissions Calculations from Wind and Other Renewables: Volume I", July 2019, Energy Systems Laboratory Report No. ESL-TR-19-07-02.

Baltazar, J.C., Haberl, J., Yazdani, B., Claridge, D., Jung, S., Kheiri, F., Kim, C., 2019, "Statewide Air Emissions Calculations from Wind and Other Renewables: Volume II - Technical Appendix", July 2019, Energy Systems Laboratory Report No. ESL-TR-19-07-03.

Baltazar, J.C., Haberl, J., Yazdani, B., Parker, P., Ellis, S., Zilbertshtein, G., and Claridge, D. 2019. “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 2018 to December 2018, Energy Systems Laboratory, Report ESL-TR-19-10-01.

Baltazar, J.C., Haberl, J., Yazdani, B., Claridge, D., Jung, S., Kheiri, F., Kim, C., 2020, "Statewide Air Emissions Calculations from Wind and Other Renewables: Volume I", July 2020, Energy Systems Laboratory Report No. ESL-TR-20-07-01.

Baltazar, J.C., Haberl, J., Yazdani, B., Claridge, D., Jung, S., Kheiri, F., Kim, C., 2020, "Statewide Air Emissions Calculations from Wind and Other Renewables: Volume II - Technical Appendix", July 2020, Energy Systems Laboratory Report No. ESL-TR-20-07-02.

Baltazar, J.C., Haberl, J., Yazdani, B., Parker, P., Ellis, S., Zilbertshtein, G., and Claridge, D. 2020. “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 to December 2019, Energy Systems Laboratory, Report ESL-TR-20-11-02.

Baltazar, J.C., Haberl, J., Yazdani, B., Parker, P., Ellis, S., Zilbertshtein, G., and Claridge, D. 2020. “Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP)”, Volume II – Technical Appendix, Annual Report to the Texas Commission on Environmental Quality, January 2019 to December 2019, Energy Systems Laboratory, Report ESL-TR-20-11-03.

Baltazar, J.C., Haberl, J., Yazdani, B., Claridge, D., Azimi, M., Ahn, J., Li, Q.B., Sun, Y. 2021, "Statewide Air Emissions Calculations from Wind and Other Renewables: Volume I", July 2021, Energy Systems Laboratory Report No. ESL-TR-21-07-01.

Baltazar, J.C., Haberl, J., Yazdani, B., Claridge, D., Azimi, M., Ahn, J., Li, Q.B., Sun, Y. 2021, "Statewide Air Emissions Calculations from Wind and Other Renewables: Volume II - Technical Appendix", July 2021, Energy Systems Laboratory Report No. ESL-TR-21-07-02.

Baltazar, J.C., Haberl, J., Yazdani, B., Parker, P., Ellis, S., Zilbertshtein, G., and Claridge, D., Li, Q.B., 2021. “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 2020 to December 2020, Energy Systems Laboratory, Report ESL-TR-21-11-01.

Baltazar, J.C., Haberl, J., Yazdani, B., Parker, P., Ellis, S., Zilbertshtein, G., and Claridge, D. Li, Q.B., 2021. “Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP)”, Volume II – Technical Appendix, Annual Report to the Texas Commission on Environmental Quality, January 2020 to December 2020, Energy Systems Laboratory, Report ESL-TR-21-11-02.

Baltazar, J.C., Haberl, J., Yazdani, B., Li Q., Claridge, D., Azimi, M., Ahn. J., and Sun. Y., 2022. "Statewide Air Emission Calculations from Wind and Other Renewables", Volume I - Technical Report, A Report to the Texas Commission on Environmental Quality, January 2021 to December 2021, Energy Systems Laboratory, Report ESL-TR-22-07-01.

Baltazar, J.C., Haberl, J., Yazdani, B., Li Q., Claridge, D., Azimi, M., Ahn. J., and Sun. Y., 2022. "Statewide Air Emission Calculations from Wind and Other Renewables", Volume II - Technical Report, A Report to the Texas Commission on Environmental Quality, January 2021 to December 2021, Energy Systems Laboratory, Report ESL-TR-22-07-02.

Baltazar, J.C., Haberl, J., Yazdani, B., Parker, P., Ellis, S., Zilbertshtein, G., and Claridge, D., Li, Q.B., 2022. "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 2021 to December 2021, Energy Systems Laboratory, Report ESL-TR-22-09-02.

Baltazar, J.C., Haberl, J., Yazdani, B., Parker, P., Ellis, S., Zilbertshtein, G., and Claridge, D. Li, Q.B., 2022. "Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP)", Volume II – Technical Appendix, Annual Report to the Texas Commission on Environmental Quality, January 2021 to December 2021, Energy Systems Laboratory, Report ESL-TR-22-09-03.

Baltazar, J.C., Haberl, J., Yazdani, B., Li Q., Claridge, D., Ahn. J., Hou. X., and Sun. Y., 2023. "Statewide Air Emission Calculations from Wind and Other Renewables", Volume I - Technical Report, A Report to the Texas Commission on Environmental Quality, January 2022 to December 2022, Energy Systems Laboratory, Report ESL-TR-23-07-01.

Baltazar, J.C., Haberl, J., Yazdani, B., Li Q., Claridge, D., Ahn. J., Hou. X., and Sun. Y., 2023. "Statewide Air Emission Calculations from Wind and Other Renewables", Volume II - Technical Report, A Report to the Texas Commission on Environmental Quality, January 2022 to December 2022, Energy Systems Laboratory, Report ESL-TR-23-07-02.

CBECS 2012. USDOE Commercial Building Energy Characteristics Survey. U.S.D.O.E. Energy Information Agency Report. https://www.eia.gov/consumption/commercial/data/2012/#b34-b37

Dodge. 2011. MarkeTrack: McGraw-Hill Construction Analytics. McGraw-Hill Construction Information Group, 148 Princeton-Hightstown Rd., Hightstown, N.J. http://dodge.construction.com.

Dodge. 2021. Dodge Data & Analytics construction starts information, Texas at the county level by select project types. New York, NY: Dodge Data& Analytics. https://www.construction.com/.

Dodge. 2022. Commercial and Multifamily Construction Starts Post Solid Recovery in 2021. New York, NY: Dodge Data & Analytics. https://www.construction.com/news/Commercial-and-Multifamily-Construction-Starts-Post-Solid-Recovery-in-2021

EIA. 2023. Texas Electricity Profile. Table 10. Supply and disposition of electricity, 1990 through 2021. Accessed: September 28, 2023. from: https://www.eia.gov/electricity/state/texas/

ERCOT. 2022. 2021 ERCOT Annual REC Report. Retrieved June 01, 2022, from: https://sa.ercot.com/rec/public-reports

ERCOT. 2022. REC Generator List. Retrieved June 01, 2022, from: https://sa.ercot.com/rec/rec-generator

ERCOT. 2022. Quarter / Annual Renewable Energy Generation in Texas by Technology Type. Retrieved June 01, 2022, from: https://sa.ercot.com/rec/account-tech

ERCOT. 2023. ERCOT Load Zone Map. Accessed: September 28, 2023. available at: https://www.ercot.com/files/assets/2023/06/05/ERCOT-Maps_Load-Zone.jpg?

Haberl, J., Baltazar, J.C., Gilman, D., Culp, C., Yazdani, B., Claridge, D., Mao, C., Sun, Y., Narayanaswamy, A., 2011, "Statewide Air Emissions Calculations from Wind and Other Renewables", August 2011, Energy Systems Laboratory Report No. ESL-TR-11-08-01.

Haberl, J., Baltazar, J.C., Culp, C., Yazdani, B., Claridge, D., Mao, C., Do, S., 2012, "Statewide Air Emissions Calculations from Wind and Other Renewables", July 2012, Energy Systems Laboratory Report No. ESL-TR-12-07-01.

Haberl, J., Baltazar, J.C., Yazdani, B., Claridge, D., Mao, C., Kota, S., 2013, "Statewide Air Emissions Calculations from Wind and Other Renewables", July 2013, Energy Systems Laboratory Report No. ESL-TR-13-07-01.

Haberl, J., Baltazar, J.C., Yazdani, B., Claridge, D., Do, S., Oh, S., 2014, "Statewide Air Emissions Calculations from Wind and Other Renewables", July 2014, Energy Systems Laboratory Report No. ESL-TR-14-07-01.

Haberl, J., Baltazar, J.C., Yazdani, B., Claridge, D., Oh, S., Mao, C., 2015, "Statewide Air Emissions Calculations from Wind and Other Renewables", July 2015, Energy Systems Laboratory Report No. ESL-TR-15-07-01.

Haberl, J., Baltazar, J.C., Yazdani, B., Claridge, D., Jung, S., Kheiri, F., 2016, "Statewide Air Emissions Calculations from Wind and Other Renewables", September 2016, Energy Systems Laboratory Report No. ESL-TR-16-09-01.

Haberl, J., Baltazar, J.C., Yazdani, B., Claridge, D., Jung, S., Kheiri, F., 2017, "Statewide Air Emissions Calculations from Wind and Other Renewables", August 2017, Energy Systems Laboratory Report No. ESL-TR-17-08-01.

Haberl, J., Baltazar, J.C., Yazdani, B., Claridge, D., Jung, S., Kheiri, F., Shin, M., 2018, "Statewide Air Emissions Calculations from Wind and Other Renewables", July 2018, Energy Systems Laboratory Report No. ESL-TR-18-08-01.

Haberl, J., Culp, C., Yazdani, B., Fitzpatrick, and Turner, D., 2002, “Texas’s Senate Bill 5 Legislation for Reducing Pollution in Non-attainment and Affected Areas,” Annual Report to the Texas Natural Resource Conservation Commission, July, Energy Systems Laboratory Report ESL-TR-02-07-01.

Haberl, J., Culp, C., Yazdani, B., Fitzpatrick, T., Bryant, J., Turner, D., 2003, “Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP),” Volume II– Technical Report, Annual Report to the Texas Commission on Environmental Quality, September 2002 to August 2003, Energy Systems Laboratory Report ESL-TR-03-12-04.

Haberl, J., Culp, C., Yazdani, B., Gilman, D., Fitzpatrick, T., Muns, S., Verdict, M., Ahmed, M., Liu, Z., Baltazar, J.C., Bryant, J., Degelman, L., Turner, D. 2004. “Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP)”, Volume II – Technical Report, Annual Report to the Texas Commission on Environmental Quality, September 2003 to August 2004, Energy Systems Laboratory Report ESL-TR-04-12-04.

Haberl, J., Culp, C., Yazdani, B., Gilman, D., Fitzpatrick, T., Muns, S., Verdict, M., Ahmed, M., Liu, Z., Baltazar, J.C., Bryant, J., Degelman, L., and Turner, D. 2006. “Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP)”, Volume II – Technical Report, Annual Report to the Texas Commission on Environmental Quality, September 2004 to December 2005, Energy Systems Laboratory, Report ESL-TR-06-06-08.

Haberl, J., Culp, C., Yazdani, B., Gilman, D., Fitzpatrick, T., Muns, S., Liu, Z., Baltazar, J.C., Mukhopadhyay, J., Degelman, L., McKelvey, K., Montgomery, C., Ahmed, M., Verdict, M., 2007. “Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP)”, Volume II – Technical Report, Annual Report to the Texas Commission on Environmental Quality, January 2006 to June 2007, Energy Systems Laboratory, Report ESL-TR-07-12-02.

