

# **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-December 2015**



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December 2016



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





**TEXAS A&M ENGINEERING  
EXPERIMENT STATION**

**Energy Systems Laboratory**

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February 6, 2017

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

Dear Mr Meiller:

The Energy Systems Laboratory (ESL) at the Texas A&M Engineering Experiment Station of the Texas A&M University System is pleased to provide its annual report, "Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP)," as required under Texas Health and Safety Code Ann. § 388.003 (e) (Senate Bill 5, 77R as amended 78 R & 78S).

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

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

Sincerely,

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

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





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



## VOLUME I – TECHNICAL REPORT

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

#### Executive Summary

The Energy Systems Laboratory (Laboratory), at the Texas A&M Engineering Experiment Station of The Texas A&M University System, in fulfillment of its responsibilities under Texas Health and Safety Code Ann. § 388.003 (e), submits its annual report, Energy Efficiency/Renewable Energy (EE/RE) Impact in the Texas Emissions Reduction Plan (TERP) to the Texas Commission on Environmental Quality.

The report is organized in two volumes.

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

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

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

#### Accomplishments:

##### a. Energy Code Amendments

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

##### b. Technical Assistance

The Laboratory provided technical assistance to the TCEQ, PUCT, SECO, ERCOT, and several political subdivisions, as well as stakeholders participating in improving the compliance of the Texas Building Energy Performance Standards (TBEPS). The Laboratory also worked closely with the TCEQ to refine the integrated NO<sub>x</sub> emissions reduction calculation procedures that provide the TCEQ with a standardized, creditable NO<sub>x</sub> emissions reduction from energy efficiency and renewable energy (EE/RE) programs, which are acceptable to the US EPA. These activities have improved the accuracy of the creditable NO<sub>x</sub> emissions reduction from EE/RE initiatives contained in the TERP and have assisted the TCEQ, local governments, and the building industry with effective, standardized implementation and reporting.

##### c. NO<sub>x</sub> Emissions Reduction

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

Figure 1 shows the integrated NO<sub>x</sub> emissions reduction through 2020 for the electricity and natural gas savings from the various EE/RE programs.

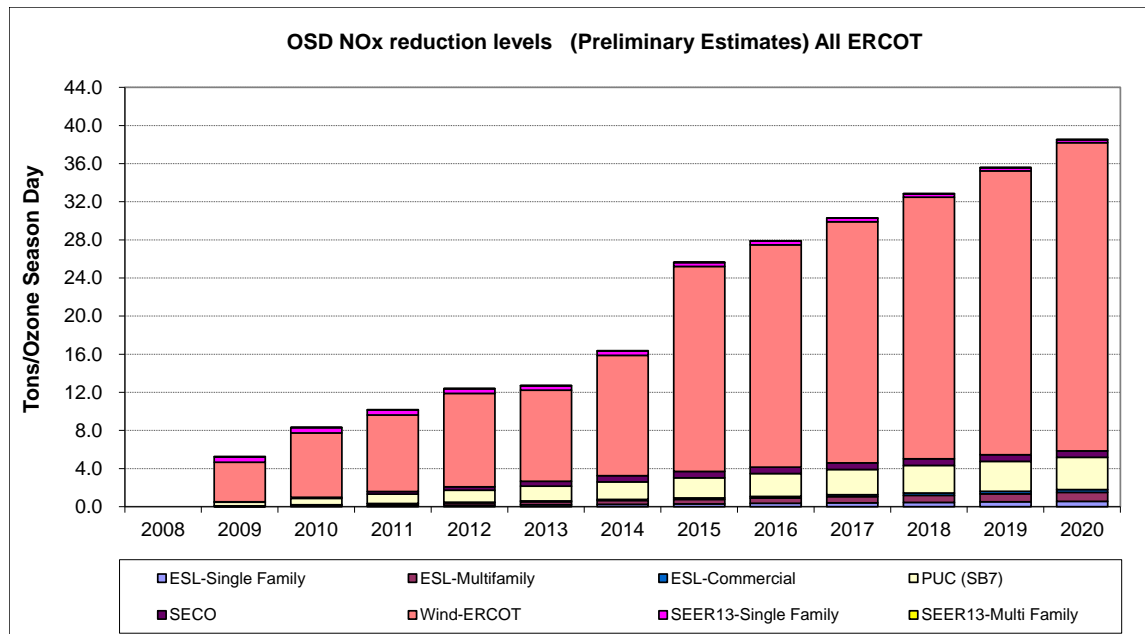


Figure 1: Integrated OSD NOx Emissions Reduction Projections through 2020 (Base Year 2008)

In 2015 (Table 1), the total integrated annual savings from all programs are 29,759,642 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 1,158,444 MWh/year (3.9% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program are 3,100,439 MWh/year (10.4%),
- Savings from SECO's Senate Bill 5 program are 940,372 MWh/year (3.2%),
- Electricity savings from green power purchases (wind) are 24,322,675 MWh/year (81.6%), and
- Savings from residential air conditioner retrofits<sup>1</sup> are 273,712 MWh/year (0.9%).

By 2020, the total integrated annual savings from all programs will be 45,126,247 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction will be 2,454,765 MWh/year (5.4% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program will be 4,927,777 MWh/year (10.9%),
- Savings from SECO's Senate Bill 5 program will be 958,959 MWh/year (2.1%),
- Electricity savings from green power purchases (wind) will be 36,572,954 MWh/year (81.0%), and
- Savings from residential air conditioner retrofits will be 211,793 MWh/year (0.5%).

In 2015 (Table 2), the total integrated annual NOx emissions reductions from all programs are 8,174 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 292 tons-NOx/year (3.6% of the total NOx savings),
- NOx emissions reductions from the PUC's Senate Bill 7 programs are 775 tons-NOx/year (9.5%),
- NOx emissions reductions from SECO's Senate Bill 5 program are 243 tons-NOx/year (3.0%),
- NOx emissions reductions from green power purchases (wind) are 6,800 tons-NOx/year (83.2%), and
- NOx emissions reductions from residential air conditioner retrofits are 64 tons-NOx/year (0.8%).

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

By 2020, the total integrated annual NOx emissions reductions from all programs will be 12,377 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 620 tons-NOx/year (5.0% of the total NOx savings),
- NOx emissions reductions from the PUC’s Senate Bill 7 programs will be 1,230 tons-NOx/year (9.9%),
- NOx emissions reductions from SECO’s Senate Bill 5 program will be 252 tons-NOx/year (2.0%),
- NOx emissions reductions from green power purchases (wind) will be 10,225 tons-NOx/year (82.6%), and
- NOx emissions reductions from residential air conditioner retrofits will be 50 tons-NOx/year (0.4%).

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

PROGRAM	ANNUAL (MWh)												
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ESL-Single Family	0	21,748	55,268	93,760	153,171	220,975	293,313	367,771	444,033	522,198	602,369	684,651	769,156
ESL-Multifamily	0	50,218	94,867	167,566	262,939	357,717	463,922	579,667	700,724	827,451	960,229	1,099,461	1,245,572
ESL-Commercial	0	0	25,750	54,550	87,230	126,228	170,173	211,006	253,367	297,350	343,053	390,579	440,036
PUC (SB7)	0	538,841	976,984	1,437,883	1,831,318	2,267,414	2,675,295	3,100,439	3,504,325	3,888,018	4,252,526	4,598,808	4,927,777
SECO	0	71,910	154,786	347,175	508,375	705,060	936,047	1,240,372	1,614,480	2,068,948	2,613,952	3,269,613	4,047,959
Wind-ERCOT	0	3,454,992	8,587,397	11,606,284	13,774,557	16,597,064	19,905,202	24,322,675	26,390,103	28,633,262	31,067,089	33,707,791	36,572,954
SEER13-Single Family	0	343,330	326,163	309,855	294,362	279,644	265,662	252,379	239,760	227,772	216,383	205,564	195,286
SEER13-Multi Family	0	29,021	27,569	26,191	24,881	23,637	22,456	21,333	20,266	19,253	18,290	17,376	16,507
<b>Total Annual (MWh)</b>	<b>0</b>	<b>4,510,059</b>	<b>10,248,785</b>	<b>14,043,263</b>	<b>16,936,834</b>	<b>20,577,739</b>	<b>24,732,069</b>	<b>29,795,642</b>	<b>32,497,059</b>	<b>35,363,686</b>	<b>38,412,029</b>	<b>41,659,843</b>	<b>45,126,247</b>

PROGRAM	OZONE SEASON DAY - OSD (MWh/day)												
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ESL-Single Family	0	124	283	468	626	808	1,002	1,202	1,407	1,617	1,833	2,055	2,283
ESL-Multifamily	0	233	460	744	999	1,253	1,539	1,851	2,177	2,519	2,878	3,254	3,650
ESL-Commercial	0	0	71	149	239	346	466	578	694	815	940	1,070	1,206
PUC (SB7)	0	1,476	2,677	3,939	5,017	6,212	7,330	8,494	9,601	10,652	11,651	12,599	13,501
SECO	0	197	424	951	1,393	1,932	2,565	2,576	2,588	2,598	2,608	2,618	2,627
Wind-ERCOT	0	15,037	24,335	29,191	35,122	34,369	45,184	76,917	83,455	90,549	98,246	106,597	115,657
SEER13-Single Family	0	2,445	2,323	2,207	2,097	1,992	1,892	1,798	1,708	1,622	1,541	1,464	1,391
SEER13-Multi Family	0	195	186	176	167	159	151	144	136	130	123	117	111
<b>Total OSD (MWh)</b>	<b>0</b>	<b>19,709</b>	<b>30,758</b>	<b>37,826</b>	<b>45,661</b>	<b>47,071</b>	<b>60,129</b>	<b>93,560</b>	<b>101,766</b>	<b>110,503</b>	<b>119,820</b>	<b>129,775</b>	<b>140,426</b>

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

PROGRAM	ANNUAL (in tons NOx)												
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ESL-Single Family	0	5	14	23	38	54	72	91	110	129	149	170	191
ESL-Multifamily	0	13	24	43	67	91	118	148	179	211	245	280	317
ESL-Commercial	0	0	6	14	22	32	43	53	64	75	87	99	111
PUC (SB7)	0	135	246	362	460	567	669	775	876	971	1,062	1,148	1,230
SECO	0	19	43	92	133	183	241	243	245	247	249	251	252
Wind-ERCOT	0	945	2,388	3,222	3,851	4,643	5,577	6,800	7,378	8,005	8,685	9,424	10,225
SEER13-Single Family	0	81	77	73	69	66	62	59	56	53	51	48	46
SEER13-Multi Family	0	7	6	6	6	6	5	5	5	5	4	4	4
<b>Total Annual (Tons NOx)</b>	<b>0</b>	<b>1,204</b>	<b>2,803</b>	<b>3,834</b>	<b>4,646</b>	<b>5,642</b>	<b>6,788</b>	<b>8,174</b>	<b>8,912</b>	<b>9,697</b>	<b>10,532</b>	<b>11,424</b>	<b>12,377</b>

PROGRAM	OZONE SEASON DAY - OSD (in tons NOx/day)												
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ESL-Single Family	0.00	0.03	0.07	0.11	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.51	0.57
ESL-Multifamily	0.00	0.06	0.12	0.19	0.26	0.32	0.39	0.47	0.55	0.64	0.73	0.83	0.93
ESL-Commercial	0.00	0.00	0.02	0.04	0.06	0.09	0.12	0.15	0.17	0.21	0.24	0.27	0.30
PUC (SB7)	0.00	0.37	0.67	0.99	1.26	1.55	1.83	2.12	2.40	2.66	2.91	3.15	3.37
SECO	0.00	0.05	0.12	0.25	0.37	0.50	0.66	0.67	0.67	0.68	0.68	0.69	0.69
Wind-ERCOT	0.00	4.15	6.75	8.04	9.79	9.56	12.64	21.50	23.33	25.31	27.46	29.80	32.33
SEER13-Single Family	0.00	0.57	0.54	0.51	0.49	0.46	0.44	0.42	0.40	0.38	0.36	0.34	0.32
SEER13-Multi Family	0.00	0.05	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03
<b>Total OSD (Tons NOx)</b>	<b>0.00</b>	<b>5.27</b>	<b>8.33</b>	<b>10.18</b>	<b>12.41</b>	<b>12.72</b>	<b>16.36</b>	<b>25.65</b>	<b>27.90</b>	<b>30.30</b>	<b>32.86</b>	<b>35.60</b>	<b>38.54</b>

#### d. Technology Transfer

In 2015, The Laboratory, along with the TCEQ, hosts the annual Clean Air Through Energy Efficiency (CATEE) conference, which is attended by top experts and policy makers in Texas and from around the country. In 2015 conference, the latest educational programs and technology is 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 will continue to provide technical assistance to the TCEQ, counties and communities working toward obtaining full SIP credit for the energy efficiency and renewable energy projects that are lowering emissions and improving the air quality for all Texans.

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

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

The Energy Systems Laboratory provides the annual report, Energy Efficiency/Renewable Energy (EE/RE) Impact in the Texas Emissions Reduction Plan (TERP), to the Texas Commission on Environmental Quality (TCEQ) in fulfillment of its responsibilities under Texas Health and Safety Code Ann. § 388.003 (e). If any questions arise, please contact us by phone at (979) 845-9213, or by email at [terpinfo@tamu.edu](mailto:terpinfo@tamu.edu).

## Acknowledgements

This work has been completed as a fulfillment of the requirements in Texas Health Code, Senate Bill 5, Section 388.003, and through Senate Bill 20, House Bill 2481 and House Bill 2129, which requires the Laboratory 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). Similarly, selected Code training workshops were funded by the US DOE through the Texas State Energy Conservation Office (SECO). Partial funding on the Texas Climate Vision project, a joint project with the City of Austin was also provided by the US DOE through SECO.

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

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## 1 Overview

The Energy Systems Laboratory (Laboratory), at the Texas A&M Engineering Experiment Station (TEES) of the Texas A&M University System, is pleased to provide our annual report, Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP), to the Texas Commission on Environmental Quality (TCEQ) in fulfillment of its responsibilities under Texas Health and Safety Code Ann. § 388.003 (e). 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 77<sup>th</sup> Legislature through the enactment of Senate Bill 5 to:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

## 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), and \$447,907.94 in FY 2013; and \$453,122.25 in FY 2014. In FY 2015 the Laboratory expended \$454,571.79. The Laboratory has also supplemented these funds with competitively awarded Federal and State grants to provide the needed statewide training for the new mandatory energy codes and to provide technical assistance to cities and counties in helping them implement adoption of the legislated energy efficiency codes. In addition, the ESL received an award from the US EPA in the spring of 2007 to establish a Center of Excellence for the Determination of Emissions Reduction (CEDER) which has helped to enhance the EE/RE emissions calculations.

### 1.3 Code Adoption

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

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

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

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

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



#### 1.4 Accomplishments since January 2015

Since January 2015, the Laboratory has accomplished the following:

- Calculated energy and resultant NO<sub>x</sub> reductions from implementation of the Texas Building Energy Performance Standards (IECC/IRC codes) to new residential and commercial construction for all non-attainment and near-non-attainment counties;
- Enhanced the Laboratory's IECC/IRC Code-Traceable Test Suite for determining emissions reduction due to code and above-code programs;
- Enhanced the IC3 calculator, which is energy code compliance software based on the Texas Building Energy Performance Standards by resolving minor defects found in the model and webpage.
- Continued development and testing of key procedures for validating simulations of building energy performance;
- Provided energy code training workshops, including: residential, commercial, IECC/IRC energy code training sessions at the 15th Building Professional Institute (BPI) Houston.
- Provided energy code training workshops, including: residential, commercial, IECC/IRC energy code training sessions at the 23rd Building Professional Institute (BPI), UT Arlington.
- Provided energy code training workshops, including: residential, commercial, IECC/IRC energy code training sessions to the City of San Antonio, the Bluebonnet Chapter of ICC, the Bay Area Municipal Inspectors Association and the Association of Energy Engineers;
- Maintained and updated the Laboratory's Texas Emissions Reduction Plan (TERP) website;
- Maintained a builder's residential energy code Self-Certification Form (Ver.1.3) for use by builders outside municipalities;
- Hosted the Clean Air Through Energy Efficiency (CATEE) Conference in December 2015, in Galveston, Texas. Conference sessions included key talks by the TCEQ, PUCT, ERCOT, EPA, SECO, several ISDs and cities, and the Laboratory about quantifying emissions reduction from EE/RE opportunities and guidance on key energy efficiency and renewable energy topics; the various topics covered: Learning from Green Schools and Existing Buildings; Innovative Technologies and Techniques; PACE as a New Program in Texas; Alternative Financing for Energy Efficiency; Commercial & Institutional Green Building Performance; Collaboration is the Key – Public/Private Partnerships; Utilities – Efficiency Resources; Energy Codes Discussion; and Regional Applications.
- Provided technical assistance to the TCEQ regarding specific issues, including:
  - Enhancement of the standardized, integrated NO<sub>x</sub> emissions reduction reporting procedures to the TCEQ for EE/RE projects, and
  - Enhancement of the procedures for weather normalizing NO<sub>x</sub> emissions reduction from renewable projects.
- Participated as exhibitors at several conferences, including at the Clean Air Through Energy Efficiency Conference in Galveston, Texas, the Texas Green Home Summit in Plano, Texas, and TCEQ Environmental Trade Fair and Conference, Austin, Texas; and
- The ESL participated in a project with 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). From January to April 2013, the project focused on reviewing the current practice of local jurisdictions to meet compliance with the Texas Building Energy Performance Standards -- the energy efficiency chapter of the 2009 International Residential Code (IRC) for Single-Family residential construction, and the 2009 International Energy Conservation Code (IECC) for commercial and residential construction, excluding single-family.
- Worked toward the code compliance tools for commercial buildings, retail and school buildings, and new Application Programming Interface (API)

## 1.5 Technology Transfer

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

- Delivered “Statewide Air Emissions Calculations from Wind and Other Renewables,” to the Texas Commission on Environmental Quality in July 2015;
- Updated previously developed degradation analysis to determine if degradation could be observed in the measured power from Texas wind farms;
- Updated previously developed database of other renewable projects in Texas, including: solar photovoltaic, geothermal, hydroelectric, and Landfill Gas-fired Power Plants;
- Applied previously developed estimation techniques for hourly solar radiation from limited data sets;
- Along with the TCEQ and the US EPA, is host to the annual Clean Air Through Energy Efficiency (CATEE) Conference attended by top Texas and national experts, and policy makers; and
- Continued the National Center of Excellence on Displaced Emissions Reduction (CEDER) by the US EPA. The benefits of CEDER include:
  - Reducing the financial, technical, and administrative costs of determining the emissions reduction from EE/RE measures;
  - Continuing to accelerate implementation of EE/RE strategies as a viable clean air effort in Texas and other states;
  - Helping other states identify and prioritize cost-effective clean air strategies from EE/RE, and;
  - Communicating the results of quantification efforts through case-studies and a clearinghouse of information.

Three presentations to the Clean Air Through Energy Efficiency Conference held in Galveston, Texas, December 2015.

- Claridge, D., 2015 “Energy Systems Laboratory” *Clean Air Through Energy Efficiency Conference*, Galveston, Texas, December 2015
- Ellis, S., 2015 “2015 IECC: Significant Changes” *Clean Air Through Energy Efficiency Conference*, Galveston, Texas, December 2015
- Haberl, J.; Yazdani, B., 2015 “Energy Efficiency and Renewable Energy Impacts on Emission Reductions” *Clean Air Through Energy Efficiency Conference*, Galveston, Texas, December 2015

The Laboratory has and will continue to provide leading-edge technical assistance to the TCEQ, counties and communities working toward obtaining full SIP credit for the energy efficiency and renewable energy projects that are lowering emissions and improving the air quality for all Texans. The Laboratory will continue to provide superior technology to the State of Texas through efforts with the TCEQ and US EPA. The efforts taken by the Laboratory have produced significant success in bringing EE/RE closer to US EPA acceptance in the SIP. These activities were designed to more accurately calculate the creditable NO<sub>x</sub> emissions reduction from EE/RE initiatives contained in the TERP and to assist the TCEQ, local governments, and the building industry with standardized, effective implementation and reporting.

## 1.6 Energy and NO<sub>x</sub> Reductions from New Residential and Commercial Construction, Including Residential Air Conditioner Retrofits

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

In 2015, the following savings were calculated:

- In 2015, the annual electricity savings from code-compliant residential and commercial Construction are 1,158,144 MWh/year (3.9% of the total electricity savings),
- Savings from residential air conditioner retrofits<sup>2</sup> are 273,712 MWh/year (0.9%).
- In 2015, the OSD electricity savings from code-compliant residential and commercial Construction are 3,631 MWh/day (3.9%),
- Savings from residential air conditioner retrofits are 1,941 MWh/day (2.1%).
- By 2020, the annual electricity savings from code-compliant residential and commercial Construction will be 2,454,765 MWh/year (5.4% of the total electricity savings),
- Savings from residential air conditioner retrofits will be 211,793 MWh/year (0.5%).
- By 2020, the OSD electricity savings from code-compliant residential and commercial Construction will be 7,139 MWh/day (5.1%),
- Savings from residential air conditioner retrofits will be 1,502 MWh/day (1.1%).
- In 2015, the annual NO<sub>x</sub> emissions reduction from code-compliant residential and commercial Construction are 292 tons-NO<sub>x</sub>/year (3.6% of the total NO<sub>x</sub> savings),
- NO<sub>x</sub> emissions reductions from residential air conditioner retrofits are 64 tons-NO<sub>x</sub>/year (0.8%).
- In 2015, the OSD NO<sub>x</sub> emissions reduction from code-compliant residential and commercial Construction are 0.91 tons-NO<sub>x</sub>/day (3.6%)
- NO<sub>x</sub> emissions reductions from residential air conditioner retrofits are 0.45 tons-NO<sub>x</sub>/day (1.8%).
- By 2020, the NO<sub>x</sub> emissions reduction from code-compliant residential and commercial Construction will be 620 tons-NO<sub>x</sub>/year (5.0% of the total NO<sub>x</sub> savings),
- NO<sub>x</sub> emissions reductions from residential air conditioner retrofits will be 50 tons-NO<sub>x</sub>/year (0.5%).
- By 2020, the OSD NO<sub>x</sub> emissions reduction from code-compliant residential and commercial Construction will be 1.80 tons-NO<sub>x</sub>/day (4.7%),
- NO<sub>x</sub> emissions reductions from residential air conditioner retrofits will be 0.35 tons-NO<sub>x</sub>/day (0.9%).

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

## 1.7 Integrated NOx Emissions Reductions Reporting Across State Agencies

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

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

In 2015, the total integrated annual savings from all programs are 29,759,642 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 1,158,444 MWh/year (3.9% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program are 3,100,439 MWh/year (10.4%),
- Savings from SECO's Senate Bill 5 program are 940,372 MWh/year (3.2%),
- Electricity savings from green power purchases (wind) are 24,322,675 MWh/year (81.6%), and
- Savings from residential air conditioner retrofits<sup>3</sup> are 273,712 MWh/year (0.9%).

In 2015, the total integrated OSD savings from all programs are 93,560 MWh/day, which would be a 3,898 MW average hourly load reduction during the OSD period. The integrated OSD electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 3,631 MWh/day (3.9%),
- Savings from the PUC's Senate Bill 7 programs are 8,494 MWh/day (9.1%),
- Savings from SECO's Senate Bill 5 program are 2,576 MWh/day (2.8%),
- Electricity savings from green power purchases (wind) are 76,917 MWh/day (82.2%), and
- Savings from residential air conditioner retrofits are 1,941 MWh/day (2.1%).

By 2020, the total integrated annual savings from all programs will be 45,126,247 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction will be 2,454,765 MWh/year (5.4% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program will be 4,927,777 MWh/year (10.9%),
- Savings from SECO's Senate Bill 5 program will be 958,959 MWh/year (2.1%),
- Electricity savings from green power purchases (wind) will be 36,572,954 MWh/year (81.0%), and
- Savings from residential air conditioner retrofits will be 211,793 MWh/year (0.5%).

By 2020, the total integrated OSD savings from all programs will be 140,426 MWh/day, which would be a 5,851 MW average hourly load reduction during the OSD period. The integrated OSD electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction will be 7,139 MWh/day (5.1%),
- Savings from the PUC's Senate Bill 7 programs will be 13,501 MWh/day (9.6%),
- Savings from SECO's Senate Bill 5 program will be 2,627 MWh/day (1.9%),
- Electricity savings from green power purchases (wind) will be 115,657 MWh/day (82.4%), and
- Savings from residential air conditioner retrofits will be 1,502 MWh/day (1.1%).

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

In 2015, the total integrated annual NOx emissions reductions from all programs are 8,174 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 292 tons-NOx/year (3.6% of the total NOx savings),
- NOx emissions reductions from the PUC's Senate Bill 7 programs are 775 tons-NOx/year (9.5%),
- NOx emissions reductions from SECO's Senate Bill 5 program are 243 tons-NOx/year (3.0%),
- NOx emissions reductions from green power purchases (wind) are 6,800 tons-NOx/year (83.2%), and
- NOx emissions reductions from residential air conditioner retrofits are 64 tons-NOx/year (0.8%).

In 2015, the total integrated OSD NOx emissions reductions from all programs are 25.65 tons-NOx/day. The integrated OSD NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction are 0.91 tons-NOx/day (3.6%),
- NOx emissions reductions from the PUC's Senate Bill 7 programs are 2.12 tons-NOx/day (8.3 %),
- NOx emissions reductions from SECO's Senate Bill 5 program are 0.67 tons-NOx/day (2.6%),
- NOx emissions reductions from green power purchases (wind) are 21.50 tons-NOx/day (83.8%), and
- NOx emissions reductions from residential air conditioner retrofits are 0.45 tons-NOx/day (1.8%).

By 2020, the total integrated annual NOx emissions reductions from all programs will be 12,377 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 620 tons-NOx/year (5.0% of the total NOx savings),
- NOx emissions reductions from the PUC's Senate Bill 7 programs will be 1,230 tons-NOx/year (9.9%),
- NOx emissions reductions from SECO's Senate Bill 5 program will be 252 tons-NOx/year (2.0%),
- NOx emissions reductions from green power purchases (wind) will be 10,225 tons-NOx/year (82.6%), and
- NOx emissions reductions from residential air conditioner retrofits will be 50 tons-NOx/year (0.4%).

By 2020, the total integrated OSD NOx emissions reductions from all programs will be 38.54 tons-NOx/day. The integrated OSD NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction will be 1.80 tons-NOx/day (4.7%),
- NOx emissions reductions from the PUC's Senate Bill 7 programs will be 3.37 tons-NOx/day (8.7%),
- NOx emissions reductions from SECO's Senate Bill 5 program will be 0.69 tons-NOx/day (1.8%),
- NOx emissions reductions from green power purchases (wind) will be 32.33 tons-NOx/day (83.9%), and
- NOx emissions reductions from residential air conditioner retrofits will be 0.35 tons-NOx/day (0.9%).

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

	ESL-Single Family <sup>16</sup>	ESL <sup>16</sup> - Multifamily	ESL <sup>16</sup> - Commercial	PUC (SB7) <sup>15</sup>	SECO <sup>15</sup>	Wind-ERCOT <sup>8</sup>	SEER13 Single Family	SEER13 Multi Family
Annual Degradation Factor <sup>11</sup>	2.0%	2.0%	2.0%	5.0%	5.0%	0.0%	5.0%	5.0%
T&D Loss <sup>9</sup>	7.0%	7.0%	7.0%	7.0%	7.0%	0.0%	7.0%	7.0%
Initial Discount Factor <sup>12</sup>	20.0%	20.0%	20.0%	10.0%	60.0%	5.0%	20.0%	20.0%
Growth Factor	4.1%	6.1%	5.3%	0.0%	0.0%	8.5%	N.A.	N.A.
Weather Normalized	Yes	Yes	Yes	No	No	No	Yes	Yes

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

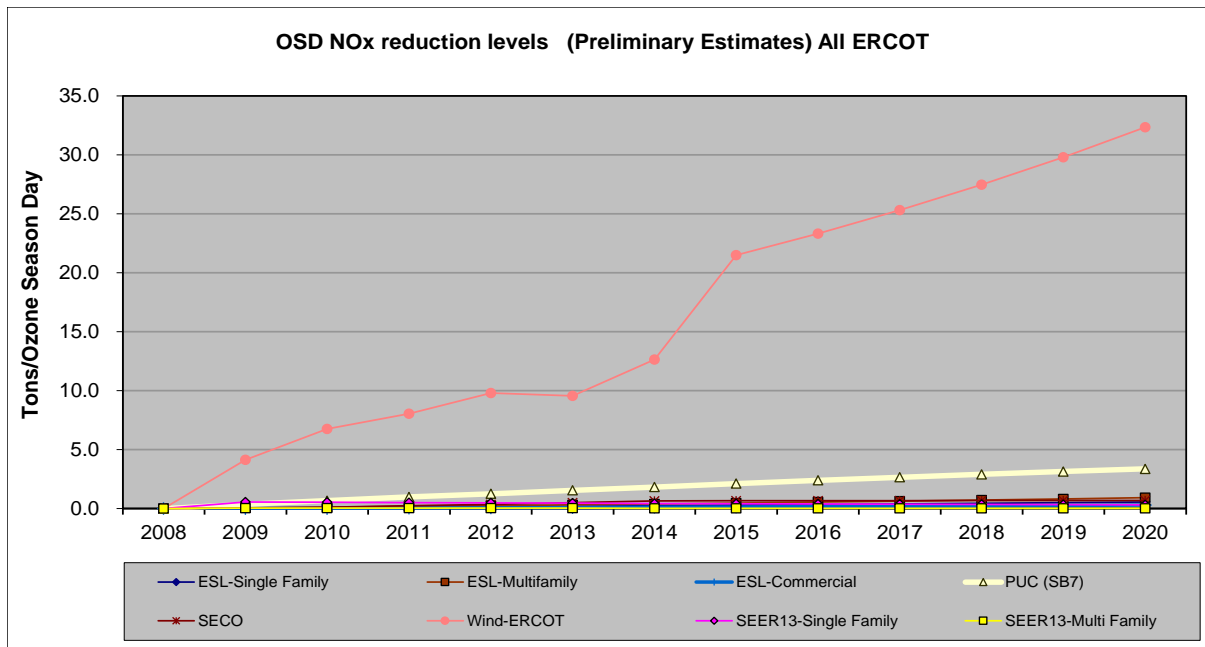


Figure 2: Integrated OSD Individual Programs NOx Emissions Reduction Projections through 2020 (Base Year 2008)

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

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

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

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

In 2008, work on both web based calculators continued;

- Deployed IC3 v3.2 to handle a wider selection of Single-Familybuilding configurations (<http://ic3.tamu.edu>);
- Delivered TCV v1.0 to the City of Austin for their testing;
- Continued to operate the original eCalc;

<sup>4</sup> eCalc reports NOx, SOx and CO2 emissions reduction from the US EPA eGRID database for power providers in the ERCOT region.

- 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

The 2011 software updates include:

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

The 2012 software updates include:

- IC3
  - 3.12 – Deprecated the 2000/2001 and 2006 Code (as of 1/1/2012)
  - 3.12.1 – Added a version of the energy report with a signature line, as requested by some municipalities. Improved the algorithm.
  - 3.12.2 – Alter help text to be more clear. Improved the algorithm.
  - 3.12.3 – Alter help pictures to make them clearer.

- 3.12.4 – Added optional input for water heaters to allow for better detail. Updated user manual. Improved the transform algorithms.

The 2013 software updates include:

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

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

The 2015 software updates include:

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

## 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 2015, the Laboratory continued to work with the TCEQ to develop an integrated NO<sub>x</sub> emissions reductions calculation that provided the TCEQ with a creditable NO<sub>x</sub> emissions reductions from energy efficiency and renewable energy (EE/RE) programs reported to the TCEQ in 2015 by the Laboratory, PUCT, SECO, and ERCOT (i.e., wind).
- At the request of the TCEQ, the Laboratory has continued the development of procedures for quantifying NO<sub>x</sub> emissions reductions from wind turbines that includes weather normalization and the quantification of NO<sub>x</sub> emissions reductions from the new Federal regulations for SEER 13 air conditioners.

## 1.10 Planned Focus for 2016

In FY 2016, the Energy Systems Laboratory will continue in its cooperative efforts with the TCEQ, PUCT, SECO, US EPA and others to evaluate the energy savings resulted from the EE/RE measures and programs of the TERP and their impact on air quality, and continue with the energy code state-wide implementation assistance under the Texas Building Energy Performance Standards program of the TERP. The Laboratory team will:

- Assist the TCEQ to obtain SIP credits from energy efficiency and renewable energy using the Laboratory's Emissions Reduction Calculator technology.
- Verify, document and report energy efficiency and renewable energy savings in all TERP EE/RE programs for the SIP in each non-attainment and affected county using the TCEQ/US EPA approved technology.
- Assist the PUCT with determining emissions reductions credits from energy efficiency programs funded by SB 7 and SB 5.
- Assist political subdivisions and Councils of Governments with calculating emissions reductions from local code changes and voluntary EE/RE programs for SIP inclusion.
- Continue to refine the cost-effective techniques to implement 15% above code (2009 IECC) energy efficiency in low-priced and moderately-priced residential housing.
- Continue to refine the cost-effective methods and techniques to implement 15% above code energy efficiency in commercial buildings.
- Continue to develop creditable procedures for calculating NO<sub>x</sub> emissions reductions from green renewable technologies, including wind power, solar energy and geothermal energy systems.



- Continue development of well-documented, integrated NO<sub>x</sub> emissions reductions methodologies for calculating and reporting NO<sub>x</sub> reductions, including a unified database framework for required reporting to TCEQ of potentially creditable measures from the ESL, PUCT, and SECO SB 5 initiatives.
- Upon request, provide written recommendations to the State Energy Conservation Office (SECO) about whether or not the energy efficiency provisions of latest published edition of the International Residential Code (IRC), or the International Energy Conservation Code (IECC), are equivalent to, or better than, the energy efficiency and air quality achievable under the editions adopted under the 2009 IRC/IECC. This will consider comments made by persons who have an interest in the adoption of the energy codes in the recommendations made to SECO.
- Develop a standardized report format to be used by providers of home energy ratings, including different report formats for rating newly constructed residences from those for existing residences.
- Continue to cooperate with an industry organization or trade association to: develop guidelines for home energy ratings; provide training for individuals performing home energy ratings and providers of home energy ratings; and provide a registry of completed ratings for newly constructed residences and residential improvement projects for the purpose of computing the energy savings and emissions reductions benefits of the home energy ratings program.
- Include all benefits attained from this program in an annual report to the commission.
- Engage production builders and municipalities in overcoming obstacles to use IC3 for their new home construction.
- Release version 4 of IC3 statewide on September 1<sup>st</sup>.
- Begin to wind down version 3 of IC3. Starting September 1st, no further projects may be entered. But, existing projects may continue to be worked on. The website will be taken offline at the end of 2016.

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, or by email at [terpinfo@tamu.edu](mailto:terpinfo@tamu.edu).

## 2 Introduction

### 2.1 Background

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

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

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<sup>5</sup> The “2000 IECC” notation is used to signify the 2000 International Residential Code (IRC), which includes the International Energy Conservation Code (IECC) as modified by the 2001 Supplement (IECC 2001), published by the ICC in March of 2001, as required by Senate Bill 5.

<sup>6</sup> The ASHRAE 90.1-1989 and 90.1-1999 weather stations are used in the emissions calculator for determining the building characteristics.