Haberl, J., Culp, C., Yazdani, B., Gilman, D., Fitzpatrick, T., Muns, S., Liu, Z., Baltazar, J.C., Mukhopadhyay, J., Degelman, L., and Claridge, D. 2008. "Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP)", Volume II – Technical Report, Annual Report to the Texas Commission on Environmental Quality, January 2007 to December 2007, Energy Systems Laboratory, Report ESL-TR-08-12-02.

Haberl, J., Culp, C., Yazdani, B., Gilman, D., Muns, S., Liu, Z., Baltazar, J.C., Mukhopadhyay, J., Degelman, L., and Claridge, D. 2009. "Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP)", Volume II – Technical Report, Annual Report to the Texas Commission on Environmental Quality, January 2008 to December 2008, Energy Systems Laboratory, Report ESL-TR-09-12-02.

Haberl, J., Culp, C., Yazdani, B., Lewis, C., Liu, Z., Baltazar, J.C., Mukhopadhyay, J., Gilman, D., Degelman, L., McKelvey, K., and Claridge, D. 2010. "Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP)", Volume II – Technical Report, Annual Report to the Texas Commission on Environmental Quality, January 2009 to December 2009, Energy Systems Laboratory, Report ESL-TR-10-12-02.

Haberl, J., Yazdani, B., Lewis, C., Liu, Z., Baltazar, J.C., Mukhopadhyay, J., Gilman, D., Degelman, L., McKelvey, K., Zilbershtein, G., and Claridge, D. 2011. "Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP)", Volume II – Technical Report, Annual Report to the Texas Commission on Environmental Quality, January 2010 to December 2010, Energy Systems Laboratory, Report ESL-TR-11-12-03.

Haberl, J., Yazdani, B., Baltazar, J.C., Lewis, C., Parker, P., Ellis, S., Mukhopadhyay, J., Kim, H., Gilman, D., Degelman, L., Zilbershtein, G., and Claridge, D. 2012. "Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP)", Volume II – Technical Report, Annual Report to the Texas Commission on Environmental Quality, January 2011 to December 2011, Energy Systems Laboratory, Report ESL-TR-12-12-05.

Haberl, J., Yazdani, B., Baltazar, J.C., Parker, P., Ellis, S., Mukhopadhyay, J., Kim, H., Gilman, D., Degelman, L., Zilbershtein, G., and Claridge, D. 2013. "Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP)", Volume II – Technical Report, Annual Report to the Texas Commission on Environmental Quality, January 2012 to December 2012, Energy Systems Laboratory, Report ESL-TR-13-10-04.

Haberl, J., Yazdani, B., Baltazar, J.C., Do, S.L., Ellis, S., Mukhopadhyay, J., Parker, P., Degelman, L., Zilbershtein, G., and Claridge, D. 2014. "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 2013 to December 2013, Energy Systems Laboratory, Report ESL-TR-14-11-01.

Haberl, J., Yazdani, B., Baltazar, J.C., Do, S.L., Ellis, S., Mukhopadhyay, J., Parker, P., Degelman, L., Zilbershtein, G., and Claridge, D. 2015. "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 2014 to December 2014, Energy Systems Laboratory, Report ESL-TR-15-11-01.

Haberl, J., Yazdani, B., Baltazar, J.C., Do, S.L., Ellis, S., Mukhopadhyay, J., Parker, P., Degelman, L., Zilbershtein, G., and Claridge, D. 2017. "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 2015 to December 2015, Energy Systems Laboratory, Report ESL-TR-16-11-01.

Haberl, J., Baltazar, J.C., Yazdani, B., Parker, P., Ellis, S., Zilbershtein, G., and Claridge, D. 2018. "Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP)", Volume I – Technical Report, Annual Report to the Texas Commission on Environmental Quality, January 2016 to December 2016, Energy Systems Laboratory, Report ESL-TR-17-12-01.

Haberl, J., Baltazar, J.C., Yazdani, B., Parker, P., Ellis, S., Zilbershtein, G., and Claridge, D. 2019. "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 2017 to December 2017, Energy Systems Laboratory, Report ESL-TR-18-12-02.

ICC. 2006. 2006 International Energy Conservation Code. Country Club Hills, IL: International Code Council, Inc.

ICC. 2009. 2009 International Energy Conservation Code. Falls Church, VA: International Code Council, Inc.

ICC. 2015. 2015 International Energy Conservation Code. Country Club Hills, IL: International Code Council, Inc.

ICC. 2018. 2018 International Energy Conservation Code. Country Club Hills, IL: International Code Council, Inc.

ICC. 2021. 2021 International Energy Conservation Code. Country Club Hills, IL: International Code Council, Inc.

LBL. 1993. DOE-2 BDL Summary Version 2.1E. LBL Report No. 349346. Berkley, CA: Lawrence Berkeley Laboratory.

LBNL. (2022). Tracking the Sun. Retrieved June 01, 2022, from: https://emp.lbl.gov/tracking-the-sun

Lim, A., "A Comparative Analysis of Predicting Energy Savings From Energy Service Projects," Department of Civil Engineering, May 2014.

NOAA 2019. Local Climatological Data (LCD), National Oceanic and Atmospheric Administration, U.S. Department of Commerce. available at: https://www.ncdc.noaa.gov

NOAA. 2022. Local Climatological Data (LCD). Retrieved from: https://www.ncei.noaa.gov/products/land-based-station/local-climatological-data

Home Innovation Research Labs, 2013, 2014, 2015, 2016, 2018, 2020. Builder Practices Survey Reports, Upper Marlboro, Maryland.

NAHB. 2008. The Builders Practices Survey Reports. National Association of Home Builders. Upper Marlboro, MD: NAHB Research Center.

NREL. 2019. National Solar Radiation Data Base: 1991 - 2005 Update: Typical Meteorological Year 3, Golden, CO. National Renewable Energy Laboratory. available at: https://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/

Parker, D.S., Dunlop, J.P., Barkaszi, S.F., Sherwin, J.R., Anello, M.T., and Sonne, J.K. 2000. "Towards Zero Energy Demand: Evaluation of Super-Efficient Building Technology with Photovoltaic Power for New Residential Housing," Proceedings of the 2000 ACEEE Summer Study of Energy Efficiency in Buildings, 1.207-1.223.

PUC 2019. Project No. 26310-20: 2019 PUC Report on Evaluation of State Energy Efficiency Programs. Public Utility Commission of Texas, available at: https://interchange.puc.texas.gov/search/documents/?controlNumber=26310&itemNumber=20

PUC 2020. Project No. 26310-21: 2020 PUC Report on Evaluation of State Energy Efficiency Programs. Public Utility Commission of Texas, available at: https://interchange.puc.texas.gov/search/documents/?controlNumber=26310&itemNumber=21

PUC 2021. Project No. 26310-22: 2021 PUC Report on Evaluation of State Energy Efficiency Programs. Public Utility Commission of Texas, available at: https://interchange.puc.texas.gov/search/documents/?controlNumber=26310&itemNumber=22

PUC 2022. Project No. 26310-23: 2022 PUC Report on Evaluation of State Energy Efficiency Programs. Public Utility Commission of Texas, available at: https://interchange.puc.texas.gov/search/documents/?controlNumber=26310&itemNumber=23

PUC 2023. 2023 PUC Report on Evaluation of State Energy Efficiency Programs. Public Utility Commission of Texas, available at: https://interchange.puc.texas.gov/

PUCT. 2022. New Electric Generating Plants in Texas since 1995. Retrieved June 09, 2022, from: http://www.puc.texas.gov/industry/Electric/reports/Default.aspx

Real Estate Center (REC). 2019. Building permits Texas. https://www.recenter.tamu.edu/data/building-permits/

Real Estate Center (REC). 2021. Building permits Texas. https://www.recenter.tamu.edu/data/building-permits/

Real Estate Center (REC). 2023. Building Permits Texas, available at: https://www.recenter.tamu.edu/data/building-permits/#!/state/Texas

SECO. 2023. Energy Use Summary. SECO Local Government. Home Comptroller.Texas.Gov. Lyndon B. Johnson State Office Building. 111 East 17th Street. Austin. Texas. 78774, Accessed: September 28, 2023. Available at: https://bivisual2.cpa.texas.gov/QvAJAXZfc/opendoc.htm?document=documents/BI_Master_UI.qvw&sheet=SecoGov_Sheet_1

Simplemaps. 2022. Retrieved June 01, 2022, from: https://simplemaps.com

TCEQ. 2016. "Texas Emissions Reduction Plan: Guidelines for Emissions Reduction Incentive Grants", Report No. RG-388, Texas Commission on Environmental Quality, available at: https://www.tceq.texas.gov/assets/public/comm_exec/pubs/rg/rg388/rg-388.pdf

Texas State Energy Conservation Office (SECO), 2021, available at: https://comptroller.texas.gov/programs/seco/reporting/local-gov.php

USDOE. 2011. Building Energy Standard Program: Final Determination Regarding Energy Efficiency Improvements in the Energy Standard for Buildings, Except Low-Rise Residential Buildings, ANSI/ASHRAE/IESNA Standard 90.1-2010. Federal Register 76(202):64904-64923.

USDOE. 2014. Building Energy Standard Program: Final Determination Regarding Energy Efficiency Improvements in ANSI/ASHRAE/IES Standard 90.1-2013: Energy Standard for Buildings, Except Low-Rise Residential Buildings. Federal Register 79(187):57900-57915.

USDOE. 2021. Department of Energy (DOE). Central Air Conditioning: Energy Saver, Accessed: September 1. https://www.energy.gov/energysaver/central-air-conditioning

USEPA. 2018. Emissions & Generation Resource Integrated Database (eGRID). Energy and the Environment, United States Environmental Protection Agency. available at: https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid.

USEPA. 2022. Emissions & Generation Resource Integrated Database (eGRID). Retrieved June 09, 2022, from: https://www.epa.gov/egrid

USEPA. 2022. Landfill Technical Data. Retrieved June 09, 2022, from: https://www.epa.gov/lmop/landfill-technical-data

8 Bibliography

Ahmed, M., Gilman, D., Mukhopadhyay, J., Haberl, J., Culp, C. 2005a. “Development of a Web-based Emissions Reduction Calculator for Code-compliant Single-Family and Multi-family Construction,” Proceedings of the 5th International Conference for Enhanced Building Operations, Pittsburg, PA (October).

Ahmed, M., Gilman, D., Kim, S., Haberl, J., Culp, C. 2005b. “Development of a Web-based Emissions Reduction Calculator for Code-compliant Commercial Construction,” Proceedings of the 5th International Conference for Enhanced Building Operations, Pittsburg, PA (October).

ASHRAE 1989. Energy Efficient Design of New Buildings Except Low-rise Residential Buildings. ASHRAE Standard 90.1-1989.

ASHRAE 1993. ANSI/ASHRAE Standard 136-1993 (RA 2006) - A Method of Determining Air Change Rates in Detached Dwellings. Atlanta, GA: American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

ASHRAE 2004a. “Advanced Energy Design Guide for Small Office Buildings,” American Society of Heating, Refrigeration and Air-conditioning Engineers, Atlanta, GA.

ASHRAE 2004b. ANSI/ASHRAE/IESNA Standard 90.1-2004, Energy Standards for Buildings Except Low-Rise Residential Buildings. American Society of Heating and Refrigerating and Air-conditioning Engineers, Inc., Atlanta, GA.