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

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

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

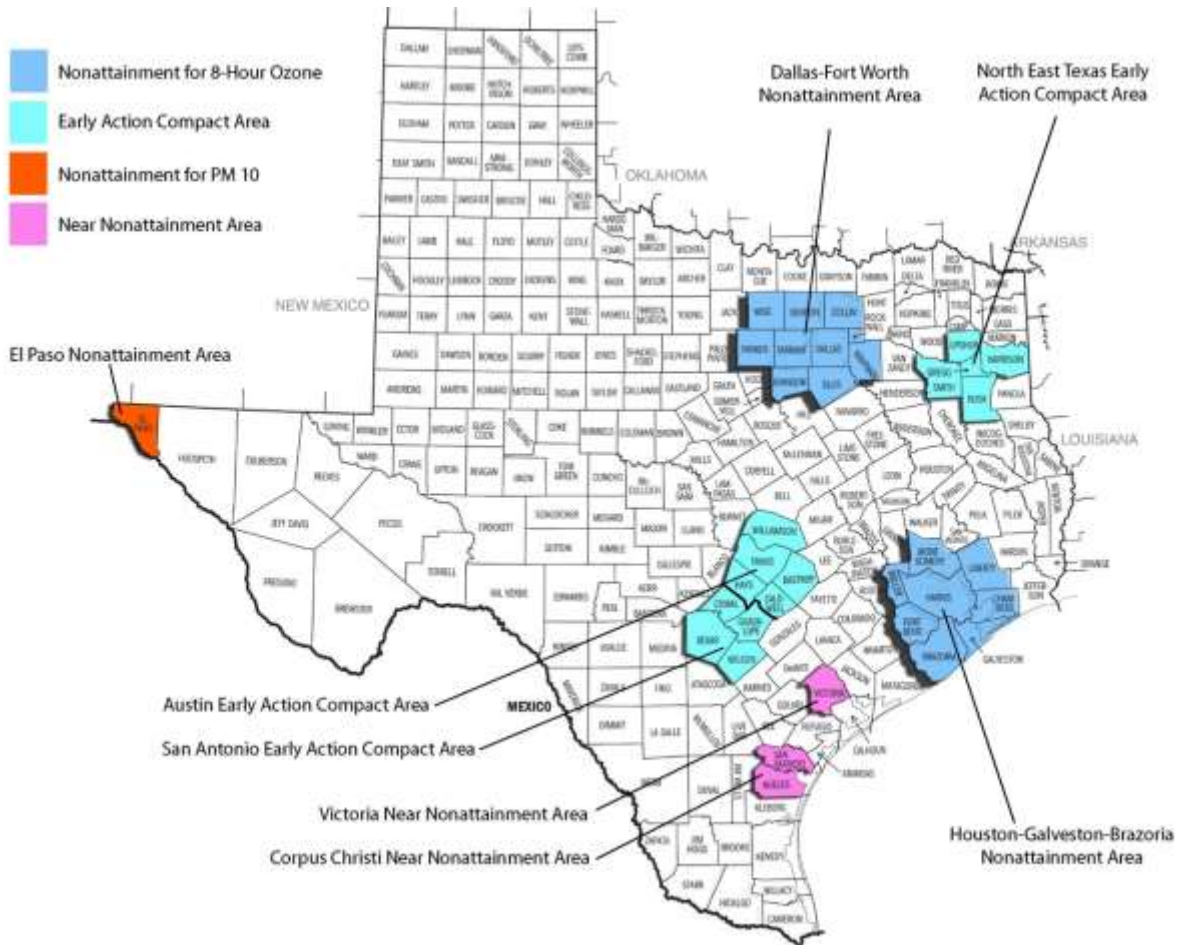


Figure 3: US EPA Nonattainment and Near Nonattainment

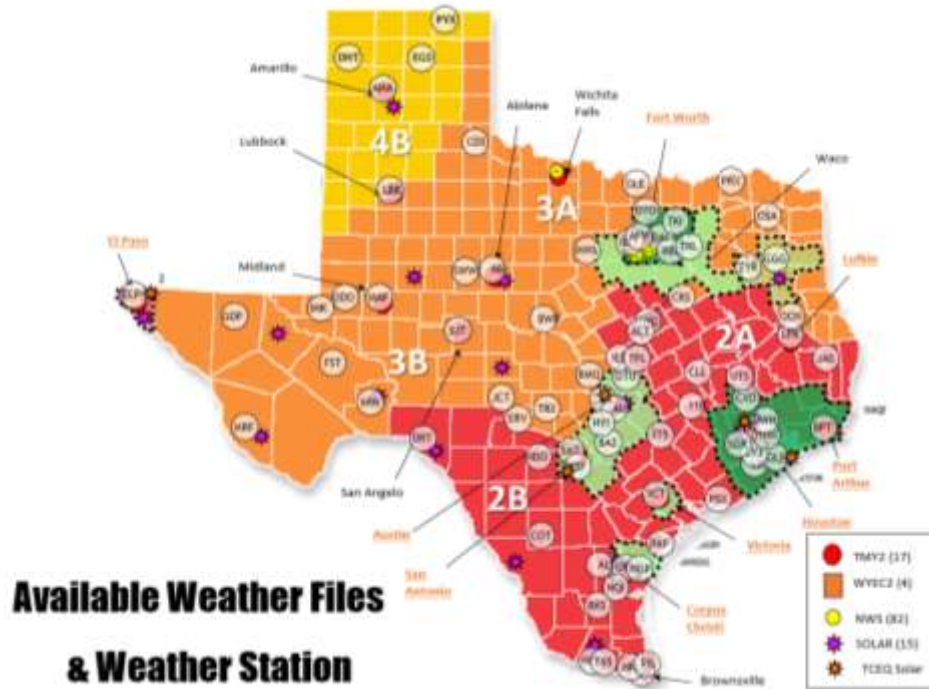
## 2.2 Energy Systems Laboratory’s Responsibilities in the TERP

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

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

In 2003 these responsibilities were modified by the following:

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



**List of Available Weather Files and Weather Stations of Texas**

File Number	File Name	File Number	File Name	File Number	File Name
1	Abilene Regional Airport (ABR)	31	Lubbock International Airport (LBB)	1	Abilene
2	Allen International Airport (AU)	32	Lubbock Regional Airport (LRF)	2	Abilene
3	Amesbury Municipal Airport (AMA)	33	Marfa Municipal Airport (MFA)	3	Abilene
4	Argusville Municipal Airport (AGV)	34	Midland International Airport (MDA)	4	Abilene
5	Artesia Municipal Airport (ART)	35	Midland International Airport (MDA)	5	Abilene
6	Aspen Municipal Airport (ASP)	36	Midland International Airport (MDA)	6	Abilene
7	Austin Municipal Airport (AUS)	37	Midland International Airport (MDA)	7	Abilene
8	Austin Municipal Airport (AUS)	38	Midland International Airport (MDA)	8	Abilene
9	Austin Municipal Airport (AUS)	39	Midland International Airport (MDA)	9	Abilene
10	Austin Municipal Airport (AUS)	40	Midland International Airport (MDA)	10	Abilene
11	Austin Municipal Airport (AUS)	41	Midland International Airport (MDA)	11	Abilene
12	Austin Municipal Airport (AUS)	42	Midland International Airport (MDA)	12	Abilene
13	Austin Municipal Airport (AUS)	43	Midland International Airport (MDA)	13	Abilene
14	Austin Municipal Airport (AUS)	44	Midland International Airport (MDA)	14	Abilene
15	Austin Municipal Airport (AUS)	45	Midland International Airport (MDA)	15	Abilene
16	Austin Municipal Airport (AUS)	46	Midland International Airport (MDA)	16	Abilene
17	Austin Municipal Airport (AUS)	47	Midland International Airport (MDA)	17	Abilene
18	Austin Municipal Airport (AUS)	48	Midland International Airport (MDA)	18	Abilene
19	Austin Municipal Airport (AUS)	49	Midland International Airport (MDA)	19	Abilene
20	Austin Municipal Airport (AUS)	50	Midland International Airport (MDA)	20	Abilene
21	Austin Municipal Airport (AUS)	51	Midland International Airport (MDA)	21	Abilene
22	Austin Municipal Airport (AUS)	52	Midland International Airport (MDA)	22	Abilene
23	Austin Municipal Airport (AUS)	53	Midland International Airport (MDA)	23	Abilene
24	Austin Municipal Airport (AUS)	54	Midland International Airport (MDA)	24	Abilene
25	Austin Municipal Airport (AUS)	55	Midland International Airport (MDA)	25	Abilene
26	Austin Municipal Airport (AUS)	56	Midland International Airport (MDA)	26	Abilene
27	Austin Municipal Airport (AUS)	57	Midland International Airport (MDA)	27	Abilene
28	Austin Municipal Airport (AUS)	58	Midland International Airport (MDA)	28	Abilene
29	Austin Municipal Airport (AUS)	59	Midland International Airport (MDA)	29	Abilene
30	Austin Municipal Airport (AUS)	60	Midland International Airport (MDA)	30	Abilene
31	Austin Municipal Airport (AUS)	61	Midland International Airport (MDA)	31	Abilene
32	Austin Municipal Airport (AUS)	62	Midland International Airport (MDA)	32	Abilene
33	Austin Municipal Airport (AUS)	63	Midland International Airport (MDA)	33	Abilene
34	Austin Municipal Airport (AUS)	64	Midland International Airport (MDA)	34	Abilene
35	Austin Municipal Airport (AUS)	65	Midland International Airport (MDA)	35	Abilene
36	Austin Municipal Airport (AUS)	66	Midland International Airport (MDA)	36	Abilene
37	Austin Municipal Airport (AUS)	67	Midland International Airport (MDA)	37	Abilene
38	Austin Municipal Airport (AUS)	68	Midland International Airport (MDA)	38	Abilene
39	Austin Municipal Airport (AUS)	69	Midland International Airport (MDA)	39	Abilene
40	Austin Municipal Airport (AUS)	70	Midland International Airport (MDA)	40	Abilene
41	Austin Municipal Airport (AUS)	71	Midland International Airport (MDA)	41	Abilene
42	Austin Municipal Airport (AUS)	72	Midland International Airport (MDA)	42	Abilene
43	Austin Municipal Airport (AUS)	73	Midland International Airport (MDA)	43	Abilene
44	Austin Municipal Airport (AUS)	74	Midland International Airport (MDA)	44	Abilene
45	Austin Municipal Airport (AUS)	75	Midland International Airport (MDA)	45	Abilene
46	Austin Municipal Airport (AUS)	76	Midland International Airport (MDA)	46	Abilene
47	Austin Municipal Airport (AUS)	77	Midland International Airport (MDA)	47	Abilene
48	Austin Municipal Airport (AUS)	78	Midland International Airport (MDA)	48	Abilene
49	Austin Municipal Airport (AUS)	79	Midland International Airport (MDA)	49	Abilene
50	Austin Municipal Airport (AUS)	80	Midland International Airport (MDA)	50	Abilene
51	Austin Municipal Airport (AUS)	81	Midland International Airport (MDA)	51	Abilene
52	Austin Municipal Airport (AUS)	82	Midland International Airport (MDA)	52	Abilene
53	Austin Municipal Airport (AUS)	83	Midland International Airport (MDA)	53	Abilene
54	Austin Municipal Airport (AUS)	84	Midland International Airport (MDA)	54	Abilene
55	Austin Municipal Airport (AUS)	85	Midland International Airport (MDA)	55	Abilene
56	Austin Municipal Airport (AUS)	86	Midland International Airport (MDA)	56	Abilene
57	Austin Municipal Airport (AUS)	87	Midland International Airport (MDA)	57	Abilene
58	Austin Municipal Airport (AUS)	88	Midland International Airport (MDA)	58	Abilene
59	Austin Municipal Airport (AUS)	89	Midland International Airport (MDA)	59	Abilene
60	Austin Municipal Airport (AUS)	90	Midland International Airport (MDA)	60	Abilene
61	Austin Municipal Airport (AUS)	91	Midland International Airport (MDA)	61	Abilene
62	Austin Municipal Airport (AUS)	92	Midland International Airport (MDA)	62	Abilene
63	Austin Municipal Airport (AUS)	93	Midland International Airport (MDA)	63	Abilene
64	Austin Municipal Airport (AUS)	94	Midland International Airport (MDA)	64	Abilene
65	Austin Municipal Airport (AUS)	95	Midland International Airport (MDA)	65	Abilene
66	Austin Municipal Airport (AUS)	96	Midland International Airport (MDA)	66	Abilene
67	Austin Municipal Airport (AUS)	97	Midland International Airport (MDA)	67	Abilene
68	Austin Municipal Airport (AUS)	98	Midland International Airport (MDA)	68	Abilene
69	Austin Municipal Airport (AUS)	99	Midland International Airport (MDA)	69	Abilene
70	Austin Municipal Airport (AUS)	100	Midland International Airport (MDA)	70	Abilene

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

In 2005 these same responsibilities were further updated:

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

These responsibilities were further updated in 2007:

- with Senate Bill 12 and House Bill 3693.

These responsibilities were further updated in 2009:

- with House Bill 1796.

These responsibilities were further updated in 2011:

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

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

These responsibilities were further updated in 2015:

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

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

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

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

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

In 2003 and 2004, the Laboratory worked with the TCEQ to identify a method to help the PUCT more accurately report their deemed savings as peak-day savings in 1999, using the Laboratory's new emissions reductions calculator. In 2005, this method was implemented in the TCEQ's Integrated Emissions Calculations, which was reported in previous (from 2005-2014) 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:

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

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

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

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

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

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

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

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

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

### 2.2.7 (HB 1365) Sec. 388.009. Energy-Efficient Building Program

In 2003, House Bill 1365 modified the TERP, adding a new Section 388.009. In this section the General Land Office, the TCEQ and the Laboratory, working with an advisory committee, may develop an energy-efficient building accreditation program for buildings that exceed the building energy performance standards under Section 388.003 by 15% or more. This program shall be updated annually to include best available energy-efficient building practices. This program shall use a checklist system to produce an energy-efficient building scorecard to help: (1)

home buyers compare potential homes and, by providing a copy of the completed scorecard to a mortgage lender, qualify for energy-efficient mortgages under the National Housing Act; and (2) communities qualify for emissions reduction credits by adopting codes that meet or exceed the energy-efficient building or energy performance standards established under this chapter. This effort may include a public information program to inform homeowners, sellers, buyers, and others regarding energy-efficient building ratings. The Laboratory shall establish a system to measure the reduction in energy and emissions produced under the energy-efficient building program and report those savings to the commission.

#### 2.2.8 (HB 3235) Sec. 388.009. Certification of Municipal 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 is required to be developed no later than January 1, 2004, with state-wide training sessions starting no later than March 1, 2004.

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

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

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

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

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

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

In addition, it requires the Laboratory to develop a standardized report format to be used by providers of home energy ratings, including different report formats for rating newly constructed residences from those for existing residences. The form must be designed to give potential buyers information on a structure's energy performance,

including: insulation; types of windows; heating and cooling equipment; water heating equipment; additional energy conserving features, if any; results of performance measurements of building tightness and forced air distribution; and an overall rating of probable energy efficiency relative to the minimum requirements of the International Energy Conservation Code or the energy efficiency chapter of the International Residential Code, as appropriate.

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

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

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

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

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

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

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

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

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



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

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

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

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

### 3 Statewide Air Emissions Calculations from Wind and Other Renewables

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

The report is organized in several deliverables:

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

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

- continuation of stakeholder’s meetings
- analysis of power generation from wind farms using improved method and 2015 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 2015 data

In this report, the weather normalization procedures, developed together with the Stakeholders, were presented and applied to all the wind farms that reported their data to ERCOT during the 2015 measurement period, together with wind data from the nearby NOAA weather stations or the zone average wind speed provided from ERCOT.

In the 2010 Wind and Renewables report to the TCEQ (Haberl et al. 2010), weather normalization analysis methods were reviewed. This report used the same analysis method as the previous 2010 report to present the same weather normalization procedure, including:

- the processing of weather and power generation data, modeling of daily power generation versus daily wind speed using the ASHRAE Inverse Model Toolkit (IMT) for two separate periods, i.e., Ozone Season Period (OSP), from July 15 to September 15, and Non-Ozone Season Period (Non-OSP);
- predicting 2008 wind power generation as a baseline, using developed coefficients from 2015 daily OSP and Non-OSP models for all the wind farms; and
- the analysis on monthly capacity factors generated using the models.

A summary of total wind power production in the base year (2008) for all of the wind farms in the ERCOT region using the developed procedure is presented, and the sixteen new wind farms which started operation in 2014 and 2015 were added, including Baffin Wind 1, Baffin Wind 2, Grandview Wind 1 GV1A, Grandview Wind 1 GV1B, Hereford Wind G, Hereford Wind V, Keechi Wind, Miami Wind G1, Miami Wind G2, Panhandle Wind 1 U1, Panhandle Wind 1 U2, Panhandle Wind 2 U1, Panhandle Wind 2 U2, Stepehens Ranch Wind 1, Spinning Spur Wind Two, and Windthorst 2 Wind. Figure 5 shows the measured annual wind power generation in 2015 and the estimated wind power generation in 2008 using the developed method for those wind farms in the ERCOT region. The total measured wind power generation in 2015 is 36,401,467 MWh/yr., which is 15.93% higher than what the same wind farms would have produced in 2008. Figure 6 shows the same comparison but for the Ozone Season Period. The measured wind power generation in the OSP of 2015 is 90,384 MWh/day, which is 14.19% higher than the 2008 OSP baseline wind production. For the analysis of this year, the measured 2015 wind power generation is fairly higher than the 2008 baseline wind power production.

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

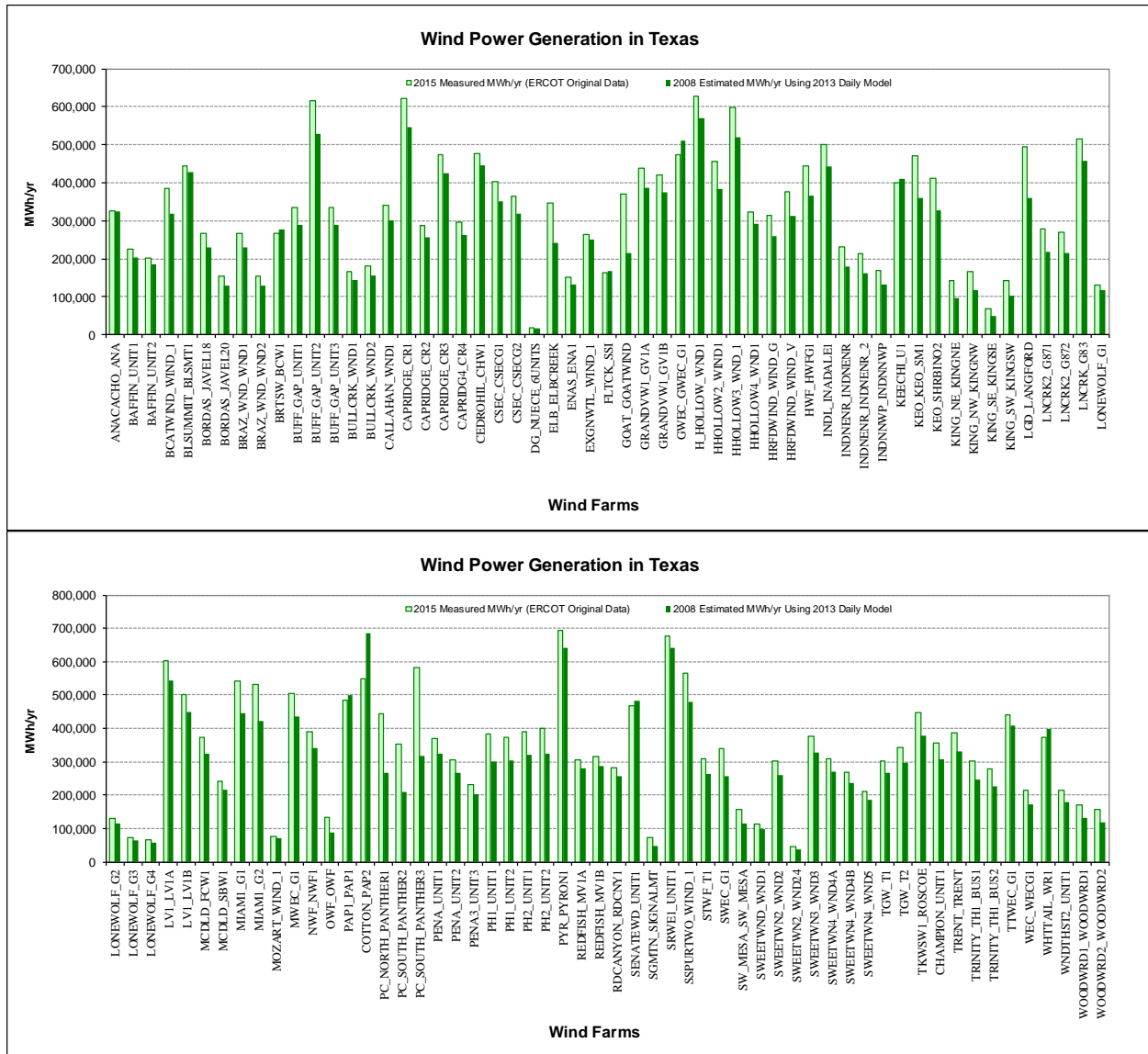


Figure 5: Comparison of 2015 Measured and 2008 Estimated Wind Power Production for Each Wind Farm

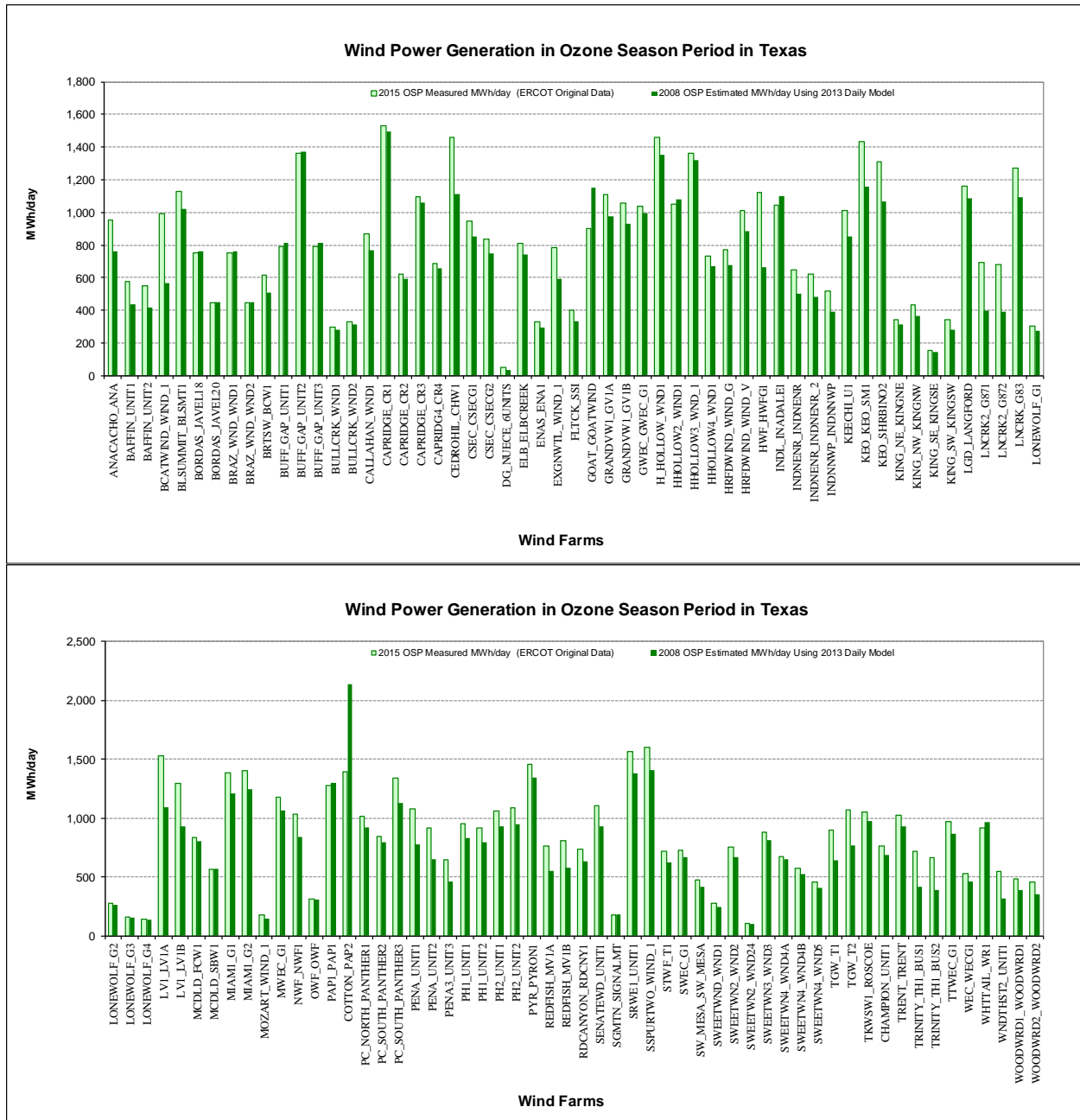


Figure 6: Comparison of 2015 OSP Measured and 2008 OSP Estimated Wind Power Production for Each Wind Farm

### 3.2 Analysis of emissions reductions from wind farms

In this report, the procedure for calculating annual and peak-day, county-wide NO<sub>x</sub> reductions from electricity savings from wind projects implemented in the congestion management (CM) zones in ERCOT was presented and, calculating the NO<sub>x</sub> emission reductions based on the special version of 2010 eGRID, developed by the ESL and EPA for the TCEQ. According to the developed models, the total MWh savings for all the wind farms in the base year 2008 within the ERCOT region are 31,399,556 MWh/yr and 79,153 MWh/day in the Ozone Season Period. The total NO<sub>x</sub> emissions reductions across all the counties amount are 8,684.31 tons/yr and 23.79 tons/day for the Ozone Season Period. Based on the 2015 measured ERCOT data, the total MWh savings for all the wind farms within the ERCOT region are 36,401,467 MWh/yr and 90,384 MWh/day in the Ozone Season Period. The total NO<sub>x</sub> emissions reductions in 2015 across all the counties amount are 10,033.16 tons/yr and 25.03 tons/day for the Ozone Season Period. Compared to the base year 2008, the total annual NO<sub>x</sub> emissions reductions increased by 15.53%, and the total NO<sub>x</sub> emissions reductions increase 14.26% for the Ozone Season Period.

### 3.3 Degradation analysis

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

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

As shown in

Table 4, of the seventy one sites analyzed, forty nine sites showed an increase when one compares the 90<sup>th</sup> percentile of the whole period to the 90<sup>th</sup> percentile of the first 12-month period, ranging from 0.1% to 289.7%. The remaining twenty sites showed a decrease from -0.5% to -16.1%. The weighted average of this increase across all wind farms is 18.3% (positive), which indicates that no degradation was observed from the aggregate energy production from these wind farms over the analyzed operation period. Similarly, the wind farms of Papalote Creek Wind Farm (-14.5%), Big Spring Wind Power (-15.4%), and Snyder Wind Project (-16.1%) have a decrease on production with a percentage larger than 10%, which may be caused by wind farm operations issues, the meter problems or other related issues.

Table 4: Summary of 90th Percentile Hourly Wind Power Analysis for Eighty Wind Farms (74 Sites) in Texas

Wind Farm	First 12-mo 90th Percentile Hourly Wind Power		Average of the Sliding 12-mo 90th Percentile Hourly Wind Power		Minimum of the Sliding 12-mo 90th Percentile Hourly Wind Power		Maximum of the Sliding 12-mo 90th Percentile Hourly Wind Power		No. of Months of Data	Capacity (MW)
	First 12-mo Ending Mo.	MW	MW	% Diff. vs. First 12-mo	MW	% Diff. vs. First 12-mo	MW	% Diff. vs. First 12-mo		
Brazos Wind Ranch	Dec-04	127.5	126.8	-0.6%	93.5	-26.7%	139.4	9.3%	133	160
Barton Chapel Wind 1	Apr-09	60.0	76.5	27.4%	43.1	-28.2%	89.1	48.5%	61	120
Buffalo Gap 1	Nov-06	100.9	98.4	-2.4%	75.4	-25.2%	105.7	4.6%	110	120
Buffalo Gap 2	Apr-08	183.4	174.1	-5.1%	104.9	-42.8%	207.6	13.2%	93	233
Buffalo Gap 3	Jun-09	86.4	136.1	57.6%	86.4	0.0%	152.1	76.0%	79	170
Bull Creek Wind Plant	Dec-09	93.9	91.5	-2.6%	41.5	-55.8%	130.4	38.9%	73	160
Big Spring Wind Power	Dec-02	27.2	23.0	-15.4%	16.3	-40.1%	27.2	0.0%	157	41
Callahan Divide Wind	Feb-06	93.3	95.1	2.0%	86.7	-7.1%	101.5	8.8%	119	114
Capricorn Ridge Wind 1&2	Aug-06	256.0	246.2	-3.8%	174.5	-32.4%	291.2	12.6%	69	364
Capricorn Ridge Wind 3	Jan-09	120.3	134.9	12.1%	97.9	-18.6%	153.5	27.6%	84	166
Capricorn Ridge Wind 4	Apr-09	85.2	84.1	-1.3%	67.6	-20.8%	92.8	9.0%	81	112.5
Camp Springs Wind Energy Center	Apr-08	111.3	106.8	-4.0%	95.0	-14.8%	120.9	8.6%	93	130
Camp Springs Energy Expansion	Jan-08	94.0	97.4	3.7%	88.9	-5.4%	107.9	14.8%	84	120
Cedro Hill Wind	Dec-11	136.3	125.6	-7.8%	102.1	-25.1%	136.9	0.4%	49	150
Champion Wind Farm	Jan-09	89.4	102.8	14.9%	67.7	-1.9%	113.2	26.6%	84	128.5
Desert Sky	Dec-02	89.0	116.8	33.4%	83.1	-6.7%	134.4	50.9%	157	160.5
Elbow Creek Wind	Dec-09	94.5	97.8	3.5%	88.5	-6.4%	104.5	10.6%	73	121.9
Forest Creek Wind Farm	Dec-07	105.2	106.2	1.0%	97.3	-7.5%	111.2	5.7%	97	124.2
Goat Wind	Feb-09	61.4	94.3	53.7%	61.4	0.0%	122.6	99.8%	83	150
Gulf Wind 1	Dec-09	63.1	105.1	66.5%	63.1	0.0%	119.4	89.1%	73	141.6
Gulf Wind 2	Dec-09	74.7	114.8	53.6%	74.7	0.0%	128.3	69.0%	73	141.6
Hackberry Wind	Dec-09	138.0	125.4	-9.1%	105.6	-23.3%	140.6	1.9%	73	165.5
Horse Hollow Phase 1	Jun-06	157.0	165.9	5.7%	141.3	-10.0%	185.1	17.9%	115	213
Horse Hollow Phase 2	Aug-07	145.7	137.4	-5.7%	99.0	-32.1%	151.5	4.0%	101	184
Horse Hollow Phase 3	May-07	169.2	165.8	-2.0%	123.9	-26.8%	167.7	11.0%	104	223.5
Horse Hollow Phase 4	Jun-07	88.6	88.6	0.1%	80.9	-8.7%	94.8	6.9%	103	115
Inadala Wind	Dec-09	81.9	131.4	60.5%	81.9	0.0%	166.3	103.1%	73	197
Indian Mesa	Dec-02	46.0	58.0	26.1%	36.0	-21.7%	72.2	56.5%	157	82.5
King Mountain Wind Ranch-NE	Dec-02	41.6	46.9	12.0%	36.3	-13.2%	56.4	34.8%	157	79.3
King Mountain Wind Ranch-NW	Dec-02	44.7	55.3	23.7%	40.2	-10.1%	65.3	46.1%	157	79.3
King Mountain Wind Ranch-SE	Dec-02	21.6	23.6	9.2%	18.4	-15.0%	28.1	29.8%	157	40.3
King Mountain Wind Ranch-SW	Dec-02	41.6	46.9	12.0%	36.4	-7.7%	53.7	29.1%	157	79.3
Langford Wind	Dec-10	115.7	126.0	8.9%	114.4	-1.1%	134.3	16.0%	61	150
Lone Star - Post Oak Wind	Dec-08	126.5	155.9	23.2%	126.5	0.0%	170.5	34.8%	85	200
Lone Star - Mesquite Wind	Feb-06	106.1	149.6	41.2%	106.1	0.0%	166.1	56.5%	95	200
Loraine Windpark I	Dec-10	30.4	35.4	16.5%	25.9	-14.8%	42.3	39.2%	61	126
Loraine Windpark II	Dec-10	27.8	35.7	28.2%	25.7	-7.6%	43.3	55.7%	61	124.5
Loraine Windpark III	Jan-12	16.2	20.6	26.9%	16.2	0.0%	22.6	39.4%	48	26
Loraine Windpark IV	Dec-12	17.4	15.6	-10.5%	5.0	-71.5%	20.8	19.1%	37	24
McAdoo Wind	Dec-09	111.7	135.8	21.5%	111.7	0.0%	143.6	28.5%	73	150
Notraes Windpower	Dec-09	97.8	112.8	15.3%	97.8	0.0%	122.9	25.7%	73	153
Ocotillo Windpower	Dec-09	39.1	42.1	7.6%	36.6	-6.4%	47.2	20.7%	73	58.6
Panther Creek 1	Dec-09	114.4	120.2	5.1%	107.8	-5.8%	128.9	12.7%	73	142.5
Panther Creek 2	Dec-09	91.8	96.3	4.9%	85.2	-7.2%	104.2	13.5%	73	115.5
Panther Creek 3	Dec-09	105.0	146.2	41.3%	105.0	0.0%	177.1	68.6%	73	199.5
Papalote Creek Wind Farm	Dec-10	150.1	128.4	-14.5%	39.6	-73.6%	157.9	5.2%	73	180
Papalote Creek Wind Farm II	Dec-11	174.2	167.7	-3.7%	155.0	-11.0%	176.4	1.2%	49	200.1
Penascal Wind 1	Dec-09	30.6	119.2	289.0%	30.6	0.0%	141.5	361.6%	73	161
Penascal Wind 2	Dec-09	83.3	109.1	31.0%	80.7	-3.1%	125.4	50.5%	73	142
Penascal Wind 3	Dec-10	68.3	79.8	16.8%	65.7	-3.9%	88.8	30.0%	73	101
Peyton Wind Farm	Dec-09	157.2	187.2	19.1%	151.4	-3.7%	220.1	40.0%	73	249
Red Canyon 1	Aug-07	75.8	76.1	0.4%	72.7	-4.1%	79.1	4.4%	101	84
Roscoe Wind Farm	Dec-08	169.4	153.4	-9.4%	108.1	-36.2%	179.8	6.2%	85	209
Sand Bluff Wind Farm	Dec-07	39.5	67.4	70.6%	39.5	0.0%	75.4	90.6%	97	90
Sherbino I Wind	Dec-09	104.7	112.9	7.9%	92.3	-11.8%	126.1	22.4%	73	150
Sherbino 2 Wind	Dec-12	125.7	91.6	-27.2%	38.0	-69.8%	125.7	0.0%	37	150
Silver Star Wind	Apr-09	40.6	45.9	13.0%	39.5	-2.7%	50.5	24.4%	81	60
South Trent Wind Farm	Dec-09	67.7	84.2	24.4%	65.4	-3.8%	91.0	34.4%	73	101.2
Southwest Mesa Wind	Dec-02	51.1	47.1	-7.8%	37.2	-27.1%	56.5	10.6%	157	74.6
Stanton Wind Energy	Dec-08	79.4	95.5	20.3%	79.4	0.0%	107.0	34.7%	85	120
Sweetwater Wind 1	Dec-04	34.1	33.0	-3.2%	29.9	-12.2%	34.9	2.4%	133	37.5
Sweetwater Wind 2 (unit 1)	Jan-06	71.4	81.7	14.5%	71.4	0.0%	88.0	23.3%	120	97.5
Sweetwater Wind 2 (unit 2)	May-08	13.8	13.8	0.5%	12.0	-13.1%	14.8	7.8%	92	16
Sweetwater Wind 3	Dec-06	99.6	101.1	1.4%	67.1	-32.7%	111.2	11.6%	109	135
Sweetwater Wind 4	Mar-08	161.0	171.0	6.2%	153.2	-4.9%	182.2	13.2%	94	240.8
Sweetwater Wind 5	Dec-08	66.5	83.3	4.8%	56.3	-15.3%	69.3	4.3%	85	80.5
Snyder Wind Project	Dec-08	52.9	44.4	-16.1%	36.1	-31.8%	52.9	0.0%	85	63
Trent Mesa	Dec-02	108.8	119.6	10.0%	90.7	-16.7%	132.8	22.0%	157	150
Trinity Hills Wind Farm 1	Dec-12	78.8	78.4	-0.5%	62.8	-20.3%	88.1	11.6%	37	118
Trinity Hills Wind Farm 2	Dec-12	74.6	77.0	2.9%	63.5	-15.0%	86.0	17.7%	37	108
Turkey Track Wind Energy Center	Dec-09	77.4	124.2	60.5%	77.0	-0.5%	143.1	85.0%	73	169.5
Whirlwind	Dec-08	54.0	50.0	-7.4%	39.8	-26.3%	56.9	5.4%	85	60
Wolf Ridge Wind	Dec-09	105.9	105.4	-0.5%	97.6	-7.8%	108.8	2.7%	73	112.5
Woodward Mountain Ranch	Dec-02	85.3	97.3	14.1%	80.4	-5.7%	112.4	31.6%	157	159.7
<b>Weighted Average:</b>				<b>17.2%</b>		<b>-16.1%</b>		<b>34.0%</b>	<b>Total:</b>	<b>9916.2</b>

### 3.4 Analysis of other renewable sources

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

This report also presents county-wide annual/Ozone Season Day (OSD) energy savings and annual NO<sub>x</sub> emission reductions for solar photovoltaic including solar power, solar thermal, biomass, and hydroelectric projects. The annual/OSD energy savings calculation for solar photovoltaic and solar thermal was conducted using the eCalc tool. The power generation data for the other renewable energy projects (solar power, biomass, and hydroelectric), which were obtained from the ERCOT, were used to evaluate the annual/OSD energy generation. Then, the annual NO<sub>x</sub> emission reductions calculation was conducted with the special version of Texas 2010 eGrid, based on their energy savings/generation.