ASHRAE 2007. ANSI/ASHRAE/IESNA Standard 90.1-2007, Energy Standards for Building Except Low-Rise Residential Buildings. American Society of Heating and Refrigerating and Air-conditioning Engineers, Inc., Atlanta, GA.

ASHRAE 2010. ANSI/ASHRAE/IESNA Standard 90.1-2010, Energy Standards for Building Except Low-Rise Residential Buildings. American Society of Heating and Refrigerating and Air-conditioning Engineers, Inc., Atlanta, GA.

ASHRAE 2016. ANSI/ASHRAE/IESNA Standard 90.1-2016, Energy Standards for Building Except Low-Rise Residential Buildings. American Society of Heating and Refrigerating and Air-conditioning Engineers, Inc., Atlanta, GA.

ASHRAE 2019. ANSI/ASHRAE/IESNA Standard 90.1-2019, Energy Standards for Building Except Low-Rise Residential Buildings. American Society of Heating and Refrigerating and Air-conditioning Engineers, Inc., Atlanta, GA.

Baltazar, J.C., Liu, Z., Gilman, D., Haberl, J., Culp, C. 2005a. “Development of a Web-based Emissions Reduction Calculator for Retrofits to Municipal Water Supply and WasteWater Facilities,” Proceedings of the 5th International Conference for Enhanced Building Operations, Pittsburg, PA (October).

CBECS 2021. USDOE Commercial Building Energy Characteristics Survey. U.S.D.O.E. Energy Information Agency Report.

Cho, S., Mukhopadhyay, J., Culp, C., Haberl, J. S., Yazdani, B., 2007. “Recommendations for 15% Above-Code Energy-Efficiency Measures for Commercial Office Buildings,” Energy Systems Laboratory Report No. ESL-TR-07-09-01, Texas A&M University.

Cho, S. “Methodology to Develop and Test an Easy-to-use Procedure for the Preliminary Selection of High-performance Systems for Office Buildings in Hot and Humid Climates” Ph.D., Department of Architecture, Aug 2009 ESL-TH-09-08-05

Choi, J-H. “Analysis of the Impact if Using Improved Multi-layer Window Models for Code-Compliant Residential Building Energy Simulation in Texas,” M. S., Department of Architecture, Dec 2014 ESL-TH-14-12-02

Do, S. L., “Development and Application of a Ground-Coupled Heat Pump Simulation Model for Residential Code-Compliant Simulation in Texas,” Department of Architecture, May 2014 ESL-TH-14-04-01

Dodge. 2005. MarkeTrack: McGraw-Hill Construction Analytics. McGraw-Hill Construction Information Group, 148 Princeton-Hightstown Rd., Hightstown, N.J. http://dodge.construction.com

Dodge. 2019. Dodge Data & Analytics construction starts information, Texas at the county level by select project types. New York, NY: Dodge Data& Analytics. https://www.construction.com/.

Dodge. 2020a. Dodge Data & Analytics construction starts information, Texas at the county level by select project types. New York, NY: Dodge Data& Analytics. https://www.construction.com/.

Dodge. 2020b. COVID-19 Crusher Construction Starts in Most Metro Areas During First-Half 2020. New York, NY: Dodge Data & Analytics. https://www.construction.com/dodge-newsletters/covid-19-crushes-construction-starts-in-most-metro-areas-during-first-half-2020

Erbs, D., Klein, G., Duffie, S. 1982. “Estimation of the diffuse fraction for hourly, daily and monthly-average global radiation,” Solar Energy, Vol. 28, pp. 293-301.

Haberl, J., Im, P., Culp, C. 2004. “NOx Emissions Reductions From Implementation of the 2000 IECC/IRC Conservation Code to Residential Construction in Texas,” Proceedings of the 14th Symposium on Improving Building Systems in Hot and Humid Climates, Texas A&M University, Richardson, Texas, accepted for publication (February), pp. 139-150.

Haberl, J., Im, P., Culp, C., Yazdani, B., Fitzpatrick, T., Bryant, J., Turner, D. 2005. “A Simulation Methodology to Estimate NOx Emissions Reductions From the Implementation of the 2000 IECC/IRC Conservation Code in Texas,” IBPSA Newsletter, Vol. 15, No. 2, pp. 39-48 (October).

IESNA 2000. The IES Lighting Handbook, Reference and Application, 9th Edition. New York: Illuminating Engineering Society of North America.

Im, P. 2003. “A Methodology to Evaluate Energy Savings and NOx Emissions Reduction from the Adoption of the 2000 IECC to New Residences in Non-attainment and Affected Counties in Texas,” Master’s Thesis, Department of Architecture, Texas A&M University (December).

Im, Piljae. “Methodology for the Preliminary Design of High Performance Schools in Hot and Humid Climates” Ph.D., Department of Architecture, Dec 2009 ESL-TH-09-12-01

Kats, G.H. et al. 1996. “Energy Efficiency as a Commodity,” ACEEE Summer Study on Energy Efficiency in Buildings.

Kim, K. H., “Development of an Improved Methodology for Analyzing Existing Single-Family Residential Energy Use,” Department of Architecture, Aug 2014 ESL-TH-14-08-04

Kissock, K., Haberl, J.S., Claridge, D.E. 2002. “Development of a Toolkit for Calculating Linear, Change-point Linear and Multiple-Linear Inverse Building Energy Analysis Models,” Final Report for ASHRAE Research Project, No. 1050-RP.

Klein, S.A., Beckman, W.A. 1985. “PV F-Chart User’s Manual: DOS Version,” F-Chart Software, 4406 Fox Bluff Road, Middleton, Wisc. 53562, www.fchart.com.

Klein, S.A., Beckman, W.A. 1993. "F-Chart Solar Energy System Analysis: Version 6.17W," F-Chart Software, 4406 Fox Bluff Road, Middleton, Wisc. 53562, www.fchart.com.

Kootin-Sanwu, V. 2004. "Development of Energy Efficient Housing for Low-Income Families," *Ph.D. Dissertation*, Department of Architecture, Texas A&M University (May).

LBNL 1981. "DOE-2 Reference Manual Version 2.1A. LBL-8706 Rev. 1," Lawrence Berkeley National Laboratory, Berkeley, CA, and Los Alamos Scientific Laboratory, Santa Fe, NM.

Liao, J., Wang, L., and Claridge, D. E., "Analysis of Whole-Building HVAC System Energy Efficiency," ASHRAE Transactions, Vol. 124, Pt. I, pp. 72-87, 2018.

Liu, Z., Gilman, D., Haberl, J., Culp, C. 2005a. "Development of a Web-based Emissions Reduction Calculator for Street Light and Traffic Light Retrofits," Proceedings of the 5th International Conference for Enhanced Building Operations, Pittsburg, PA (October).

Liu, Z., Baltazar, J.C., Gilman, D., Haberl, J., Culp, C. 2005b. "Development of a Web-based Emissions Reduction Calculator for Green Power Purchases from Texas Wind Energy Providers," Proceedings of the 5th International Conference for Enhanced Building Operations, Pittsburg, PA (October).

Malhotra, M. 2005. "An Analysis of Maximum Residential Energy-Efficiency in Hot and Humid Climates," M.S., Department of Architecture, Dec 2005 ESL-TH-05-12-01

Malhotra, M. 2009. "An Analysis of Off-grid, Off-pipe Housing in Six U.S. Climates" Ph.D., Department of Architecture, Dec 2009 ESL-TH-09-12-02

Malhotra, M. and Haberl, J. 2006. "An Analysis of Building Envelope Upgrades for Residential Energy Efficiency in Hot and Humid Climates," Conference Paper for Presentation at SimBuild 2006, Second National Conference of IBPSA-USA. Cambridge, MA.

Malhotra, M. and J. Haberl. 2006. An Analysis of Maximum Residential Energy Efficiency in Hot and Humid Climates. Proceedings of the Fifteenth Symposium on Improving Building Systems in Hot and Humid Climates. Orlando, FL.

Malhotra, M., J. Mukhopadhyay, B. Liu, J. Haberl, C. Culp, B. Yazdani. 2007. Recommendations for 15% Above-Code Energy Efficiency Measures for Single-Family Residences. Energy Systems Laboratory Report No. ESL-TR-07-09-01.

Mao, C., Baltazar, J.C, Haberl, J. 2018. "Comparison of Building Envelop Peak Load Design Methods", Science and Technology for the Built Environment, accepted for publication (December).

Mao, C., Baltazar, J.C., Haberl, J.S., 2018. "Literature Review of Building Peak Cooling Load Design Methods for Commercial Buildings in the United States", Science and Technology for the Built Environment, Volume 24, No. 3, pp. 228-237 (March).

Mukhopadhyay, J. 2005. "Analysis of improved fenestration for code-compliant residential buildings in hot and humid climates," Master's Thesis, Department of Architecture, Texas A&M University.

NAECA. 2015. National Appliance Energy Conservation Act.

NAHB 2000. Builder Practices Survey Reports, National Association of Home Builders, Research Center, Upper Marlboro, Maryland (September).

NREL 1995. User's Manual for TMY2's (Typical Meteorological Years). NREL/SP-463-7668, and TMY2s, Typical Meteorological Years Derived from the 1961-1990. National Solar Radiation Data Base, June 1995 [CD-ROM]. Golden, Colorado: National Renewable Energy Laboratory.

NOAA 1993. Automated Surface Observing System Guide for Pilots, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, National Weather Service (April).

NREL. 2001. Building America house performance analysis procedures. (NREL/TP-550-27754) Golden, CO: National Renewable Energy Laboratory. p. 34.

Oh, S., Haberl, J. 2016. "Origins of the Methods for Simulation of Building Energy Simulation: Part I: Whole Building Energy Use", Science and Technology for the Built Environment, Volume 22, Issue 1, pp.118-137, ESL-PA-16-01-02 (January).

Oh, S., Haberl, J. 2016. "Origins of the Methods for Simulation of Building Energy Simulation: Part II: Lighting and Daylighting Simulation", Science and Technology for the Built Environment, Volume 22, Issue 1, pp. 107-117, ESL-PA-16-01-03 (January).

Oh, S., Haberl, J. 2016. "Origins of the Methods for Simulation of Building Energy Simulation: Part III: Solar Thermal, PV and Passive Solar Simulation", Science and Technology for the Built Environment, Volume 22, Issue 1, pp. 87-106, ESL-PA-16-01-04 (January)

Ottinger, R.L., Wooley, D.R., Robinson, N.A., Hodas, D.R., and Babb, S.E. 1991. Environmental Costs of Electricity. Oceana Publications, Inc., New York, N.Y.

RERC 2022. Texas Real Estate Research Center, College of Business, Texas A&M University, College Station, Texas. URL: https://www.recenter.tamu.edu/

Reilly, M., Winkelmann, D., Arasteh, D., and Caroll, W. 1992. "Modeling windows in DOE-2.1e. Proceedings of Thermal Performance of the Exterior Envelopes of Buildings VI," American Society of Heating Refrigeration and Air-Conditioning Engineers, 1992.

Song, S. 2006. "Development of New Methodologies for Evaluating the Energy Performance of New Commercial Buildings," Texas A&M University, in preparation, (August).