In 2015, the total annual/OSD energy savings from each renewable projects across all the counties were:

- solar photovoltaic projects with 7% T&D loss: 319,343 MWh/yr and 960.54 MWh/day; in addition, solar power projects only with 7% T&D loss: 328,352 MWh/yr and 900 MWh/day,
- solar thermal projects with 7% T&D loss: 248 MWh/yr and 0.7 MWh/day,
- biomass projects with 7% T&D loss: 543,454 MWh/yr and 1,489 MWh/day, and
- hydroelectric projects with 7% T&D loss: 157,776 MWh/yr and 432 MWh/day.

In 2015, the annual NO<sub>x</sub> emission reductions from renewable projects across all the counties were:

- solar photovoltaic projects: 102.606 tons/yr; in addition, solar power projects only: 105.5 tons/yr,
- solar thermal projects: 0.1 tons/yr,
- biomass projects: 150.3 tons/yr, and
- hydroelectric projects: 45.3 tons/yr.

Table 5: Number of Identified Projects for Other Renewable Sources

Renewable Energy Projects	Number of 2015 New Projects	Total Number of Projects
Solar Photovoltaic <sup>10</sup>	37	4,684
(Solar Power)	(4)	(16)
Solar Thermal	0	38
Biomass <sup>11</sup>	1	21
Hydroelectric <sup>12</sup>	2	29
Geothermal	0	286
Landfill Gas-Fired <sup>13</sup>	2	36

<sup>10</sup> The Open PV project database of National Renewable Energy Laboratory (NREL) (<https://openpv.nrel.gov/>), which was checked in March, 2015, provides updated PV projects for 2006, 2008, 2009, 2010, 2011, 2012. Thus, the total number of PV projects until 2013, including PV projects from various websites, is now 4,534. Previously, it was 3,223.

<sup>11</sup> This report includes one more biomass project information which was not identified in the previous year report; however, it does not mean the State of Texas has a new biomass power plant constructed in 2015.

<sup>12</sup> This report includes one more hydroelectric project information which was not identified in the previous year report; however, it does not mean the State of Texas has a new hydroelectric power plant constructed in 2015.

<sup>13</sup> Landfill gas-fired projects information from EPA have seven sub-categories for their status: operational, candidates, potential, construction, shutdown, planned, and other. EPA rearranged/added/removed some projects information within the seven sub-categories. Operational projects were considered for the number of the projects. This report includes four more (new) and two less (shutdown) operational landfill gas-fired project information which was not identified in the previous year report; however, the new operational projects do not mean the State of Texas has new landfill gas-fired projects constructed in 2015.

### 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 Program site [www.texasrenewables.com](http://www.texasrenewables.com) is 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 2015 reports to the Legislature and information from ERCOT’s listing of REC generators.

Each year ERCOT is required to compile a list of grid-connected sources that generate electricity from renewable energy and report them to the Legislature. Table 6 contains the data reported by ERCOT from 2001 to 2015. Figure 7 is included to better illustrate the annual data collected by ERCOT.

Table 6: Annual Electricity Generation by Renewable Resources (MWh, ERCOT: 2001 - 2015)

Year	Biomass (MWh)	Hydro	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

NOTE: The REC Program tracks renewable generation in Texas, including non-ERCOT regions of Texas<sup>14</sup>.

<sup>14</sup> <https://www.texasrenewables.com/reports.asp>



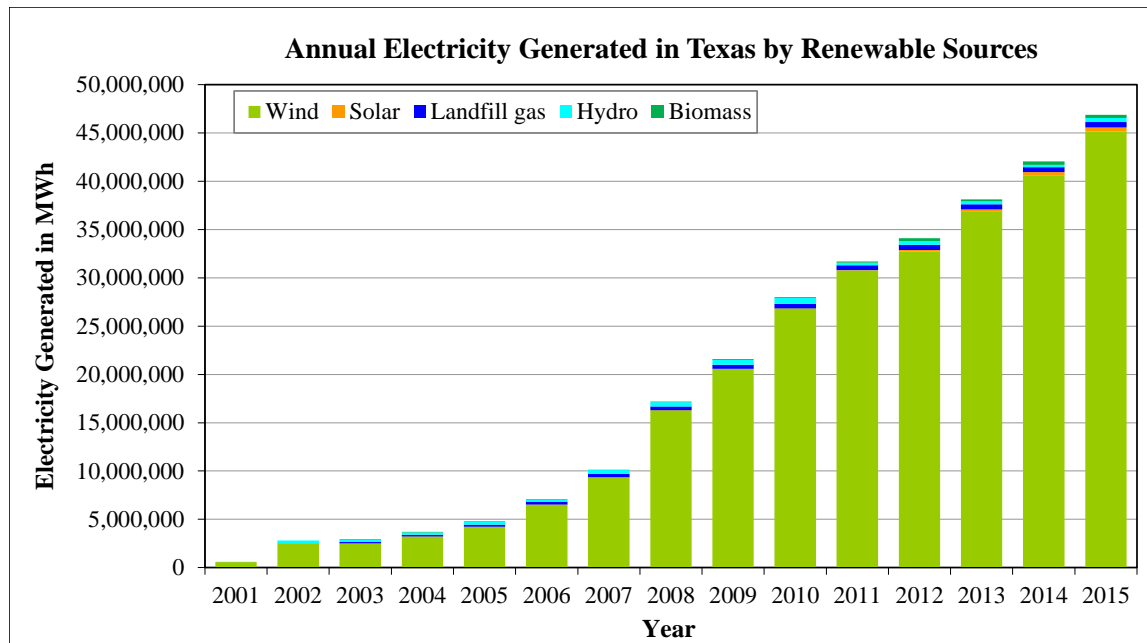


Figure 7: Electricity Generation by Renewable Resources (ERCOT: 2001–2015 Annual)

#### 4 Calculated NO<sub>x</sub> Reductions Potential from Energy Savings of New Construction in 2015

A complete reporting of the savings, using 2008 base year (the implementation of the 2006 IECC and the ASHRAE Standard 90.1-2004), 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) and commercial buildings.

##### 4.1 2015 Results for New Single-family Residential Construction

This section provides the potential electricity and natural gas savings and the associated NO<sub>x</sub> emissions reductions in 2015 using the 2008 base year which implemented the 2006 IECC for new single-family residences in the 36 non-attainment and affected counties as well as other counties in the ERCOT region<sup>15</sup>. To calculate the NO<sub>x</sub> emissions reductions, the following procedures were adopted. First, new construction activity was determined by county. To accomplish this, the number of 2015 building permits per county was obtained from the real estate center at Texas A&M University (REC 2016). Next, energy savings attributable to the 2006 IECC were calculated using the Laboratory's code-traceable, DOE-2.1e simulation, which was developed for the TERP. For the savings calculation, the 2014 Home Innovation Research Labs (HIRL) data<sup>16</sup> were used to determine the appropriate construction data

<sup>15</sup> The three new counties added in the 2003 Legislative session (i.e., Henderson, Hood, and Hunt) were included in the ERCOT region.

<sup>16</sup> For the 2014 and 2015 report, the 2014 HIRL data (previously, NAHB data) were used. 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>

corresponding to housing types. Then the NO<sub>x</sub> reductions potential from the electricity and natural gas savings in each county was calculated using the US EPA's 2010 eGRID database<sup>17</sup>.

In Table 7<sup>18</sup>, the 2015 new single-family and 2006 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 2006 IECC code-compliant characteristics are the minimum building code characteristics required for each county for single-family residences (i.e., Type A.1). In Table 7, the rows are first sorted by the US EPA's non-attainment, affected designation, and then other ERCOT counties alphabetically. Next, in the fourth column, the HIRL's survey classification is listed. The fifth through eighth columns show the HIRL's survey data: average glazing U-value, Solar Heat Gain Coefficient (SHGC), roof insulation, and wall insulation, respectively. In addition, the ninth through twelfth columns show the 2006 IECC minimum requirements for glazing U-value, SHGC, roof insulation, and wall insulation.

All the houses were assumed to have air-conditioner efficiency equal to a SEER of 13<sup>19</sup>, furnace efficiency (AFUE) of 0.80, and domestic water heater efficiency of 0.78 for a natural gas type and 1 for an electric type. The values shown in Table 7 represent the only changes that were made to the simulation to obtain the savings calculations. All other variables in the simulation remained the same for the 2015 new single-family and the 2006 IECC code-compliant simulations. In cases where the 2015 values were more efficient than the 2006 IECC requirements, the 2015 values were used in the 2015 new single-family simulations. Otherwise, the 2006 IECC values were used in both simulations. For example, in the Collin County, according to the HIRL's survey data, the roof insulation is R-27.09, which is less than the code-required insulation of R-30. Therefore, R-30 was used in the 2015 simulation.

In Table 8 the code-traceable simulation results for single-family residences are shown for each county. In a similar fashion to Table 7, Table 8 is first divided into the US EPA's non-attainment and affected classifications, followed by an alphabetical list of other ERCOT counties. In the third column, the 2006 IECC climate zone is listed followed by the number of new projected housing units<sup>20</sup> in the fourth column. In the fifth column, the total simulated energy use is listed if all new Construction had been built to pre-code specifications. In the sixth column, the total county-wide energy use for code-compliant Construction is shown. The values in the fifth and sixth columns come from the associated 24 simulation runs for each county, which were then distributed according to the HIRL's survey data to account for 1 story, 2 story, slab-on-grade, crawlspace, and three different system types (i.e., central air conditioning with electric resistance heating, heat pump heating, or a natural gas-fired furnace). In the seventh column, the total annual electricity savings are shown for each county. A 7% transmission and distribution loss is used in the 2015 report, which represents a fixed 1.07 multiplier for the electricity use. In the eighth and ninth columns, the total annual pre-code and code-compliant natural gas use is shown for those residences that had natural gas-fired furnaces and domestic water heaters. Finally, in the tenth column, the total annual natural gas savings are shown for each county.

In Table 9, the Congestion Management (CM) Zones<sup>21</sup> assignments for each county are shown. In Table 10, the annual electricity savings are assigned to CM Zones provider(s) according to Table 9<sup>22</sup>. The total electricity savings for each CM Zone, as shown in Table 10, then entered into the bottom row of Table 11, which is the 2010 US EPA's eGRID database<sup>23</sup> for Texas. Next, the county's NO<sub>x</sub> reductions (lbs) are calculated using the assigned 2010 eGrid proportions (lbs-NO<sub>x</sub>/MWh) to each CM zone in the county. The calculated NO<sub>x</sub> reductions are presented in the columns adjacent to the corresponding CM Zone columns. By adding the NO<sub>x</sub> reductions values in each row, then, the total of the NO<sub>x</sub> reductions per county (lbs and Tons) is calculated. Counties that do not show NO<sub>x</sub> reductions represent counties that do not have power plants in eGRID's database.

<sup>17</sup> This preliminary analysis does not include actual power transfers on the grid, and assumes transmission and distribution losses of 7%. Counties were assigned to utility service districts as indicated.

<sup>18</sup> Hardin, Jefferson, and Orange Counties were removed from Table 7 and Table 8 because since 2012 they are not in the category of "Nonattainment County" based on [<http://www.tceq.texas.gov/airquality/sip/bpa/bpa-status>], and these counties do not belong to ERCOT region.

<sup>19</sup> Based on the regulation effective.

<sup>20</sup> The number of the new housing units in 2015 were obtained from the Real Estate Center at Texas A&M University.

<sup>21</sup> ERCOT region has employed the Congestion Management (CM) since 2010, and it is currently divided into four zones: Houston (H), North (N), South (S), and West (W).

<sup>22</sup> Of a total of 202 counties, 138 counties are not included in this table since the corresponding providers could not be assigned for these 138 counties.

<sup>23</sup> This preliminary analysis does not include actual power transfers on the grid, and assumes transmission and distribution losses of 7%. Counties were assigned to CM Zones as indicated.

Table 7: 2015 and 2006 IECC Code-compliant Building Characteristics Used in the DOE-2 Simulations for New Single-family Residences

	County	Climate Zone	Division East or West	2015 Average				2006 IECC				
				Glazing U-value (Btu/hr-ft <sup>2</sup> -F)	SHGC	Roof Insulation (hr-ft <sup>2</sup> -F/Btu)	Wall Insulation (hr-ft <sup>2</sup> -F/Btu)	Glazing U-value (Btu/hr-ft <sup>2</sup> -F)	SHGC	Roof Insulation (hr-ft <sup>2</sup> -F/Btu)	Wall Insulation (hr-ft <sup>2</sup> -F/Btu)	
Non-attainment	BRAZORIA	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
	CHAMBERS	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
	COLLIN	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	DALLAS	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	DENTON	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	EL PASO	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	ELLIS	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	FORT BEND	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
	GALVESTON	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
	HARRIS	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
	JOHNSON	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	KAUFMAN	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	LIBERTY	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
	MONTGOMERY	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
	PARKER	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	ROCKWALL	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	TARRANT	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	WALLER	3	West Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
	WISE	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	Affected	BASTROP	2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13
BEXAR		2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13	
CALDWELL		2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13	
COMAL		2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13	
GREGG		3	East Texas	0.39	0.53	26.12	13.55	0.65	0.4	30	13	
GUADALUPE		2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13	
HARRISON		3	East Texas	0.39	0.53	26.12	13.55	0.65	0.4	30	13	
HAYS		2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13	
INDIES		2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
RUSK		3	East Texas	0.39	0.53	26.12	13.55	0.65	0.4	30	13	
SAN PATRICIO		2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
SMITH		3	East Texas	0.39	0.53	26.12	13.55	0.65	0.4	30	13	
TRAVIS		2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13	
UPSHUR		3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
VICTORIA		2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
WILLIAMSON		2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13	
WILSON		2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13	
ERCOT		ANDERSON	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13
		ANDREWS	2	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13
		ANGELINA	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13
	ARANSAS	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
	ARCHER	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	ATASCOSA	2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13	
	AUSTIN	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
	BANDERA	2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13	
	BASTROP	2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13	
	BAYLOR	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	BEE	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
	BELL	2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13	
	BEXAR	2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13	
	BLANCO	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	BORDEN	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	BOSQUE	2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13	
	BRAZORIA	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
	BRAZOS	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
	BREWSTER	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	BRISCOE	4	West Texas	0.39	0.53	27.09	13.56	0.4	NR	38	13	
	BROOKS	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
	BROWN	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	BURLESON	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
	BURNET	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	CALDWELL	2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13	
	CALHOUN	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
	CALLAHAN	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	CAMERON	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
	CHAMBERS	2	East Texas	0.39	0.53	26.119	13.548	0.75	0.4	30	13	
	CHEROKEE	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
	CHILDRESS	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	CLAY	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	COKE	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	COLEMAN	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	COLLIN	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	COLORADO	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
	COMAL	2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13	
	COMANCHE	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	CONCHO	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	COOKE	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	CORYELL	2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13	
	COTTLER	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	CRANE	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	CROCKETT	2	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	CROSBY	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	CULBERSON	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	DALLAS	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	DAWSON	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
	DE WITT	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13	
	DELTA	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13	
DENTON	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13		
DICKENS	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13		
DIMMIT	2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13		
DUVAL	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13		
EASTLAND	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13		
ECTOR	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13		
EDWARDS	2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13		
ELLIS	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13		
ERATH	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13		
FALLS	2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13		
FANNIN	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13		
FAYETTE	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13		
FISHER	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13		
FOARD	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13		
FORT BEND	2	East Texas	0.39	0.53	26.12	13.55	0.75	0.4	30	13		
FRANKLIN	3	West Texas	0.39	0.53	27.09	13.56	0.65	0.4	30	13		
FREESTONE	2	West Texas	0.39	0.53	27.09	13.56	0.75	0.4	30	13		

Table 7: 2015 and 2006 IECC Code-compliant Building Characteristics Used in the DOE-2 Simulations for New Single-family Residences (Continued)