U.S. Census 2021. Annual Estimates of the Resident Population for Counties: April 1, 2020 to July 1, 2021 (CO-EST2021-POP) and Annual and Cumulative Estimates of the Components of Resident Population Change for Counties in the United States: April 1, 2020 to July 1, 2021 (CO-EST2021-COMP), U.S. Department of Commerce, March 1, 2022, URL: https://www.census.gov/en.html

USCB. 2002. Square Footage by Household and Unit Size, Income, and Costs—Occupied Units. American Housing Survey for the United States: 2001, p. 84. U.S. Census Bureau, Current Housing Reports, Series H150/01. Washington, DC: U.S. Government Printing Office.

USDOE. 2021. Final Determination Regarding Energy Efficiency Improvements in ANSI/ASHRAE/IES Standard 90.1-2019: Energy Standard for Buildings, Except Low-Rise Residential Buildings. Federal Register 83(39):8463-8465.

USEPA. 2008 "Estimation of Annual Reductions of NOx Emissions in ERCOT for the HB3693 Electricity Savings Goals", December 2008, Energy Systems Laboratory Report No. ESL-TR-08-12-04

USEPA. 2016. Emissions & Generation Resource Integrated Database (eGRID), eGRID 2016. Energy and the Environment, United States Environmental Protection Agency (July).

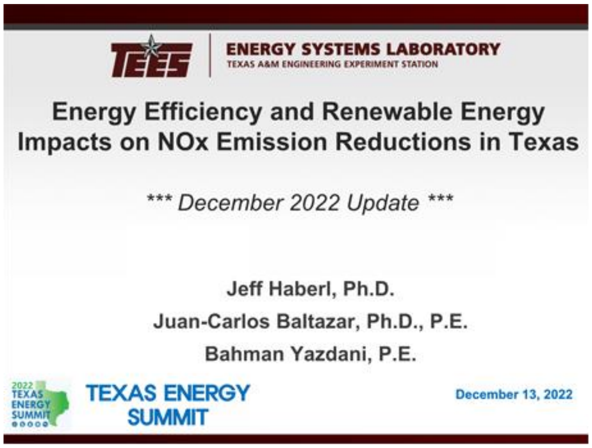
Appendix A: Presentations to Various Entities at Conferences and Workshops in 2020

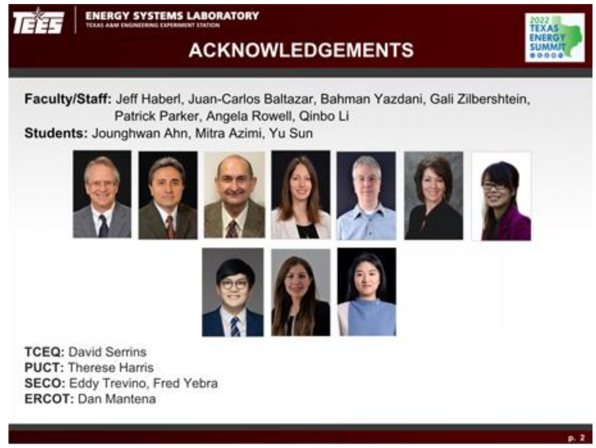
Appendix B: IC3 Parameter Reports

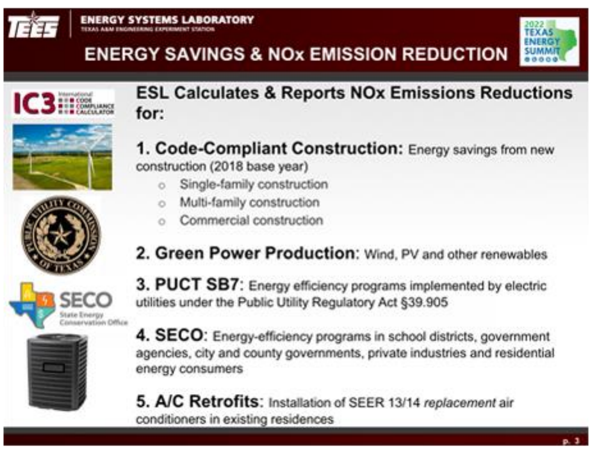
Appendix A: Presentations to Various Entities at Conferences and Workshops in 2022

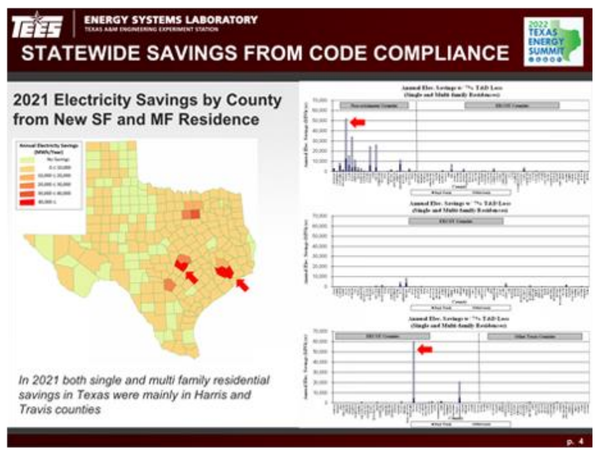
The Energy Systems Laboratory made presentations at several conferences and workshops about ways to save energy, and the appendix shows the presentation slides.

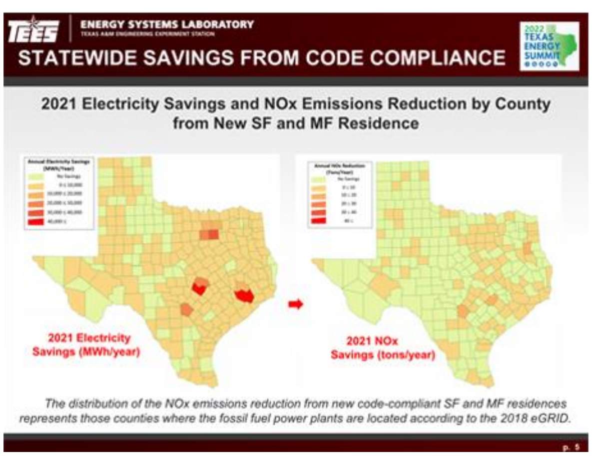
- "Energy Efficiency and Renewable Energy Impacts on NOx Emission Reductions" Texas Energy Summit conference, Online Virtual Event, December 2022, presented by Prof. Jeff Haberl.

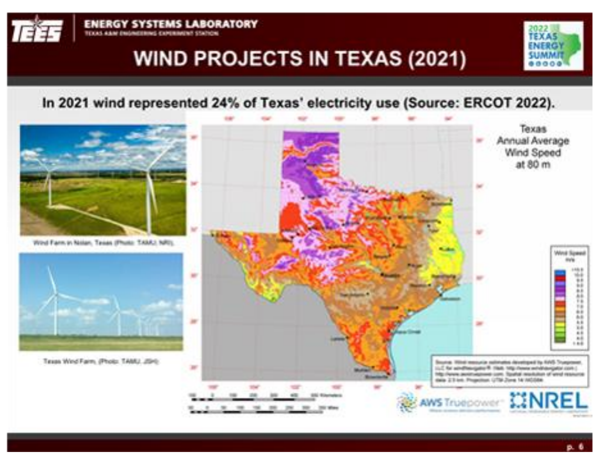


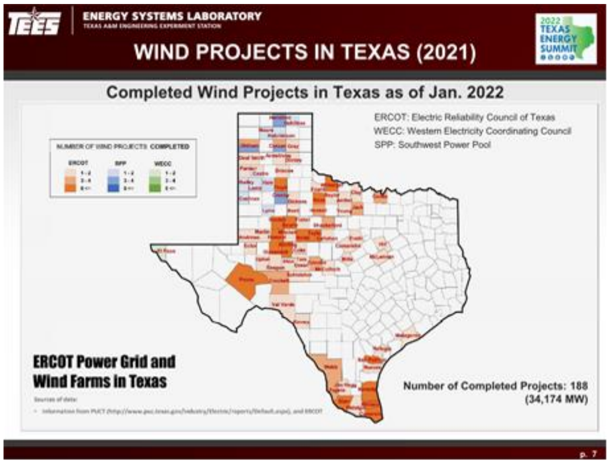


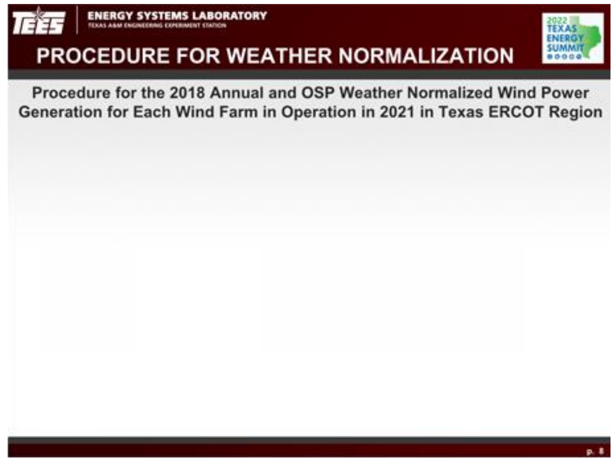


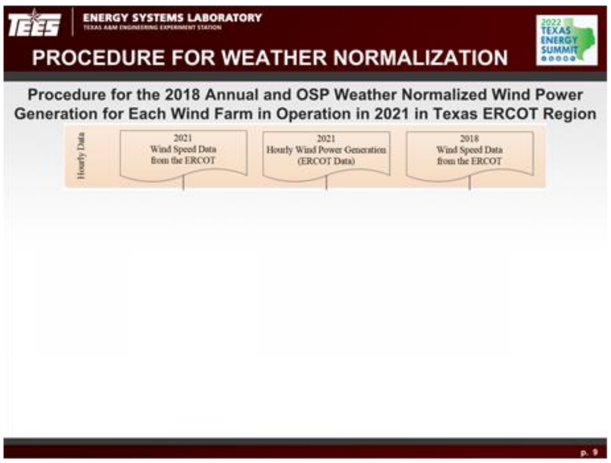


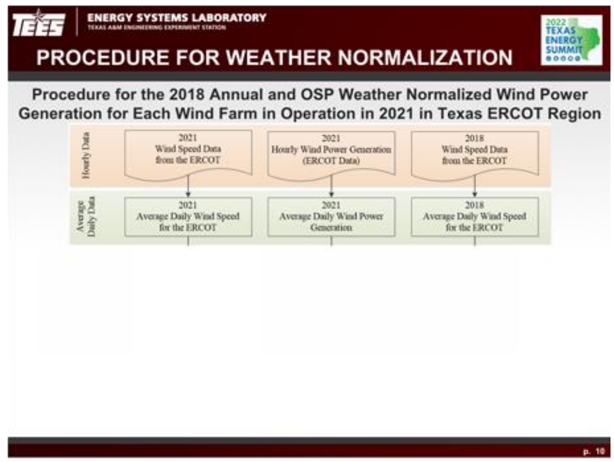


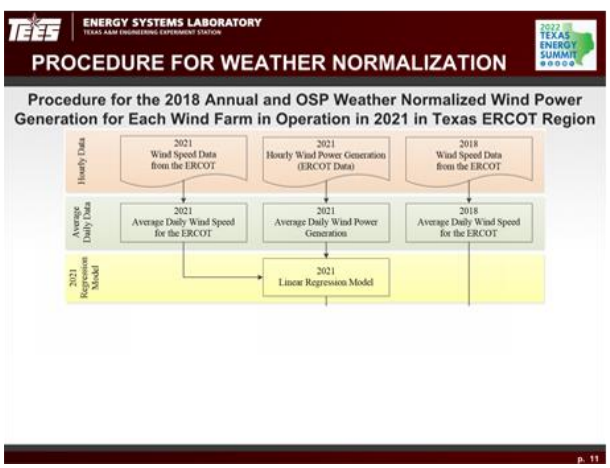


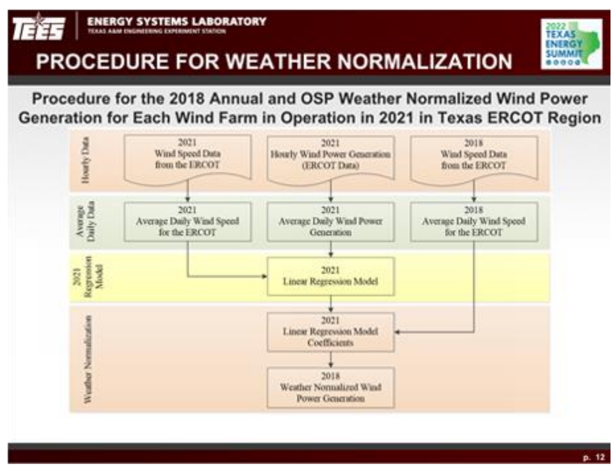

ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION
WIND PROJECTS IN TEXAS (2021)
2022 TEXAS ENERGY SUMMIT
Completed Wind Projects in Texas as of Jan. 2022
ERCOT: Electric Reliability Council of Texas
WECC: Western Electricity Coordinating Council
SPP: Southwest Power Pool
ERCOT Power Grid and Wind Farms in Texas
Number of Completed Projects: 188 (34,174 MW)
p. 7

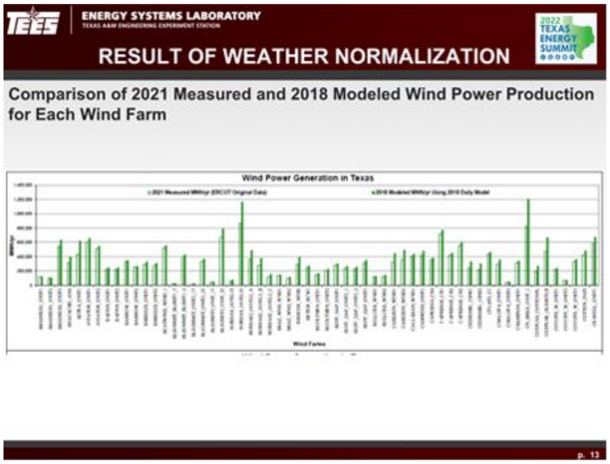

ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION
PROCEDURE FOR WEATHER NORMALIZATION
2022 TEXAS ENERGY SUMMIT
Procedure for the 2018 Annual and OSP Weather Normalized Wind Power Generation for Each Wind Farm in Operation in 2021 in Texas ERCOT Region
p. 8

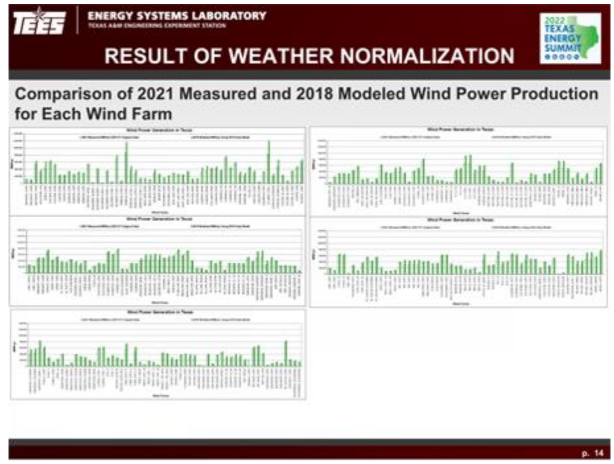

ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION
PROCEDURE FOR WEATHER NORMALIZATION
2022 TEXAS ENERGY SUMMIT
Procedure for the 2018 Annual and OSP Weather Normalized Wind Power Generation for Each Wind Farm in Operation in 2021 in Texas ERCOT Region
Hourly Data
2021 Wind Speed Data from the ERCOT
2021 Hourly Wind Power Generation (ERCOT Data)
2018 Wind Speed Data from the ERCOT
p. 9

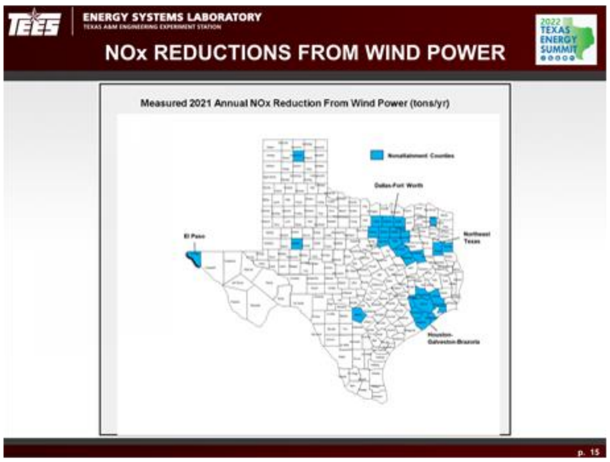

ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION
PROCEDURE FOR WEATHER NORMALIZATION
2022 TEXAS ENERGY SUMMIT
Procedure for the 2018 Annual and OSP Weather Normalized Wind Power Generation for Each Wind Farm in Operation in 2021 in Texas ERCOT Region
Hourly Data
2021 Wind Speed Data from the ERCOT
2021 Hourly Wind Power Generation (ERCOT Data)
2018 Wind Speed Data from the ERCOT
Average Daily Data
2021 Average Daily Wind Speed for the ERCOT
2021 Average Daily Wind Power Generation
2018 Average Daily Wind Speed for the ERCOT
p. 10


ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION
PROCEDURE FOR WEATHER NORMALIZATION
2022 TEXAS ENERGY SUMMIT
Procedure for the 2018 Annual and OSP Weather Normalized Wind Power Generation for Each Wind Farm in Operation in 2021 in Texas ERCOT Region
Hourly Data
2021 Wind Speed Data from the ERCOT
2021 Hourly Wind Power Generation (ERCOT Data)
2018 Wind Speed Data from the ERCOT
Average Daily Data
2021 Average Daily Wind Speed for the ERCOT
2021 Average Daily Wind Power Generation
2018 Average Daily Wind Speed for the ERCOT
2021 Regression Model
2021 Linear Regression Model
p. 11

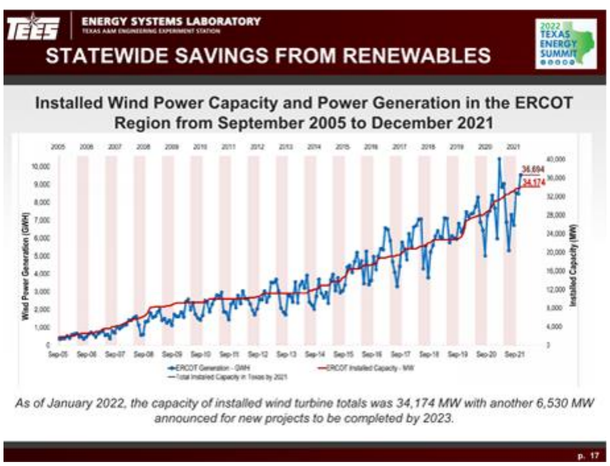

ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION
PROCEDURE FOR WEATHER NORMALIZATION
2022 TEXAS ENERGY SUMMIT
Procedure for the 2018 Annual and OSP Weather Normalized Wind Power Generation for Each Wind Farm in Operation in 2021 in Texas ERCOT Region
Hourly Data
2021 Wind Speed Data from the ERCOT
2021 Hourly Wind Power Generation (ERCOT Data)
2018 Wind Speed Data from the ERCOT
Average Daily Data
2021 Average Daily Wind Speed for the ERCOT
2021 Average Daily Wind Power Generation
2018 Average Daily Wind Speed for the ERCOT
2021 Regression Model
2021 Linear Regression Model
Weather Normalization
2021 Linear Regression Model Coefficients
2018 Weather Normalized Wind Power Generation
p. 12

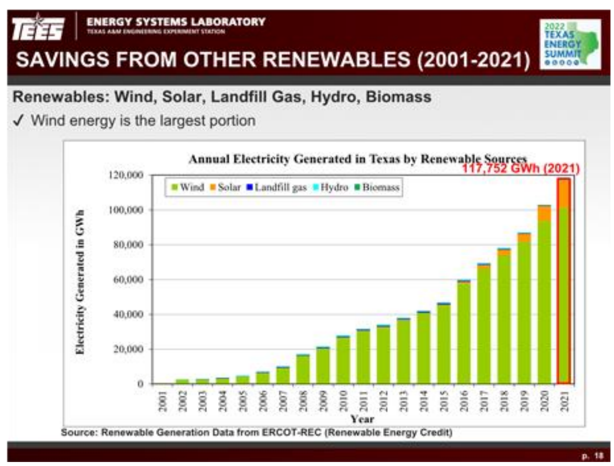

ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION
2022 TEXAS ENERGY SUMMIT
RESULT OF WEATHER NORMALIZATION
Comparison of 2021 Measured and 2018 Modeled Wind Power Production for Each Wind Farm
Wind Power Generation in Texas
Wind Farms
p. 13

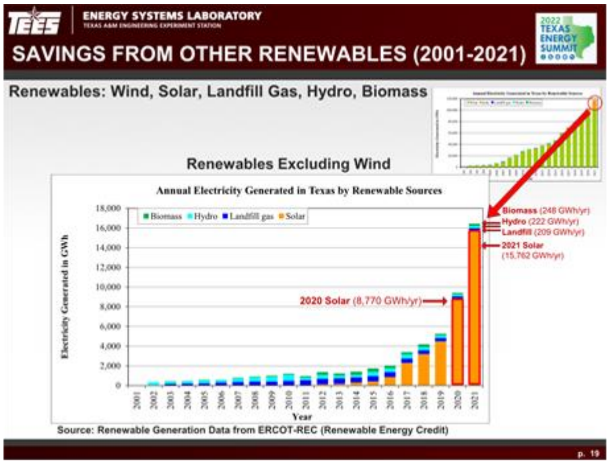

ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION
2022 TEXAS ENERGY SUMMIT
RESULT OF WEATHER NORMALIZATION
Comparison of 2021 Measured and 2018 Modeled Wind Power Production for Each Wind Farm
p. 14