County	Climate Zone	Division East or West	2015 Average			2006 IECC				
			Chasing U-value (Btu/hr-ft <sup>2</sup> -F)	SHGC	Roof Insulation (R-47, F/Btu)	Wall Insulation (R-47, F/Btu)	Chasing U-value (Btu/hr-ft <sup>2</sup> -F)	SHGC	Roof Insulation (R-47, F/Btu)	Wall Insulation (R-47, F/Btu)
FRIO	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
GALVESTON	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
GILLESPIE	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
GLASSOCK	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
GOLIAD	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
GONZALES	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
GRAYSON	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
GRIMES	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
GUADALUPE	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
HALL	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
HAMILTON	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
HARDENMAN	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
HARRIS	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
HASKELL	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
HASKIN	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
HENDERSON	3	East Texas	0.39	0.53	26.12	15.55	0.65	0.4	30	13
HIDALGO	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
HILL	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
HOGG	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
HOPKINS	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
HOUSTON	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
HOWARD	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
HUIDSPETH	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
HUNT	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
IRION	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
JACK	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
JACKSON	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
JEFF DAVIS	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
JIM HOGG	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
JIM WELLS	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
JOHNSON	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
JONES	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
JORDAN	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
KAUFMAN	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
KENDALL	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
KENEDY	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
KENT	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
KERR	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
KIMBLE	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
KINN	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
KINNEY	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
KLEBERG	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
KNOX	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
KOSSALE	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
KRAMER	3	East Texas	0.39	0.53	26.12	15.55	0.65	0.4	30	13
LAMPASAS	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
LAVACA	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
LEE	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
LEON	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
LIBERTY	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
LIVE OAK	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
LIVINGSTON	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
LOVING	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
LUDLOW	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
MARTIN	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
MASON	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
MATAGORDA	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
MAVERICK	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
MCCLINTOCK	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
MCLENNAN	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
MCMULLEN	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
MEHNER	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
MENARD	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
MIDLAND	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
MILAM	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
MILBURN	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
MITCHELL	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
MONTAGUE	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
MONTGOMERY	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
MOTLEY	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
NACOGDOCHES	3	East Texas	0.39	0.53	26.12	15.55	0.65	0.4	30	13
NAVARRO	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
NEUBAUER	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
NELSON	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
NICHOLS	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
PALO PINTO	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
PARKER	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
PARKS	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
PRESIDIO	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
RAINS	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
REGAN	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
REID	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
RED RIVER	3	East Texas	0.39	0.53	26.12	15.55	0.65	0.4	30	13
REEVES	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
RENFRO	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
ROBERTSON	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
ROCKWALL	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
ROSEN	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
RUSK	3	East Texas	0.39	0.53	26.12	15.55	0.65	0.4	30	13
SAN PATRICK	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
SAN SABA	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
SCHLEICHER	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
SCURRY	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
SHACKELFORD	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
SMITH	3	West Texas	0.39	0.53	26.12	15.55	0.65	0.4	30	13
SOHMERVELL	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
STARR	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
STEPHENS	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
STERLING	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
STONEWALL	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
SUTTON	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
TARRANT	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
TAYLOR	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
TERRILL	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
THROCKMORTON	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
TITUS	3	East Texas	0.39	0.53	26.12	15.55	0.65	0.4	30	13
TOM GREEN	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
TRAVIS	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
UPTON	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
UVALDE	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
VAL VERDE	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
VAN HANDEL	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
VICTORIA	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
WALLER	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
WARD	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
WASHINGTON	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
WEBB	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
WEBSTER	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
WICHITA	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
WILBARGER	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
WILLACY	2	East Texas	0.39	0.53	26.12	15.55	0.75	0.4	30	13
WILLAMSON	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
WILSON	2	West Texas	0.39	0.53	27.09	15.56	0.75	0.4	30	13
WINKLER	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
WISE	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
WISDOM	3	West Texas	0.39	0.53	27.09	15.56	0.65	0.4	30	13
ZAPATA	2	West Texas	0.39	0.53	27.09	15.56	0.75			

Table 8: 2015 Annual Electricity Savings from New Single-family Residences

2015 Summary TRY 2008										
	County	Climate Zone	No. of Projected Units (2015)	Precode Total Annual Elec. Use (MWh/yr)	Code-compliant Total Annual Elec. Use (MWh/yr)	Total Annual Elec. Savings (MWh/yr) w/ 7% of T&D Loss	Precode Total NG Use (Therm/yr)	Code-compliant Total NG Use (Therm/yr)	Total Annual NG Savings (Therm/yr)	
Nonattain-ment County	BRAZORIA	3	2,975	39,089	36,961	2,276	696,563	648,125	48,437	
	CHAMBERS	3	317	4,073	3,858	230	77,543	72,588	4,955	
	COLLIN	3	7,878	134,038	125,250	9,493	1,309,577	1,161,547	148,030	
	DALLAS	3	4,806	81,707	76,354	5,728	802,081	711,661	90,420	
	DENTON	3	6,594	112,192	104,836	7,871	1,096,135	972,232	123,903	
	EL PASO	2	2,518	38,335	35,997	2,501	468,138	408,964	59,174	
	ELLIS	3	1,327	22,560	21,082	1,582	221,465	196,499	24,966	
	FORT BEND	3	9,096	119,527	113,016	6,967	2,125,845	1,981,629	144,215	
	GALVESTON	3	2,372	31,166	29,470	1,815	555,377	516,757	38,620	
	HARRIS	2	16,721	219,723	207,755	12,807	3,907,899	3,642,791	265,108	
	JOHNSON	2	558	9,487	8,865	665	93,125	82,627	10,498	
	KAUFMAN	2	265	4,509	4,213	316	44,052	39,072	4,979	
	LIBERTY	2	306	4,023	3,804	235	71,512	66,582	4,930	
	MONTGOMERY	3	4,970	65,309	61,751	3,807	1,161,549	1,082,750	78,798	
	PARKER	2	383	6,516	6,089	457	63,667	56,470	7,197	
	ROCKWALL	2	1,046	17,797	16,630	1,249	173,879	154,224	19,655	
	TARRANT	2	5,850	99,456	92,940	6,973	976,316	866,254	110,062	
	WALLER	2	10	151	124	8	2,357	2,179	159	
	WILEY	3	89	1,361	1,272	95	13,299	11,795	1,503	
	Affected County	BASTROP	2	113	1,573	1,482	97	33,199	29,382	3,817
BEXAR		2	3,294	50,371	47,652	2,909	377,930	337,387	40,543	
CALDWELL		3	268	4,256	3,997	277	38,597	34,179	4,417	
COMAL		3	1,670	25,537	24,159	1,475	191,604	171,049	20,555	
GREGG		3	206	3,046	2,863	196	67,090	62,447	4,643	
GUADALUPE		2	1,197	18,304	17,316	1,057	137,335	122,602	14,733	
HARRISON		2	34	501	472	32	11,165	10,398	767	
HAYS		2	2,077	32,982	30,978	2,144	298,915	264,449	34,465	
NEUCES		3	1,205	16,448	15,495	1,020	238,641	223,745	14,896	
RUSK		2	13	170	160	10	3,811	3,524	287	
SAN PATRICIO		2	225	3,071	2,893	190	44,560	41,778	2,781	
SMITH		2	420	6,191	5,822	395	138,205	128,734	9,471	
TRAVIS		3	5,652	89,753	84,299	5,835	813,416	719,628	93,788	
UPSHUR		3	2	30	28	2	681	605	78	
VICTORIA		2	136	1,827	1,723	111	31,555	29,364	2,191	
WILLIAMSON		3	3,747	59,502	55,886	3,868	539,255	477,078	62,177	
WILSON		2	48	734	694	42	8,507	4,916	591	
ERCOT		ANDERSON	2	7	92	86	6	2,052	1,897	155
		ANDREWS	3	22	354	335	21	4,011	3,524	486
		ANGELINA	2	54	706	666	43	15,830	14,637	1,193
	ARANSAS	2	177	2,416	2,276	150	35,053	32,865	2,188	
	ARCHER	3	6	105	99	7	1,312	1,153	159	
	ATASCOSA	2	43	649	617	34	4,702	4,164	538	
	AUSTIN	2	19	250	236	15	4,441	4,139	301	
	BANDERA	2	0	0	0	0	0	0	0	
	BAYLOR	3	1	18	16	1	219	192	26	
	BEE	2	7	94	89	6	1,624	1,511	113	
	BELL	2	1,680	26,801	25,398	1,502	278,546	244,960	33,586	
	BLANCO	3	10	159	149	10	1,439	1,273	166	
	BORDEN	3	0	0	0	0	0	0	0	
	BOSQUE	2	1	16	15	1	166	146	20	
	BRAZOS	2	1,131	14,862	14,052	866	264,328	246,397	17,932	
	BREWSTER	3	4	64	60	4	645	567	78	
	BRISCOE	4	0	0	0	0	0	0	0	
	BROOKS	2	0	0	0	0	0	0	0	
	BROWN	3	66	1,053	998	59	10,943	9,623	1,319	
	BURLESON	2	3	39	37	2	701	654	48	
	BURNET	3	305	4,843	4,549	315	43,895	38,833	5,061	
	CALHOUN	2	69	927	874	56	16,009	14,898	1,112	
	CALLAHAN	3	4	65	61	4	743	656	87	
	CAMERON	2	1,129	15,677	14,737	1,006	171,017	160,316	10,701	
	CHEROKEE	2	5	65	62	4	1,466	1,355	110	
	CHILDRESS	3	0	0	0	0	0	0	0	
	CLAY	3	2	35	33	2	437	384	53	
	COKE	3	0	0	0	0	0	0	0	
	COLEMAN	3	0	0	0	0	0	0	0	
	COLORADO	2	5	66	62	4	1,169	1,089	79	
	COMANCHE	3	0	0	0	0	0	0	0	
	CONCHO	3	0	0	0	0	0	0	0	
	COOKE	3	40	680	636	48	6,671	5,911	760	
	CORYELL	2	142	2,265	2,147	127	23,544	20,705	2,839	
	COTTLE	3	0	0	0	0	0	0	0	
	CRANE	3	2	32	30	2	365	320	44	
	CROCKETT	3	0	0	0	0	0	0	0	
	CROSBY	3	5	70	66	4	2,630	2,306	324	
	CULBERSON	3	1	15	14	1	180	157	24	
	DAWSON	3	0	0	0	0	0	0	0	
DE WITT	2	13	175	165	11	3,016	2,807	209		
DELTA	3	3	51	48	4	499	442	56		
DICKENS	3	0	0	0	0	0	0	0		
DIMMIT	2	6	90	86	5	561	507	54		
DUVAL	2	0	0	0	0	0	0	0		
EASTLAND	3	0	0	0	0	0	0	0		
ECTOR	3	468	7,535	7,119	445	85,320	74,976	10,344		
EDWARDS	2	0	0	0	0	0	0	0		
ERATH	3	30	484	458	28	5,574	4,921	653		
FALLS	2	5	80	76	4	829	729	100		
FANNIN	3	11	187	175	13	1,835	1,625	209		
FAYETTE	2	8	105	99	6	1,870	1,745	127		
FISHER	3	0	0	0	0	0	0	0		
FOARD	3	0	0	0	0	0	0	0		
FRANKLIN	3	1	17	16	1	166	147	19		
FRESTONE	2	3	48	45	3	497	437	60		
FRIO	2	6	91	86	5	656	581	75		

Table 8: 2015 Annual Electricity Savings from New Single-family Residences (Continued)

2015 Summary TRY 2008									
County	Climate Zone	No. of Projected Units (2015)	Precode Total Annual Elec. Use (MWh/yr)	Code-compliant Total Annual Elec. Use (MWh/yr)	Total Annual Elec. Savings (MWh/yr) w/ 7% of T&D Loss	Precode Total NG Use (Therm/yr)	Code-compliant Total NG Use (Therm/yr)	Total Annual NG Savings (Therm/yr)	
GILLESPIE	3	41	651	612	42	5,901	5,220	680	
GLASSCOCK	3	0	0	0	0	0	0	0	
GOLIAD	2	3	40	38	2	696	648	48	
GONZALES	2	18	275	260	16	2,065	1,844	222	
GRAYSON	3	322	5,476	5,118	384	53,701	47,582	6,119	
GRIMES	2	17	223	211	13	3,973	3,704	270	
HALL	3	0	0	0	0	0	0	0	
HAMILTON	3	6	96	91	5	995	875	120	
HARDEMAN	3	0	0	0	0	0	0	0	
HASKELL	3	2	32	31	2	372	328	44	
HENDERSON	2	47	693	651	44	15,466	14,406	1,060	
HIDALGO	2	2,929	40,671	38,233	2,609	443,675	415,912	27,763	
HILL	2	7	112	106	6	1,161	1,021	140	
HOPKINS	3	10	170	159	12	1,662	1,474	188	
HOUSTON	2	0	0	0	0	0	0	0	
HOWARD	3	100	1,610	1,521	95	18,231	16,020	2,210	
HOOD	2	140	2,386	2,224	167	23,365	20,731	2,634	
HUDSPETH	3	0	0	0	0	0	0	0	
HUNT	2	102	1,735	1,621	122	17,011	15,073	1,938	
IRION	3	0	0	0	0	0	0	0	
JACK	3	0	0	0	0	0	0	0	
JACKSON	2	13	175	165	11	3,016	2,807	209	
JEFF DAVIS	3	0	0	0	0	0	0	0	
JIM HOGG	2	0	0	0	0	0	0	0	
JIM WELLS	2	12	164	154	10	2,377	2,228	148	
JONES	3	0	0	0	0	0	0	0	
KARNES	2	45	675	642	35	5,009	4,455	553	
KENDALL	3	190	2,870	2,730	150	20,713	18,378	2,335	
KENEDY	2	0	0	0	0	0	0	0	
KENT	3	0	0	0	0	0	0	0	
KERR	3	63	1,000	940	65	9,067	8,021	1,045	
KIMBLE	3	0	0	0	0	0	0	0	
KING	3	0	0	0	0	0	0	0	
KINNEY	2	2	31	29	2	229	205	25	
KLEBERG	2	44	597	563	36	8,181	7,637	544	
KNOX	3	0	0	0	0	0	0	0	
LA SALLE	2	11	165	157	8	1,028	929	99	
LAMAR	3	20	293	276	17	6,339	5,883	455	
LAMPASAS	3	18	287	272	16	2,984	2,628	360	
LAVACA	2	19	254	240	15	4,173	3,864	309	
LEE	2	8	127	119	8	1,152	1,020	132	
LEON	2	0	0	0	0	0	0	0	
LIMESTONE	2	2	32	30	2	332	292	40	
LIVE OAK	2	10	137	129	8	1,980	1,857	124	
LLANO	3	76	1,207	1,134	78	10,938	9,677	1,261	
LOVING	3	0	0	0	0	0	0	0	
MADISON	2	3	39	37	2	701	654	48	
MARTIN	3	5	81	76	5	912	801	111	
MASON	3	3	48	45	3	432	382	50	
MATAGORDA	2	85	1,142	1,077	69	19,722	18,352	1,369	
MAVERICK	2	79	1,188	1,131	61	7,384	6,674	710	
MCCULLOCH	3	0	0	0	0	0	0	0	
MCLENNAN	2	587	9,365	8,874	525	97,325	85,590	11,735	
MCMLLEN	2	0	0	0	0	0	0	0	
MEDINA	2	36	551	521	32	4,130	3,687	443	
MENARD	3	0	0	0	0	0	0	0	
MIDLAND	3	761	12,283	11,576	724	138,736	121,916	16,821	
MILAM	2	4	59	56	3	447	398	49	
MILLS	3	0	0	0	0	0	0	0	
MITCHELL	3	1	16	15	1	186	164	22	
MONTAGUE	3	2	34	32	2	334	296	38	
MOTLEY	3	0	0	0	0	0	0	0	
NACOGDOCHES	3	13	170	160	10	3,811	3,524	287	
NAVARRO	3	96	1,532	1,451	86	15,917	13,998	1,919	
NOLAN	3	0	0	0	0	0	0	0	
PALO PINTO	3	7	113	107	7	1,301	1,148	152	
PECOS	3	7	111	105	7	1,129	991	137	
PRESDIO	3	7	111	105	7	1,129	991	137	
RAINS	3	2	34	32	2	332	295	38	
REGAN	3	0	0	0	0	0	0	0	
REAL	2	0	0	0	0	0	0	0	
RED RIVER	3	9	132	124	8	2,852	2,647	205	
REEVES	3	3	48	46	3	547	481	66	
REFUGIO	2	4	54	51	3	928	864	64	
ROBERTSON	2	75	986	932	57	17,528	16,339	1,189	
RUNNELS	3	2	32	30	2	322	283	39	
SAN SABA	3	2	32	30	2	288	255	33	
SCHLEICHER	3	2	32	30	2	322	283	39	
SCURRY	3	6	84	79	5	3,153	2,767	389	
SHACKELFORD	3	0	0	0	0	0	0	0	
SOMERVELL	3	9	153	143	11	1,502	1,333	169	
STARR	2	6	83	78	5	909	852	57	
STEPHENS	3	2	32	31	2	372	328	44	
STERLING	3	0	0	0	0	0	0	0	
STONEWALL	3	0	0	0	0	0	0	0	
SUTTON	3	10	159	150	9	1,612	1,416	196	
TAYLOR	3	299	4,825	4,564	280	55,588	49,046	6,513	
TERRELL	3	0	0	0	0	0	0	0	
THROCKMORTON	3	0	0	0	0	0	0	0	
TITUS	3	20	293	276	17	6,339	5,883	455	
TOM GREEN	3	236	3,754	3,548	224	38,050	33,426	4,623	
UPTON	3	1	16	15	1	182	160	22	
UVALDE	2	20	306	289	18	2,295	2,048	246	
VAL VERDE	2	79	1,208	1,143	70	9,064	8,092	972	
VAN ZANDT	3	17	289	270	20	3,328	2,807	319	
WARD	3	40	644	608	38	7,292	6,408	884	
WASHINGTON	2	51	670	634	39	11,919	11,111	809	
WEBB	2	1,032	15,517	14,774	795	96,455	87,180	9,275	
WHARTON	2	69	927	874	56	16,009	14,898	1,112	
WCHITA	3	72	1,262	1,187	80	15,740	13,832	1,908	
WLBARGER	3	2	35	33	2	437	384	53	
WILLACY	2	54	750	705	48	8,180	7,668	512	
WINKLER	3	0	0	0	0	0	0	0	
WHEE	3	80	1,361	1,272	95	13,299	11,795	1,503	
YOUNG	3	12	194	183	11	2,230	1,968	261	
ZAPATA	2	0	0	0	0	0	0	0	
ZAVALA	2	5	75	72	4	467	422	45	
<b>TOTAL</b>		<b>102,067</b>			<b>96,899</b>			<b>1,704,364</b>	

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

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

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

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



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

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

Table 10: 2015 Totalized Annual Electricity Savings by CM Zone from New Single-family Residences

CM Zone	Total Electricity Savings by CM Zone (MWh) 2015-TRY 2008
<b>Houston (H)</b>	30,516
<b>North (N)</b>	28,523
<b>West (W)</b>	2,033
<b>South (S)</b>	16,655
<b>Total</b>	77,727

Table 11: 2015 Annual NOx Reductions from New Single-family Residences Using 2010 eGRID

Area	County	H	NOx Reductions (lbs)	N	NOx Reductions (lbs)	W	NOx Reductions (lbs/year)	S	NOx Reductions (lbs)	Total Nox Reductions (lbs)	Total Nox Reductions (Tons)	
Houston-Galveston Area	Brazoria	0.0562032	1715.07	0.0000071	0.20	0.0000003	0.00	0.0005265	8.77	1724.05	0.86	
	Chambers	0.0204500	624.04	0.0000026	0.07	0.0000001	0.00	0.0001916	3.19	627.31	0.31	
	Fort Bend	0.0313463	956.55	0.0000040	0.11	0.0000002	0.00	0.0002937	4.89	961.56	0.48	
	Galveston	0.0226620	691.54	0.0000029	0.08	0.0000001	0.00	0.0002123	3.54	695.16	0.35	
	Harris	0.1486911	4537.40	0.0000189	0.54	0.0000009	0.00	0.0013930	23.20	4561.14	2.28	
Dallas/ Fort Worth Area	Collin	0.0012932	39.46	0.0079329	226.27	0.0003832	0.78	0.0000809	1.35	267.86	0.13	
	Dallas	0.0024826	75.76	0.0152295	434.40	0.0007356	1.50	0.0001554	2.59	514.24	0.26	
	Denton	0.0001267	3.87	0.0007770	22.16	0.0000375	0.08	0.0000079	0.13	26.24	0.01	
	Tarrant	0.0004742	14.47	0.0029089	82.97	0.0001405	0.29	0.0000297	0.49	98.22	0.05	
	Ellis	0.0029920	91.30	0.0183544	523.53	0.0008865	1.80	0.0001873	3.12	619.75	0.31	
	Johnson	0.0007256	22.14	0.0044512	126.96	0.0002150	0.44	0.0000454	0.76	150.30	0.08	
	Kaufman	0.0059718	182.23	0.0366343	1044.94	0.0017695	3.60	0.0003738	6.22	1236.99	0.62	
	Parker	0.0000012	0.04	0.0000075	0.22	0.0000004	0.00	0.0000001	0.00	0.25	0.00	
	Henderson	0.0006908	21.08	0.0042376	120.87	0.0002047	0.42	0.0000432	0.72	143.09	0.07	
	Hood	0.0050771	154.93	0.0311454	888.37	0.0015044	3.06	0.0003178	5.29	1051.66	0.53	
	Hunt	0.0088463	269.95	0.0047066	134.25	0.0002273	0.46	0.0652823	1087.28	1491.94	0.75	
San Antonio Area	Bexar	0.0138906	423.88	0.0009368	26.72	0.0000452	0.09	0.1109355	1847.63	2298.33	1.15	
	Gauidalpe	0.0032029	97.74	0.0002160	6.16	0.0000104	0.02	0.0255795	426.03	529.95	0.26	
Austin Area	Bastrop	0.0033782	103.09	0.0002278	6.50	0.0000110	0.02	0.0269798	449.35	558.96	0.28	
	Hays	0.0008331	25.42	0.0000562	1.60	0.0000027	0.01	0.0066537	110.82	137.85	0.07	
	Travis	0.0051785	158.03	0.0003493	9.96	0.0000169	0.03	0.0413577	688.81	856.84	0.43	
Corpus Christi Area	Nueces	0.0128578	392.36	0.0008672	24.73	0.0000419	0.09	0.1026870	1710.25	2127.44	1.06	
	San Patricio	0.0015100	46.08	0.0001018	2.90	0.0000049	0.01	0.0120591	200.84	249.84	0.12	
Victoria Area	Victoria	0.0021192	64.67	0.0001429	4.08	0.0000069	0.01	0.0169244	281.88	350.63	0.18	
	Andrews	0.0000037	0.11	0.0000230	0.66	0.0039003	7.93	0.0000002	0.00	8.70	0.00	
	Bosque	0.0022204	67.76	0.0136212	388.52	0.0006579	1.34	0.0001390	2.31	459.93	0.23	
	Brazos	0.0024089	73.51	0.0112305	320.33	0.0005425	1.10	0.0047829	79.66	474.60	0.24	
	Calhoun	0.0009466	28.89	0.0000638	1.82	0.0000031	0.01	0.0075598	125.91	156.62	0.08	
	Cameron	0.0063536	193.88	0.0004285	12.22	0.0000207	0.04	0.0507425	845.12	1051.27	0.53	
	Cherokee	0.0027392	83.59	0.0168033	479.29	0.0008116	1.65	0.0001714	2.86	567.38	0.28	
	Ector	0.0019215	58.64	0.0006604	18.84	0.0911346	185.31	0.0146527	244.04	506.82	0.25	
	Fannin	0.0000041	0.12	0.0000249	0.71	0.0000012	0.00	0.0000003	0.00	0.84	0.00	
	Fayette	0.0051867	158.28	0.0103217	294.41	0.0004986	1.01	0.0283993	472.99	926.69	0.46	
	Freestone	0.0047643	145.39	0.0292268	833.65	0.0014117	2.87	0.0002982	4.97	986.87	0.49	
	Hidalgo	0.0053716	163.92	0.0003623	10.33	0.0000175	0.04	0.0428994	714.49	888.78	0.44	
	Howard	0.0002411	7.36	0.0007641	21.79	0.1283942	261.08	0.0009490	15.81	306.03	0.15	
	Jack	0.0030783	93.94	0.0188839	538.63	0.0009121	1.85	0.0001927	3.21	637.63	0.32	
	Lamar	0.0040001	122.07	0.0245388	699.93	0.0011853	2.41	0.0002504	4.17	828.58	0.41	
	Other ERCOT counties	Llano	0.0040314	123.02	0.0002719	7.76	0.0000131	0.03	0.0321966	536.24	667.04	0.33
		McLennan	0.0056576	172.65	0.0347066	989.95	0.0016764	3.41	0.0003541	5.90	1171.91	0.59
		Milam	0.0012686	38.71	0.0000856	2.44	0.0000041	0.01	0.0101316	168.74	209.90	0.10
		Mitchell	0.0000311	0.95	0.0001910	5.45	0.0324260	65.93	0.0000019	0.03	72.36	0.04
		Nolan	0.0000293	0.89	0.0001795	5.12	0.0304745	61.97	0.0000018	0.03	68.01	0.03
		Palo Pinto	0.0036129	110.25	0.0221635	632.18	0.0010705	2.18	0.0002261	3.77	748.37	0.37
		Pecos	0.0000020	0.06	0.0000121	0.34	0.0020520	4.17	0.0000001	0.00	4.58	0.00
		Robertson	0.0039506	120.55	0.0055755	159.03	0.0002693	0.55	0.0246170	410.00	690.13	0.35
		Upton	0.0000025	0.08	0.0000156	0.45	0.0026494	5.39	0.0000002	0.00	5.91	0.00
		Ward	0.0001995	6.09	0.0012239	34.91	0.2078335	422.61	0.0000125	0.21	463.81	0.23
		Webb	0.0042017	128.22	0.0002834	8.08	0.0000137	0.03	0.0335565	558.89	695.21	0.35
		Wharton	0.0021095	64.37	0.0001423	4.06	0.0000069	0.01	0.0168474	280.59	349.04	0.17
		Wichita	0.0000121	0.37	0.0000743	2.12	0.0126190	25.66	0.0000008	0.01	28.16	0.01
		Wilbarger	0.0179710	548.40	0.1102430	3144.51	0.0053249	10.83	0.0011247	18.73	3722.47	1.86
		Wise	0.0010202	31.13	0.0062583	178.51	0.0003023	0.61	0.0000638	1.06	211.32	0.11
		Young	0.0071054	216.83	0.0435880	1243.28	0.0021054	4.28	0.0004447	7.41	1471.79	0.74
		<b>Total</b>		<b>0.4414501</b>	<b>13471.11</b>	<b>0.4812863</b>	<b>13727.95</b>	<b>0.5345786</b>	<b>1087.01</b>	<b>0.6829349</b>	<b>11374.30</b>	<b>39660.37</b>
	<b>Energy Savings by PCA (MWh)</b>											
		30,516		28,523		2,033		16,655				

## 4.2 2015 Results for New Multi-family Residential Construction

This section provides the potential electricity and natural gas savings and the associated NO<sub>x</sub> emissions reductions in 2015 using the 2008 base year which implemented the 2006 IECC for new multi-family residences in the 36 non-attainment and affected counties as well as other counties in the ERCOT region<sup>24</sup>. To calculate the NO<sub>x</sub> emissions reductions, the following procedures were adopted. First, new construction activity was determined by county. To accomplish this, the number of 2015 building permits per county was obtained from the real estate center at Texas A&M University (REC 2016). Next, energy savings attributable to the 2006 IECC were calculated using the Laboratory's code-traceable, DOE-2.1e simulation, which was developed for the TERP. For the savings calculation, the 2014 HIRL's survey data<sup>25</sup> were used to determine the appropriate construction data corresponding to housing types. Then, the NO<sub>x</sub> reductions potential from the electricity and natural gas savings in each county was calculated using the US EPA's 2010 eGRID database<sup>26</sup>.

In Table 12<sup>27</sup>, the 2015 new multi-family and 2006 IECC code-compliant building characteristics are shown for each county. The 2006 IECC code-compliant characteristics are the minimum building code characteristics required for each county for multi-family residences (i.e., Type A.2). In Table 12, the rows are first sorted by the US EPA's non-attainment, affected designation, and other ERCOT counties, alphabetically. Next, in the fourth column, the HIRL's survey classification is listed. The fifth through eighth columns show the HIRL's survey data including: average glazing U-value, Solar Heat Gain Coefficient (SHGC), roof insulation, and wall insulation, respectively. In addition, the ninth through twelfth columns show the 2006 IECC minimum requirements for glazing U-value, SHGC, roof insulation, and wall insulation.

All the houses were assumed to have air conditioner efficiency equal to a SEER of 13 and furnace efficiency (AFUE) of 0.80, and domestic water heater efficiency of 0.78 for a natural gas type and 1 for an electric type. The values shown in Table 12 represent the only changes that were made to the simulations to obtain the savings calculations. All other variables in the simulations remained the same for the 2015 new multi-family and the 2006 IECC code-compliant simulations. In cases where the 2015 new multi-family values were more efficient than the 2006 IECC requirements, the 2015 new multi-family values were used in 2015 new multi-family simulations. Otherwise, the 2006 IECC values were used in both simulations.

In Table 13, the code-traceable simulation results for multi-family residences are shown for each county. In a similar fashion to Table 12, Table 13 is first divided into the US EPA's non-attainment and affected classifications, followed by an alphabetical list of other ERCOT counties. In the third column, the 2006 IECC climate zone is listed followed by the number of new projected housing units<sup>28</sup> in the fourth column. In the fifth column, the total simulated energy use is listed if all new Construction had been built to pre-code specifications. In the sixth column, the total county-wide energy use for code-compliant Construction is shown. The values in the fifth and sixth columns come from the associated 144 simulation runs for each county, which were then distributed according to the HIRL's survey data to account for 1, 2 or 3 story, and 3 different fuel options (i.e., central air conditioning with electric resistance heating, heat pump heating, or a natural gas-fired furnace). In the seventh column, the total annual electricity savings are shown for each county. A 7% transmission and distribution loss is used, which represents a fixed 1.07 multiplier for the electricity use. In the eighth and ninth columns, the total annual pre-code and code-compliant natural gas use is shown for those residences that had natural gas-fired furnaces and domestic water heaters. Finally, in the tenth column, the total annual natural gas savings are shown for each county.

The annual electricity savings from

Table 13 are assigned to CM Zones<sup>29</sup> provider(s) in a similar fashion to the single-family residential assignments. The total electricity savings for each CM Zone, as shown in Table 14, are then entered into the bottom row of Table

<sup>24</sup> The three new counties added in the 2003 Legislative session (i.e., Henderson, Hood, and Hunt) were included in the ERCOT region.

<sup>25</sup> For the 2014 and 2015 report, the 2014 HIRL data (previously, NAHB data) were used. The NAHB Research Center announced that it has changed its name to Home Innovation Research Labs (HIRL). See more at: <http://www.homeinnovation.com>

<sup>26</sup> This analysis assumes transmission and distribution losses of 7%. Counties were assigned to utility service districts as indicated.

<sup>27</sup> Hardin, Jefferson, and Orange Counties were removed from Table 12 and Table 13 because since 2012 they are not in the category of

"Nonattainment County" based on [<http://www.tceq.texas.gov/airquality/sip/bpa/bpa-status>], and these counties do not belong to ERCOT region.

<sup>28</sup> The number of the new housing units in 2015 were obtained from the Real Estate Center at Texas A&M University.

<sup>29</sup> ERCOT region has employed the Congestion Management (CM) since 2010, and it is currently divided into four zones: Houston (H), North (N), South (S), and West (W).

15, the 2010 US EPA's eGRID database for Texas. Next, the county's NO<sub>x</sub> reductions (lbs) are calculated using the assigned 2010 eGrid proportions (lbs-NO<sub>x</sub>/MWh) to each CM zone in the county. The calculated NO<sub>x</sub> reductions are presented in the columns adjacent to the corresponding CM Zone columns. By adding the NO<sub>x</sub> reductions values in each row, then, the total of the NO<sub>x</sub> reductions per county (lbs and Tons) is calculated. Counties that do not show NO<sub>x</sub> reductions represent counties that do not have power plants in eGRID's database.

Table 12: 2015 and 2006 IECC Code-compliant Building Characteristics Used in the DOE-2 Simulations for New Multi-family Residences

	County	Climate Zone	Division East or West	2015 Average			2006 IECC					
				Glazing U-value (Btu-in <sup>2</sup> -F)	SHGC	Roof Insulation (in-R <sup>2</sup> /Rtu)	Wall Insulation (in-R <sup>2</sup> -F/Rtu)	Glazing U-value (Btu-in <sup>2</sup> -F)	SHGC	Roof Insulation (in-R <sup>2</sup> -F/Rtu)	Wall Insulation (in-R <sup>2</sup> -F/Rtu)	
Non-attainment	BRAZORIA	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	CHAMBERS	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	COLLIN	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	DALLAS	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	DENTON	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	EL PASO	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	ELLIS	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	FORT BEND	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	GALVESTON	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	HARRIS	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	JOHNSON	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	KAUFMAN	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	LIBERTY	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	MONTGOMERY	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	PARKEE	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	ROCKWALL	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	TARRANT	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	WALLER	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	WISE	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	Affected	HASTROP	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
		HENRI	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
		CALDWELL	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
		COMAL	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
		GREGG	3	East Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
		GUADALUPE	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
		HARRISON	2	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
		HAYS	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
		NUCKES	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
RUSK		3	East Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
SAN PATRICK		2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
SMITH		3	East Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
TRAVIS		2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
UPSHUR		3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
VICTORIA		2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
WILLIAMSON		2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
WILSON		2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
ERCOT		ANDERSON	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
		ANDREWS	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
		ANGELINA	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
		ARANSAS	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
		ARCHER	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
		ATASCOSA	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
		AUSTIN	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
		BANDERA	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
		BASTROP	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
		BATLOR	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
		BECK	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
	BELL	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	BELAR	2	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	BLANCK	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	BORDEN	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	BOSQUE	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	BRAZORIA	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	BRAZOS	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	BREWSTER	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	BRIDGECRE	4	West Texas	0.39	0.53	29.81	14.86	0.4	NR	38	13	
	BROOKS	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	BROWN	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	BURLESON	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	BURNETT	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	CALDWELL	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	CALHOUN	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	CALLAHAN	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	CAMERON	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	CHAMBERS	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	CHESTER	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	CHILDRESS	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	CLAY	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	COKE	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	COLLEMAN	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	COLLIN	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	COLORADO	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	COMAL	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	COMANCHE	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	CONCHO	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	COOKE	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	CORVELL	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13	
	COTTLE	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	CRANE	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	CROCKETT	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	CROSBY	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	CULBERSON	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	DALLAS	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
	DANWORTH	2	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13	
DEWITT	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13		
DELTA	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13		
DENTON	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13		
DICKENS	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13		
DIMMIT	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13		
DUVAL	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13		
EASTLAND	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13		
ECTOR	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13		
EDWARDS	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13		
ELLIS	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13		
ERATH	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13		
FALLS	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13		
FANNIN	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13		
FAYETTE	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13		
FENDER	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13		
FOARD	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13		
FORT BEND	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13		
FRANKLIN	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13		
FREESTONE	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13		

Table 12: 2015 and 2006 IECC Code-compliant Building Characteristics Used in the DOE-2 Simulations for New Multi-family Residences (Continued)