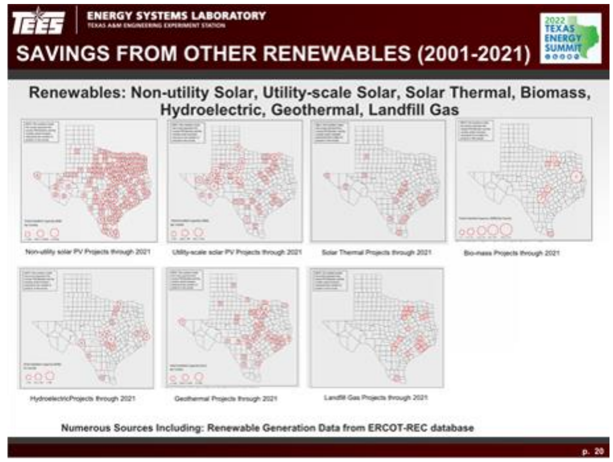

ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION
2022 TEXAS ENERGY SUMMIT
NOx REDUCTIONS FROM WIND POWER
Measured 2021 Annual NOx Reduction From Wind Power (tons/yr)
Nonattainment Counties
Dallas-Fort Worth
El Paso
Northeast Texas
Houston-Galveston-Brazoria
p. 15

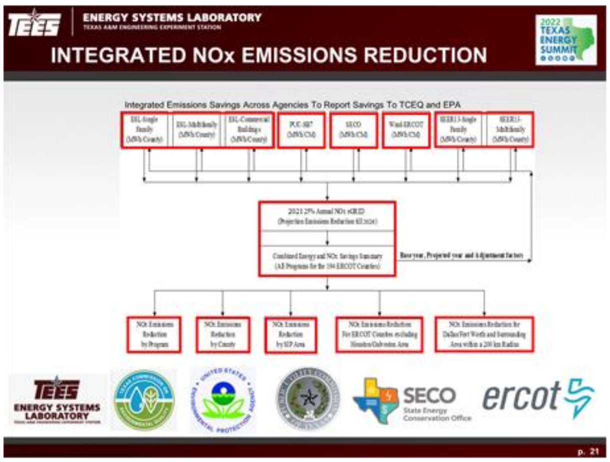

ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION
2022 TEXAS ENERGY SUMMIT
STATEWIDE SAVINGS FROM RENEWABLES
Blue Wing Solar PV Array ,San Antonio, TX
Sunmaxx Solar Thermal, Fort Hood, TX
Dam at Elephant Butte, El Paso, TX
Wind
Brazos Wind Ranch, TX
Solar
Hydro
Biomass
Landfill Gas
Geothermal
p. 16

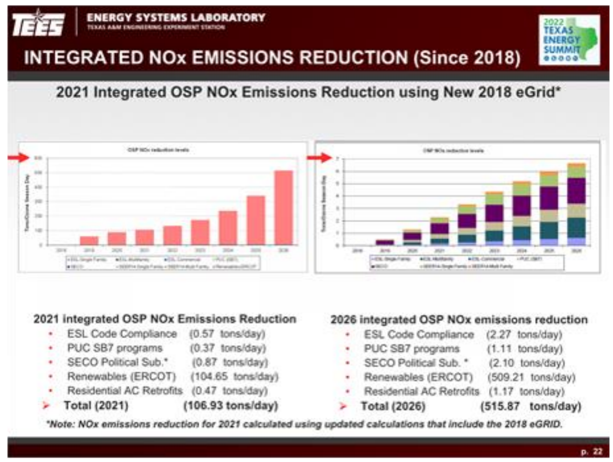

ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION
2022 TEXAS ENERGY SUMMIT
STATEWIDE SAVINGS FROM RENEWABLES
Installed Wind Power Capacity and Power Generation in the ERCOT Region from September 2005 to December 2021
Wind Power Generation (GWH)
Installed Capacity (MW)
36,694
34,174
ERCOT Generation - GWH
ERCOT Installed Capacity - MW
Total Installed Capacity in Texas by 2021
As of January 2022, the capacity of installed wind turbine totals was 34,174 MW with another 6,530 MW announced for new projects to be completed by 2023.
p. 17

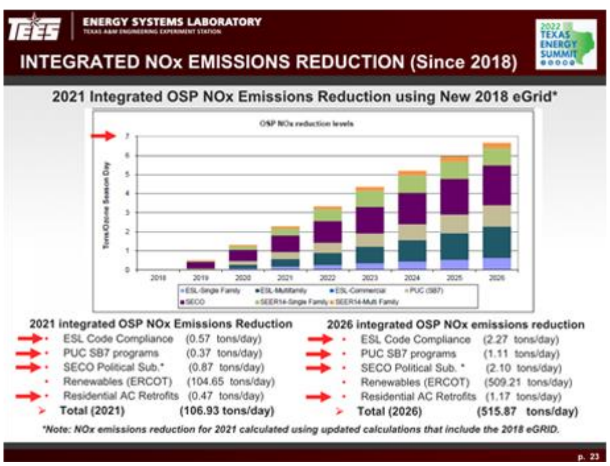

ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION
2022 TEXAS ENERGY SUMMIT
SAVINGS FROM OTHER RENEWABLES (2001-2021)
Renewables: Wind, Solar, Landfill Gas, Hydro, Biomass
✓ Wind energy is the largest portion
Annual Electricity Generated in Texas by Renewable Sources
117,752 GWh (2021)
Wind
Solar
Landfill gas
Hydro
Biomass
Electricity Generated in GWh
Year
Source: Renewable Generation Data from ERCOT-REC (Renewable Energy Credit)
p. 18

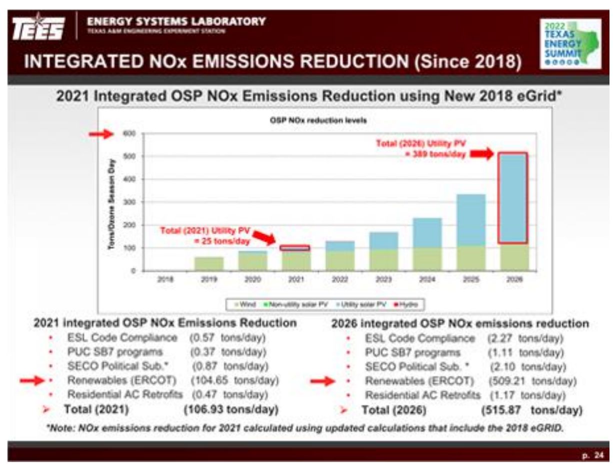

ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION
2022 TEXAS ENERGY SUMMIT
SAVINGS FROM OTHER RENEWABLES (2001-2021)
Renewables: Wind, Solar, Landfill Gas, Hydro, Biomass
Renewables Excluding Wind
Annual Electricity Generated in Texas by Renewable Sources
Biomass Hydro Landfill gas Solar
Electricity Generated in GWh
Year
Biomass (248 GWh/yr)
Hydro (222 GWh/yr)
Landfill (209 GWh/yr)
2021 Solar (15,762 GWh/yr)
2020 Solar (8,770 GWh/yr)
Source: Renewable Generation Data from ERCOT-REC (Renewable Energy Credit)
p. 19

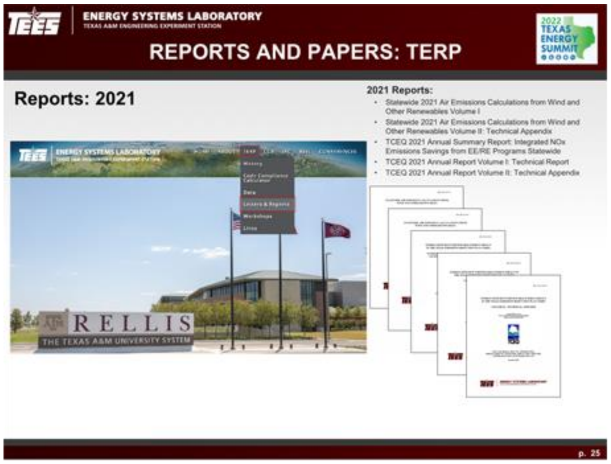

ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION
2022 TEXAS ENERGY SUMMIT
SAVINGS FROM OTHER RENEWABLES (2001-2021)
Renewables: Non-utility Solar, Utility-scale Solar, Solar Thermal, Biomass, Hydroelectric, Geothermal, Landfill Gas
Non-utility solar PV Projects through 2021
Utility-scale solar PV Projects through 2021
Solar Thermal Projects through 2021
Bio-mass Projects through 2021
HydroelectricProjects through 2021
Geothermal Projects through 2021
Landfill Gas Projects through 2021
Numerous Sources Including: Renewable Generation Data from ERCOT-REC database
p. 20

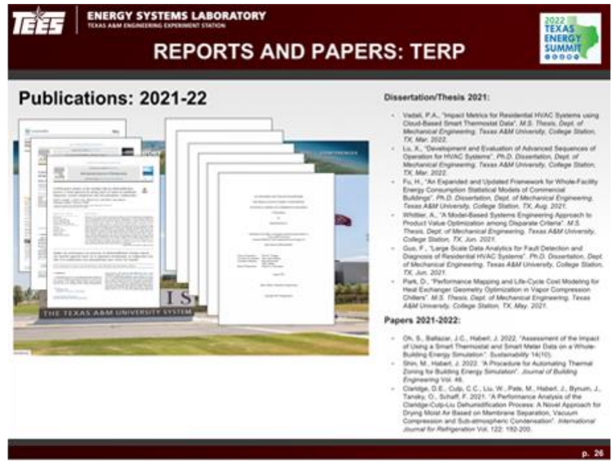

ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION
2022 TEXAS ENERGY SUMMIT
INTEGRATED NOx EMISSIONS REDUCTION
Integrated Emissions Savings Across Agencies To Report Savings To TCEQ and EPA
TEES ENERGY SYSTEMS LABORATORY
SECO State Energy Conservation Office
ercot
p. 21


ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION
2022 TEXAS ENERGY SUMMIT
INTEGRATED NOx EMISSIONS REDUCTION (Since 2018)
2021 Integrated OSP NOx Emissions Reduction using New 2018 eGrid*
2021 integrated OSP NOx Emissions Reduction
ESL Code Compliance (0.57 tons/day)
PUC SB7 programs (0.37 tons/day)
SECO Political Sub.* (0.87 tons/day)
Renewables (ERCOT) (104.65 tons/day)
Residential AC Retrofits (0.47 tons/day)
Total (2021) (106.93 tons/day)
2026 integrated OSP NOx emissions reduction
ESL Code Compliance (2.27 tons/day)
PUC SB7 programs (1.11 tons/day)
SECO Political Sub. * (2.10 tons/day)
Renewables (ERCOT) (509.21 tons/day)
Residential AC Retrofits (1.17 tons/day)
Total (2026) (515.87 tons/day)
*Note: NOx emissions reduction for 2021 calculated using updated calculations that include the 2018 eGRID.
p. 22


ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION
2022 TEXAS ENERGY SUMMIT
INTEGRATED NOx EMISSIONS REDUCTION (Since 2018)
2021 Integrated OSP NOx Emissions Reduction using New 2018 eGrid*
OSP NOx reduction levels
Tons/Ozone Season Day
ESL-Single Family
ESL-Multifamily
ESL-Commercial
PUC (SB7)
SECO
SEER14-Single Family
SEER14-Multi Family
2021 integrated OSP NOx Emissions Reduction
ESL Code Compliance (0.57 tons/day)
PUC SB7 programs (0.37 tons/day)
SECO Political Sub.* (0.87 tons/day)
Renewables (ERCOT) (104.65 tons/day)
Residential AC Retrofits (0.47 tons/day)
Total (2021) (106.93 tons/day)
2026 integrated OSP NOx emissions reduction
ESL Code Compliance (2.27 tons/day)
PUC SB7 programs (1.11 tons/day)
SECO Political Sub. * (2.10 tons/day)
Renewables (ERCOT) (509.21 tons/day)
Residential AC Retrofits (1.17 tons/day)
Total (2026) (515.87 tons/day)
*Note: NOx emissions reduction for 2021 calculated using updated calculations that include the 2018 eGRID.
p. 23


ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION
2022 TEXAS ENERGY SUMMIT
INTEGRATED NOx EMISSIONS REDUCTION (Since 2018)
2021 Integrated OSP NOx Emissions Reduction using New 2018 eGrid*
OSP NOx reduction levels
Tons/Ozone Season Day
Total (2026) Utility PV = 389 tons/day
Total (2021) Utility PV = 25 tons/day
Wind
Non-utility solar PV
Utility solar PV
Hydro
2021 integrated OSP NOx Emissions Reduction
ESL Code Compliance (0.57 tons/day)
PUC SB7 programs (0.37 tons/day)
SECO Political Sub.* (0.87 tons/day)
Renewables (ERCOT) (104.65 tons/day)
Residential AC Retrofits (0.47 tons/day)
Total (2021) (106.93 tons/day)
2026 integrated OSP NOx emissions reduction
ESL Code Compliance (2.27 tons/day)
PUC SB7 programs (1.11 tons/day)
SECO Political Sub. * (2.10 tons/day)
Renewables (ERCOT) (509.21 tons/day)
Residential AC Retrofits (1.17 tons/day)
Total (2026) (515.87 tons/day)
*Note: NOx emissions reduction for 2021 calculated using updated calculations that include the 2018 eGRID.
p. 24


ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION
REPORTS AND PAPERS: TERP
2022 TEXAS ENERGY SUMMIT
Reports: 2021
2021 Reports:
Statewide 2021 Air Emissions Calculations from Wind and Other Renewables Volume I
Statewide 2021 Air Emissions Calculations from Wind and Other Renewables Volume II: Technical Appendix
TCEQ 2021 Annual Summary Report: Integrated NOx Emissions Savings from EE/RE Programs Statewide
TCEQ 2021 Annual Report Volume I: Technical Report
TCEQ 2021 Annual Report Volume II: Technical Appendix
RELLIS
THE TEXAS A&M UNIVERSITY SYSTEM
p. 25


ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION
REPORTS AND PAPERS: TERP
2022 TEXAS ENERGY SUMMIT
Publications: 2021-22
Dissertation/Thesis 2021:
Vadeli, P.A., "Impact Metrics for Residential HVAC Systems using Cloud-Based Smart Thermostat Data". M.S. Thesis, Dept. of Mechanical Engineering, Texas A&M University, College Station, TX, Mar. 2022.
Lu, X., "Development and Evaluation of Advanced Sequences of Operation for HVAC Systems". Ph.D. Dissertation, Dept. of Mechanical Engineering, Texas A&M University, College Station, TX, Mar. 2022.
Fu, H., "An Expanded and Updated Framework for Whole-Facility Energy Consumption Statistical Models of Commercial Buildings". Ph.D. Dissertation, Dept. of Mechanical Engineering, Texas A&M University, College Station, TX, Aug. 2021.
Whittier, A., "A Model-Based Systems Engineering Approach to Product Value Optimization among Disparate Criteria". M.S. Thesis, Dept. of Mechanical Engineering, Texas A&M University, College Station, TX, Jun. 2021.
Guo, F., "Large Scale Data Analytics for Fault Detection and Diagnosis of Residential HVAC Systems". Ph.D. Dissertation, Dept. of Mechanical Engineering, Texas A&M University, College Station, TX, Jun. 2021.
Park, D., "Performance Mapping and Life-Cycle Cost Modeling for Heat Exchanger Geometry Optimization in Vapor Compression Chillers". M.S. Thesis, Dept. of Mechanical Engineering, Texas A&M University, College Station, TX, May. 2021.
Papers 2021-2022:
Oh, S., Baltazar, J.C., Haberl, J. 2022. "Assessment of the Impact of Using a Smart Thermostat and Smart Meter Data on a Whole-Building Energy Simulation". Sustainability 14(10).
Shin, M., Haberl, J. 2022. "A Procedure for Automating Thermal Zoning for Building Energy Simulation". Journal of Building Engineering Vol. 46.
Claridge, D.E., Culp, C.C., Liu, W., Pate, M., Haberl, J., Bynum, J., Tansky, O., Schaff, F. 2021. "A Performance Analysis of the Claridge-Culp-Liu Dehumidification Process: A Novel Approach for Drying Moist Air Based on Membrane Separation, Vacuum Compression and Sub-atmospheric Condensation". International Journal for Refrigeration Vol. 122: 192-200.
THE TEXAS A&M UNIVERSITY SYSTEM
p. 26


ENERGY SYSTEMS LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION
ESL Contact Information
2022 TEXAS ENERGY SUMMIT
Contact Information:
Jeff Haberl: jhaberl@tamu.edu
Juan-Carlos Baltazar: jcbaltazar@tamu.edu
Bahman Yazdani: byazdani@tamu.edu
http://esl.tamu.edu/terp
RELLIS
THE TEXAS A&M UNIVERSITY SYSTEM
p. 27

Appendix B: IC3 Parameter Reports

Table 28 to Table 37 show the annual average values by county from projects that passed code compliance in IC3. Table 28 shows wall cavity insulation across Texas in 2022.

Table 28: Annual Average Wall Cavity Insulation Distribution by County in 2022.

County	Avg Wall Insulation (R-value)	No. of Houses		County	Avg Wall Insulation (R-value)	No. of Houses
Anderson	13.00	1		Hood	14.63	57
Aransas	15.00	1		Hopkins	13.86	7
Atascosa	13.00	1		Howard	13.00	1
Austin	13.00	1		Hunt	13.86	141
Bastrop	13.00	8		Jim wells	15.00	1
Bell	20.00	1		Johnson	14.55	275
Bexar	13.40	42		Kaufman	13.92	304
Blanco	13.00	1		Lamar	13.00	1
Brazoria	14.50	4		Liberty	13.00	26
Brazos	13.93	106		Llano	14.75	16
Burnet	14.34	5		Madison	19.00	1
Caldwell	13.00	3		Mclennan	14.50	8
Collin	14.19	1679		Medina	33.00	1
Comal	13.00	27		Montague	13.57	6
Cooke	13.45	38		Montgomery	15.11	90
Dallas	14.42	1665		Navarro	13.24	126
Denton	13.95	1093		Orange	13.00	1
Ellis	13.71	305		Palo pinto	15.00	2
Fannin	13.17	12		Parker	14.38	177
Fort bend	13.20	30		Rains	14.14	7
Freestone	15.00	1		Rockwall	13.31	211
Frio	10.00	1		Smith	13.00	5
Galveston	13.86	28		Somervell	13.00	1
Gillespie	16.00	4		Tarrant	14.10	2507
Grayson	13.84	227		Taylor	15.00	1
Gregg	13.00	8		Titus	14.67	6
Grimes	14.94	36		Travis	14.74	910
Guadalupe	14.33	3		Van zandt	13.86	14
Hamilton	13.00	1		Washington	13.43	72
Harris	15.13	1036		Williamson	14.36	22
Hays	14.69	432		Wise	14.11	123
Henderson	13.67	124		Wood	13.00	1
Hidalgo	13.00	1		Zapata	15.00	2
Hill	13.02	22				

Table 29 to Table 31 show water heater efficiencies by county from projects that passed code compliance in IC3.

Table 29: Annual Average Electric Water Heater Energy Factor Distribution by County in 2022.

County	Avg Electric Energy Factor	No. of Houses		County	Avg Electric Energy Factor	No. of Houses
Aransas	0.95	1		Hood	0.96	44
Atascosa	0.94	1		Hopkins	0.92	7
Bastrop	0.94	2		Howard	0.91	1
Bexar	0.93	9		Hunt	0.94	102
Blanco	0.94	1		Jim wells	0.93	1
Brazoria	0.97	1		Johnson	0.94	229
Brazos	0.93	10		Kaufman	0.93	211
Burnet	0.95	3		Lamar	0.95	1
Caldwell	0.95	1		Liberty	0.95	3
Collin	0.94	174		Mclennan	0.96	5
Comal	0.93	1		Medina	0.90	1
Cooke	0.94	36		Montague	0.97	3
Dallas	0.94	757		Montgomery	0.90	42
Denton	0.94	251		Navarro	0.95	117
Ellis	0.95	172		Palo pinto	0.93	2
Fannin	0.95	11		Parker	0.94	116
Fort bend	0.90	25		Rains	0.95	7
Frio	0.95	1		Rockwall	0.93	53
Galveston	0.93	23		Smith	0.95	4
Gillespie	0.95	2		Somervell	0.95	1
Grayson	0.94	168		Tarrant	0.94	1117
Gregg	0.95	8		Titus	0.95	6
Guadalupe	0.94	2		Travis	0.93	231
Hamilton	0.95	1		Van zandt	0.96	11
Harris	0.93	59		Washington	0.95	1
Hays	0.96	6		Williamson	0.94	10
Henderson	0.94	121		Wise	0.95	115
Hidalgo	0.98	1		Wood	0.95	1
Hill	0.94	22		Zapata	0.93	2

Table 30: Annual Average NG Water Heater Energy Factor Distribution by County in 2022.

County	Avg NG Energy Factor	No. of Houses		County	Avg NG Energy Factor	No. of Houses
Bastrop	0.67	6		Hood	0.82	11
Bell	0.90	1		Hunt	0.80	35
Bexar	0.68	17		Johnson	0.82	39
Brazoria	0.90	3		Kaufman	0.79	87
Brazos	0.69	8		Liberty	0.63	23
Caldwell	0.62	2		Llano	0.65	14
Collin	0.92	978		Madison	0.90	1
Comal	0.64	25		Mclennan	0.95	3
Cooke	0.90	1		Montague	0.66	3
Dallas	0.90	699		Montgomery	0.88	22
Denton	0.89	605		Navarro	0.89	8
Ellis	0.80	109		Parker	0.78	61
Fort bend	0.66	4		Rockwall	0.90	153
Freestone	0.90	1		Smith	0.80	1
Galveston	0.88	4		Tarrant	0.89	1280
Grayson	0.89	49		Taylor	0.96	1
Grimes	0.65	9		Travis	0.80	410
Guadalupe	0.96	1		Van zandt	0.85	3
Harris	0.76	939		Washington	0.62	43
Hays	0.82	129		Williamson	0.65	12
Henderson	0.90	3		Wise	0.84	4

Table 31: Annual Average Heat Pump Water Heater Energy Factor Distribution by County in 2022.

County	Avg Heat Pump WH Energy Factor	No. of Houses
Anderson	2.36	1
Brazos	2.11	22
Dallas	2.02	4
Denton	0.96	1
Ellis	2.00	1
Fannin	2.11	1
Harris	1.98	1
Hays	0.82	7
Hunt	2.27	3
Johnson	2.18	1
Tarrant	2.20	1
Travis	2.19	36
Washington	2.11	1

Table 32 shows the average A/C SEER by county from projects that passed code compliance in IC3.

Table 32: Average A/C SEER across Counties in 2022.

County	Avg A/C SEER	No. of Houses		County	Avg A/C SEER	No. of Houses
Anderson	19.00	1		Hood	15.81	57
Aransas	16.00	1		Hopkins	14.00	7
Atascosa	14.00	1		Howard	14.00	1
Austin	16.00	1		Hunt	14.42	140
Bastrop	15.50	8		Jim wells	16.00	1
Bell	16.00	1		Johnson	14.75	275
Bexar	15.74	42		Kaufman	14.71	304
Blanco	14.00	1		Lamar	14.00	1
Brazoria	14.50	4		Liberty	15.69	26
Brazos	15.89	106		Llano	16.38	16
Burnet	15.40	5		Madison	14.00	1
Caldwell	15.33	3		Mclennan	15.75	8
Collin	15.81	1679		Medina	14.00	1
Comal	15.72	27		Montague	15.33	6
Cooke	14.89	38		Montgomery	14.66	90
Dallas	15.25	1665		Navarro	14.58	126
Denton	15.55	1093		Orange	15.50	1
Ellis	14.75	305		Palo pinto	15.00	2
Fannin	14.17	12		Parker	15.37	177
Fort bend	15.93	30		Rains	15.43	7
Freestone	16.00	1		Rockwall	15.86	211
Frio	14.00	1		Smith	14.80	5
Galveston	15.70	28		Somervell	16.00	1
Gillespie	17.25	4		Tarrant	15.41	2506
Grayson	14.92	227		Taylor	21.00	1
Gregg	14.00	8		Titus	14.67	6
Grimes	15.94	36		Travis	16.43	910
Guadalupe	15.33	3		Van zandt	14.57	14
Hamilton	14.00	1		Washington	16.08	72
Harris	15.47	1034		Williamson	15.64	22
Hays	16.00	432		Wise	14.69	123
Henderson	15.16	124		Wood	16.00	1
Hidalgo	16.00	1		Zapata	15.00	2
Hill	14.23	22				

Table 33 shows the average ceiling insulation by county from projects that passed code compliance in IC3.

Table 33: Average Ceiling Insulation across Counties in 2022.

County	Avg Ceiling Insulation (R-value)	No. of Houses		County	Avg Ceiling Insulation (R-value)	No. of Houses
Anderson	42.75	1		Hood	35.54	57
Aransas	30.00	1		Hopkins	41.14	7
Atascosa	38.00	1		Howard	38.00	1
Austin	38.00	1		Hunt	38.85	140
Bastrop	44.88	8		Jim wells	30.00	1
Bell	38.00	1		Johnson	35.64	275
Bexar	28.67	42		Kaufman	36.31	304
Blanco	38.00	1		Lamar	38.00	1
Brazoria	33.25	4		Liberty	38.00	26
Brazos	37.82	106		Llano	20.31	16
Burnet	34.88	5		Madison	38.00	1
Caldwell	20.67	3		Mclennan	38.38	8
Collin	38.06	1679		Medina	33.00	1
Comal	37.70	27		Montague	37.40	6
Cooke	43.23	38		Montgomery	35.54	90
Dallas	36.51	1665		Navarro	37.44	126
Denton	36.80	1093		Orange	38.00	1
Ellis	36.21	305		Palo pinto	38.00	2
Fannin	38.92	12		Parker	36.13	177
Fort bend	24.40	30		Rains	38.00	7
Freestone	49.00	1		Rockwall	37.25	211
Frio	15.00	1		Smith	39.20	5
Galveston	34.00	28		Somervell	21.00	1
Gillespie	26.00	4		Tarrant	36.40	2506
Grayson	36.57	227		Taylor	38.00	1
Gregg	38.00	8		Titus	34.17	6
Grimes	38.00	36		Travis	36.52	910
Guadalupe	32.67	3		Van zandt	38.79	14
Hamilton	38.00	1		Washington	37.78	72
Harris	35.42	1034		Williamson	36.55	22
Hays	37.96	432		Wise	32.60	123
Henderson	35.16	124		Wood	38.00	1
Hidalgo	38.00	1		Zapata	49.00	2
Hill	37.30	22				

Table 34 and Table 35 show the average heating efficiency by county from projects that passed code compliance in IC3.

Table 34: Average NG Heating Efficiency across Counties in 2022.

County	Avg NG Efficiency	No. of Houses		County	Avg NG Efficiency	No. of Houses
Austin	0.80	1		Hood	0.94	31
Bastrop	0.80	6		Hopkins	0.85	4
Bell	0.90	1		Howard	0.80	1
Bexar	0.82	18		Hunt	0.85	93
Brazoria	0.85	3		Johnson	0.86	80
Brazos	0.81	77		Kaufman	0.83	115
Burnet	0.88	2		Lamar	0.90	1
Caldwell	0.81	3		Liberty	0.80	23
Collin	0.81	1511		Llano	0.80	14
Comal	0.81	26		Madison	0.81	1
Cooke	0.87	4		Mclennan	0.95	4
Dallas	0.86	1228		Montague	0.82	3
Denton	0.82	859		Montgomery	0.89	48
Ellis	0.83	150		Navarro	0.91	20
Fort bend	0.81	5		Palo pinto	0.96	1
Freestone	0.90	1		Parker	0.81	87
Frio	0.80	1		Rains	0.94	4
Galveston	0.82	6		Rockwall	0.81	166
Gillespie	0.95	1		Smith	0.80	2
Grayson	0.82	68		Tarrant	0.83	1450
Gregg	0.90	8		Taylor	1.00	1
Grimes	0.80	36		Travis	0.81	584
Harris	0.81	993		Van zandt	0.90	8
Hays	0.80	426		Washington	0.80	69
Henderson	0.90	24		Williamson	0.80	18
Hill	0.90	1		Wise	0.93	11

Table 35: Average Heat Pump Heating Efficiency across Counties in 2022.

County	Avg Heat Pump Efficiency	No. of Houses		County	Avg Heat Pump Efficiency	No. of Houses
Anderson	9.00	1		Hopkins	10.20	3
Aransas	10.00	1		Hunt	8.59	48
Atascosa	9.00	1		Jim wells	13.00	1
Bastrop	8.60	2		Johnson	8.62	195
Bexar	8.49	24		Kaufman	8.56	189
Blanco	9.00	1		Liberty	9.00	3
Brazoria	9.00	1		Llano	11.30	2
Brazos	8.52	29		Mclennan	10.00	2
Burnet	8.57	3		Medina	10.00	1
Collin	8.53	168		Montague	8.20	3
Comal	13.00	1		Montgomery	12.00	42
Cooke	8.75	34		Navarro	8.33	106
Dallas	8.80	437		Orange	8.50	1
Denton	8.53	234		Palo pinto	8.30	1
Ellis	8.75	155		Parker	8.52	90
Fannin	8.20	12		Rains	8.20	3
Fort bend	8.20	25		Rockwall	8.39	45
Galveston	8.30	22		Smith	9.23	3
Gillespie	9.67	3		Somervell	9.60	1
Grayson	8.51	159		Tarrant	8.56	1054
Guadalupe	9.67	3		Titus	8.52	6
Hamilton	8.20	1		Travis	9.56	293
Harris	9.50	40		Van zandt	8.73	6
Hays	9.38	6		Washington	9.67	3
Henderson	8.44	100		Williamson	8.40	4
Hidalgo	8.20	1		Wise	8.60	112
Hill	8.52	21		Wood	9.00	1
Hood	8.66	26		Zapata	8.60	2

Table 36 shows the average SHGC by county from projects that passed code compliance in IC3.

Table 36: Average SHGC across Counties in 2022.

County	Avg SHGC	No. of Houses		County	Avg SHGC	No. of Houses
Anderson	0.50	1		Hood	0.24	57
Aransas	0.23	1		Hopkins	0.20	7
Atascosa	0.20	1		Howard	0.25	1
Austin	0.34	1		Hunt	0.23	140
Bastrop	0.25	8		Jim wells	0.19	1
Bell	0.25	1		Johnson	0.22	275
Bexar	0.27	42		Kaufman	0.23	302
Blanco	0.25	1		Lamar	0.25	1
Brazoria	0.23	4		Liberty	0.23	26
Brazos	0.24	105		Llano	0.30	16
Burnet	0.21	5		Madison	0.23	1
Caldwell	0.22	3		Mclennan	0.24	8
Collin	0.24	1679		Medina	0.22	1
Comal	0.22	27		Montague	0.24	6
Cooke	0.22	38		Montgomery	0.23	90
Dallas	0.23	1664		Navarro	0.23	126
Denton	0.23	1093		Orange	0.21	1
Ellis	0.23	305		Palo pinto	0.26	2
Fannin	0.24	12		Parker	0.24	176
Fort bend	0.25	30		Rains	0.22	7
Freestone	0.25	1		Rockwall	0.24	211
Frio	0.32	1		Smith	0.25	5
Galveston	0.24	28		Somervell	0.22	1
Gillespie	0.20	4		Tarrant	0.23	2507
Grayson	0.23	227		Taylor	0.30	1
Gregg	0.23	8		Titus	0.22	6
Grimes	0.23	36		Travis	0.23	910
Guadalupe	0.27	3		Van zandt	0.23	14
Hamilton	0.20	1		Washington	0.23	72
Harris	0.25	1036		Williamson	0.25	22
Hays	0.23	432		Wise	0.24	123
Henderson	0.23	124		Wood	0.25	1
Hidalgo	0.25	1		Zapata	0.26	2
Hill	0.24	22				

Table 37 shows the average window U-Factor by county from projects that passed code compliance in IC3.

Table 37: Average Window U-Factor across Counties in 2022.

County	Avg U-factor	No. of Houses		County	Avg U-factor	No. of Houses
Anderson	1.00	1		Hood	0.28	57
Aransas	0.33	1		Hopkins	0.29	7
Atascosa	0.35	1		Howard	0.35	1
Austin	0.34	1		Hunt	0.29	140
Bastrop	0.33	8		Jim wells	0.31	1
Bell	0.35	1		Johnson	0.30	275
Bexar	0.36	42		Kaufman	0.32	304
Blanco	0.35	1		Lamar	0.35	1
Brazoria	0.35	4		Liberty	0.33	26
Brazos	0.34	106		Llano	0.21	16
Burnet	0.28	5		Madison	0.35	1
Caldwell	0.33	3		Mclennan	0.34	8
Collin	0.33	1679		Medina	0.33	1
Comal	0.35	27		Montague	0.32	6
Cooke	0.33	38		Montgomery	0.33	90
Dallas	0.31	1665		Navarro	0.31	126
Denton	0.33	1093		Orange	0.34	1
Ellis	0.32	305		Palo pinto	0.26	2
Fannin	0.29	12		Parker	0.31	176
Fort bend	0.39	30		Rains	0.23	7
Freestone	0.32	1		Rockwall	0.32	211
Frio	0.34	1		Smith	0.30	5
Galveston	0.31	28		Somervell	0.28	1
Gillespie	0.38	4		Tarrant	0.32	2507
Grayson	0.32	227		Taylor	1.00	1
Gregg	0.33	8		Titus	0.30	6
Grimes	0.33	36		Travis	0.33	910
Guadalupe	0.30	3		Van zandt	0.30	14
Hamilton	0.28	1		Washington	0.33	72
Harris	0.34	1036		Williamson	0.37	22
Hays	0.34	432		Wise	0.30	123
Henderson	0.31	124		Wood	0.30	1
Hidalgo	0.25	1		Zapata	0.27	2
Hill	0.33	22				