County	Climate Zone	Division East or West	2015 Average				2006 IECC			
			Chasing U-value (Btu/hr-ft <sup>2</sup> -F)	SHGC	Roof Insulation (R-ft <sup>2</sup> -F/Btu)	Wall Insulation (R-ft <sup>2</sup> -F/Btu)	Chasing U-value (Btu/hr-ft <sup>2</sup> -F)	SHGC	Roof Insulation (R-ft <sup>2</sup> -F/Btu)	Wall Insulation (R-ft <sup>2</sup> -F/Btu)
FRIO	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
GALVESTON	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
GILLESPIE	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
GLASSOCK	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
GOLIAD	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
GONZALES	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
GRAYSON	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
GRIMES	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
GUADALUPE	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
HALL	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
HAMILTON	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
HARDENMAN	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
HARRIS	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
HASKELL	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
HASKIN	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
HENDERSON	3	East Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
HIDALGO	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
HILL	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
HOGG	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
HOPKINS	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
HOUSTON	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
HOWARD	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
HUIDSPETH	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
HUNT	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
IRION	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
JACK	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
JACKSON	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
JEFF DAVIS	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
JIM HOGG	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
JIM WELLS	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
JOHNSON	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
JONES	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
JUAREZ	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
KAUFMAN	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
KENDALL	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
KENEDY	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
KENT	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
KERR	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
KIMBLE	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
KINN	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
KINNEY	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
KLEBERG	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
KNOX	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
KOSSALE	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
LAMAR	3	East Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
LAMPASAS	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
LAVACA	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
LEE	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
LEON	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
LIBERTY	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
LIVE OAK	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
LIVING	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
LIVING	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
MADISON	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
MARTIN	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
MASON	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
MATAGORDA	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
MAVERICK	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
MCCULLOUGH	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
MCLENNAN	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
MCMLLEN	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
MEHNER	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
MENARD	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
MIDLAND	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
MILAM	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
MILBURN	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
MITCHELL	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
MONTAGUE	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
MONTGOMERY	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
MOTLEY	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
NACOGDOCHES	3	East Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
NAVARRO	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
NOLAN	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
NUECES	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
PALO PINTO	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
PARKER	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
PARKS	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
PRESIDIO	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
RAINS	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
REGAN	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
REGG	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
RED RIVER	3	East Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
REEVES	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
REFUGIO	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
ROBERTSON	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
ROCKWALL	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
ROSNELLE	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
RUSK	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
SAN PATRICK	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
SAN SABA	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
SCHLEICHER	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
SCURRY	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
SHACKELFORD	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
SMITH	3	East Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
SOHMERVELL	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
STARR	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
STEPHENS	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
STERLING	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
STONEWALL	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
SUTTON	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
TARRANT	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
TAYLOR	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
TERRILL	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
THROCKMORTON	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
TITUS	3	East Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
TOM GREEN	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
TRAVIS	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
UPTON	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
UVALDE	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
VAL VERDE	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
VAN LANDUT	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
VICTORIA	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
WALLER	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
WARD	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
WASHINGTON	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
WEBB	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
WEBSTER	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
WICHITA	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
WILBARGER	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
WILLACY	2	East Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
WILLAMSON	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
WILSON	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
WINKLER	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
WISE	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
WISDOM	3	West Texas	0.39	0.53	29.81	14.86	0.65	0.4	30	13
ZAPATA	2	West Texas	0.39	0.53	29.81	14.86	0.75	0.4	30	13
ZAVALA	2	West Texas	0.39	0.53	29.81	14.86				

Table 13: 2015 Annual Electricity Savings from New Multi-family Residences

2015 Summary TRY 2008										
	County	Climate Zone	No. of Projected Units (2015)	Precode Total Annual Elec. Use (MWh/yr)	Code-compliant Total Annual Elec. Use (MWh/yr)	Total Annual Elec. Savings (MWh/yr) w/ 7% of T&D Loss	Precode Total NG Use (Therm/yr)	Code-compliant Total NG Use (Therm/yr)	Total Annual NG Savings (Therm/yr)	
Nonattainment County	BRAZORIA	2	390	16,886	16,338	586.32	90,593	90,647	-54.07	
	CHAMBERS	2	0	0	0	0.00	0	0	0.00	
	COLLIN	2	6,259	306,027	290,358	16,765.28	1,997,554	1,848,117	149,436.94	
	DALLAS	2	16,892	825,031	782,944	45,033.58	5,401,553	4,998,033	403,519.81	
	DENTON	2	1,293	63,220	59,983	3,463.41	412,660	381,789	30,871.06	
	EL PASO	3	1,973	87,975	83,830	4,434.99	656,380	597,314	59,065.94	
	ELLIS	3	10	488	463	26.66	3,198	2,959	238.88	
	FORT BEND	2	182	7,881	7,625	273.91	42,248	42,302	-54.28	
	GALVESTON	2	75	3,247	3,142	112.75	17,422	17,432	-10.40	
	HARRIS	2	17,254	747,144	722,875	25,967.64	4,005,162	4,010,307	-5,145.40	
	JOHNSON	3	189	9,231	8,760	503.87	60,437	55,922	4,514.87	
	KAUFMAN	2	313	15,304	14,520	838.40	99,894	92,421	7,473.04	
	LIBERTY	3	0	0	0	0.00	0	0	0.00	
	MONTGOMERY	3	2,054	88,944	86,055	3,091.31	476,794	477,406	-612.53	
	PARKER	2	12	587	557	32.14	3,830	3,543	286.51	
	ROCKWALL	2	0	0	0	0.00	0	0	0.00	
	TARRANT	3	3,134	153,069	145,261	8,355.15	1,002,159	927,293	74,865.68	
	WALLER	2	160	6,928	6,703	240.80	37,141	37,188	-47.71	
	WISE	3	2	98	93	5.36	638	591	47.75	
	Affected County	BASTROP	3	14	642	611	33.39	3,894	3,608	286.45
		BEXAR	3	1,110	49,584	47,497	2,232.96	270,634	255,173	15,461.62
		CALDWELL	3	0	0	0	0.00	0	0	0.00
		COMAL	3	73	3,216	3,081	144.84	17,553	16,552	1,002.92
		GREGG	2	23	1,107	1,098	41.11	6,766	6,771	-4.91
GUADALUPE		3	116	5,182	4,964	233.35	28,283	26,667	1,615.81	
HARRISON		3	20	960	928	35.16	5,915	5,919	-4.27	
HAYS		3	549	25,196	23,971	1,310.66	152,703	141,184	11,518.99	
NUECES		2	12	528	508	21.04	2,505	2,506	-0.25	
RUSK		2	0	0	0	0.00	0	0	0.00	
SAN PATRICIO		3	532	23,395	22,523	932.65	111,066	111,078	-11.13	
SMITH		3	50	2,400	2,318	87.52	14,804	14,813	-8.59	
TRAVIS		3	8,172	375,051	356,818	19,509.56	2,273,015	2,101,558	171,457.02	
UPSHUR		3	4	196	186	10.72	1,279	1,184	95.12	
VICTORIA		2	0	0	0	0.00	0	0	0.00	
WILLIAMSON		2	1,778	81,601	77,634	4,244.74	494,545	457,241	37,304.28	
WILSON		2	48	2,144	2,054	96.56	11,703	11,035	668.61	
ERCOT		ANDERSON	2	0	0	0	0.00	0	0	0.00
		ANDREWS	3	0	0	0	0.00	0	0	0.00
		ANGELINA	2	0	0	0	0.00	0	0	0.00
		ARANSAS	2	2	88	85	3.51	418	418	-0.04
		ARCHER	3	0	0	0	0.00	0	0	0.00
		ATASCOSA	2	0	0	0	0.00	0	0	0.00
		AUSTIN	2	0	0	0	0.00	0	0	0.00
	BANDERA	2	0	0	0	0.00	0	0	0.00	
	BAYLOR	3	0	0	0	0.00	0	0	0.00	
	BEE	2	0	0	0	0.00	0	0	0.00	
	BELL	2	362	16,987	16,137	909.21	114,830	105,723	9,107.99	
	BLANCO	3	0	0	0	0.00	0	0	0.00	
	BORDEN	3	0	0	0	0.00	0	0	0.00	
	BOSQUE	2	4	188	178	10.05	1,269	1,168	100.64	
	BRAZOS	2	485	21,002	20,320	729.94	112,583	112,727	-144.63	
	BREWSTER	3	7	333	315	18.85	2,229	2,049	179.43	
	BRISCOE	4	0	0	0	0.00	0	0	0.00	
	BROOKS	2	0	0	0	0.00	0	0	0.00	
	BROWN	3	60	2,815	2,675	150.70	19,033	17,523	1,509.55	
	BURLESON	2	6	260	251	9.03	1,393	1,395	-1.79	
	BURNET	3	2	92	87	4.77	556	514	41.96	
	CALLHOUN	2	12	526	508	19.23	2,736	2,731	5.64	
	CALLAHAN	3	0	0	0	0.00	0	0	0.00	
	CAMERON	2	156	6,915	6,645	289.36	29,236	29,247	-11.77	
	CERROKES	2	0	0	0	0.00	0	0	0.00	
	CHELDRESS	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	2	0	0	0	0.00	0	0	0.00	
	COLORADO	2	0	0	0	0.00	0	0	0.00	
	COMANCHE	3	0	0	0	0.00	0	0	0.00	
	CONCHO	3	0	0	0	0.00	0	0	0.00	
	COOKE	3	0	0	0	0.00	0	0	0.00	
	CORYELL	2	108	5,068	4,814	271.25	34,259	31,542	2,717.18	
	COTTLE	3	0	0	0	0.00	0	0	0.00	
	CRANE	3	0	0	0	0.00	0	0	0.00	
	CROCKETT	3	0	0	0	0.00	0	0	0.00	
	CROSBY	3	0	0	0	0.00	0	0	0.00	
	CULBERSON	3	0	0	0	0.00	0	0	0.00	
	DAWSON	3	0	0	0	0.00	0	0	0.00	
	DEWITT	2	0	0	0	0.00	0	0	0.00	
	DELTA	3	0	0	0	0.00	0	0	0.00	
	DICKENS	3	0	0	0	0.00	0	0	0.00	
	DIMMIT	2	0	0	0	0.00	0	0	0.00	
	DUVAL	2	0	0	0	0.00	0	0	0.00	
	EASTLAND	3	0	0	0	0.00	0	0	0.00	
	ECTOR	3	144	6,920	6,541	405.38	49,497	45,346	4,150.78	
	EDWARDS	2	0	0	0	0.00	0	0	0.00	
	ERATH	3	188	9,019	8,530	522.90	65,385	60,022	5,363.10	
	FALLS	2	0	0	0	0.00	0	0	0.00	
	FANNIN	3	10	489	464	26.77	3,192	2,958	234.06	
	FAYETTE	2	0	0	0	0.00	0	0	0.00	
FISHER	3	0	0	0	0.00	0	0	0.00		
FOARD	3	0	0	0	0.00	0	0	0.00		
FRANKLIN	3	0	0	0	0.00	0	0	0.00		
FREESTONE	2	0	0	0	0.00	0	0	0.00		
FRIO	2	2	89	86	4.02	488	460	28.33		

Table 13: 2015 Annual Electricity Savings from New Multi-family Residences (Continued)

2015 Summary TRY 2008								
County	Climate Zone	No. of Projected Units (2015)	Precode Total Annual Elec. Use (MWh/yr)	Code-compliant Total Annual Elec. Use (MWh/yr)	Total Annual Elec. Savings (MWh/yr) w/ 7% of T&D Loss	Precode Total NG Use (Therm/yr)	Code-compliant Total NG Use (Therm/yr)	Total Annual NG Savings (Therm/yr)
GILLESPIE	3	0	0	0	0.00	0	0	0.00
GLASSCOCK	3	0	0	0	0.00	0	0	0.00
GOLIAD	2	0	0	0	0.00	0	0	0.00
GONZALES	2	0	0	0	0.00	0	0	0.00
GRAVSON	3	18	880	835	48.18	5,746	5,325	-421.30
GRIMES	2	0	0	0	0.00	0	0	0.00
HALL	3	0	0	0	0.00	0	0	0.00
HAMILTON	3	0	0	0	0.00	0	0	0.00
HARDEMAN	3	0	0	0	0.00	0	0	0.00
HASKELL	3	0	0	0	0.00	0	0	0.00
HENDERSON	2	0	0	0	0.00	0	0	0.00
HIDALGO	2	1,377	61,038	58,651	2,554.15	258,062	258,165	-103.87
HILL	2	0	0	0	0.00	0	0	0.00
HOOD	3	4	195	185	10.66	1,279	1,184	-95.55
HOPKINS	3	6	293	278	16.07	1,915	1,772	-143.25
HOUTON	2	0	0	0	0.00	0	0	0.00
HOWARD	3	0	0	0	0.00	0	0	0.00
HUDSPETH	3	0	0	0	0.00	0	0	0.00
HUNT	2	0	0	0	0.00	0	0	0.00
IBRON	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	2	0	0	0	0.00	0	0	0.00
KENNY	2	0	0	0	0.00	0	0	0.00
KENT	3	0	0	0	0.00	0	0	0.00
KERR	3	0	0	0	0.00	0	0	0.00
KIMBLE	3	0	0	0	0.00	0	0	0.00
KING	3	0	0	0	0.00	0	0	0.00
KINNEY	2	0	0	0	0.00	0	0	0.00
KLEBERG	2	11	484	466	19.15	2,296	2,297	-0.23
KNOX	3	0	0	0	0.00	0	0	0.00
LA SALLE	2	11	484	466	19.28	2,296	2,297	-0.23
LAMAR	3	20	978	928	53.57	6,383	5,905	-477.51
LAMPASAS	3	0	0	0	0.00	0	0	0.00
LAVACA	2	0	0	0	0.00	0	0	0.00
LEE	2	0	0	0	0.00	0	0	0.00
LEON	2	0	0	0	0.00	0	0	0.00
LIMESTONE	2	0	0	0	0.00	0	0	0.00
LIVE OAK	2	0	0	0	0.00	0	0	0.00
LLANO	3	0	0	0	0.00	0	0	0.00
LOVING	3	0	0	0	0.00	0	0	0.00
MADISON	2	0	0	0	0.00	0	0	0.00
MARTIN	3	0	0	0	0.00	0	0	0.00
MASON	3	0	0	0	0.00	0	0	0.00
MATAGORDA	2	0	0	0	0.00	0	0	0.00
MAVERICK	2	16	701	677	29.05	3,340	3,341	-0.33
MCCULLOCH	3	0	0	0	0.00	0	0	0.00
MCCLENNAN	2	915	42,936	40,788	2,298.13	290,347	267,227	-23,020.58
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	264	12,686	11,991	743.20	90,743	83,135	-7,609.76
MILAM	2	10	433	419	15.05	2,321	2,324	-2.98
MILLS	3	0	0	0	0.00	0	0	0.00
MITCHELL	3	0	0	0	0.00	0	0	0.00
MONTAGUE	3	0	0	0	0.00	0	0	0.00
MOTLEY	3	0	0	0	0.00	0	0	0.00
NACOGDOCHES	3	8	352	340	12.06	2,099	2,101	-2.39
NAVARRO	3	2	94	89	5.02	634	584	-50.32
NOLAN	3	0	0	0	0.00	0	0	0.00
PALO PINTO	3	0	0	0	0.00	0	0	0.00
PREVOS	3	0	0	0	0.00	0	0	0.00
PRESDID	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
REYES	3	0	0	0	0.00	0	0	0.00
REFUGIO	2	0	0	0	0.00	0	0	0.00
ROBERTSON	2	12	520	503	18.06	2,786	2,789	-3.58
RUNNELS	3	0	0	0	0.00	0	0	0.00
SAN SABA	3	0	0	0	0.00	0	0	0.00
SCHLEICHER	3	0	0	0	0.00	0	0	0.00
SCURRY	3	0	0	0	0.00	0	0	0.00
SHACKELFORD	3	0	0	0	0.00	0	0	0.00
SOMERVELL	3	0	0	0	0.00	0	0	0.00
STARR	2	3	133	128	5.56	562	562	-0.23
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	232	11,130	10,527	645.28	80,688	74,070	-6,618.29
TERRELL	3	0	0	0	0.00	0	0	0.00
TERROCKMORTON	3	0	0	0	0.00	0	0	0.00
TITUS	3	122	5,963	5,660	328.79	38,936	36,023	-2,912.81
TOM GREEN	3	0	0	0	0.00	0	0	0.00
UPTON	3	0	0	0	0.00	0	0	0.00
UVALDE	2	8	357	342	16.09	1,951	1,839	-111.44
VAL VERDE	2	0	0	0	0.00	0	0	0.00
VAN ZANDT	3	0	0	0	0.00	0	0	0.00
WARD	3	0	0	0	0.00	0	0	0.00
WASHINGTON	2	80	3,464	3,352	120.40	18,570	18,594	-23.86
WEBB	2	816	35,884	34,547	1,430.53	170,357	170,375	-17.07
WHARTON	2	2	88	85	3.21	456	455	-0.94
WICHITA	3	0	0	0	0.00	0	0	0.00
WILBARGER	3	0	0	0	0.00	0	0	0.00
WILLACY	2	80	3,546	3,407	148.39	14,993	14,999	-6.03
WINKLER	3	0	0	0	0.00	0	0	0.00
WISE	3	2	98	93	5.36	638	591	-47.75
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
<b>TOTAL</b>		<b>68,259</b>			<b>150,583</b>			<b>1,028,406</b>



Table 14: 2015 Totalized Annual Electricity Savings by CM Zone from New Multi-family Residences

<b>CM Zone</b>	<b>Total Electricity Savings by CM Zone (MWh) 2015-TRY 2008</b>
<b>Houston (H)</b>	40,277
<b>North (N)</b>	64,136
<b>West (W)</b>	3,472
<b>South (S)</b>	26,221
<b>Total</b>	134,106

Table 15: 2015 Annual NOx Reductions from New Multi-family Residences Using 2010 eGRID

Area	County	H	NOx Reductions (lbs)	N	NOx Reductions (lbs)	W	NOx Reductions (lbs/year)	S	NOx Reductions (lbs)	Total NOx Reductions (lbs)	Total NOx Reductions (Tons)
Houston-Galveston Area	Brazoria	0.0562032	2263.69	0.0000071	0.46	0.0000003	0.00	0.0005265	13.81	2277.96	1.14
	Chambers	0.0204500	823.66	0.0000026	0.17	0.0000001	0.00	0.0001916	5.02	828.85	0.41
	Fort Bend	0.0313463	1262.53	0.0000040	0.26	0.0000002	0.00	0.0002937	7.70	1270.49	0.64
	Galveston	0.0226620	912.75	0.0000029	0.18	0.0000001	0.00	0.0002123	5.57	918.51	0.46
	Harris	0.1486911	5988.82	0.0000189	1.21	0.0000009	0.00	0.0013930	36.53	6026.56	3.01
Dallas/ Fort Worth Area	Collin	0.0012932	52.08	0.0079329	508.78	0.0003832	1.33	0.0000809	2.12	564.32	0.28
	Dallas	0.0024826	99.99	0.0152295	976.76	0.0007356	2.55	0.0001554	4.07	1083.38	0.54
	Denton	0.0001267	5.10	0.0007770	49.83	0.0000375	0.13	0.0000079	0.21	55.27	0.03
	Tarrant	0.0004742	19.10	0.0029089	186.56	0.0001405	0.49	0.0000297	0.78	206.93	0.10
	Ellis	0.0029920	120.51	0.0183544	1177.17	0.0008865	3.08	0.0001873	4.91	1305.67	0.65
	Johnson	0.0007256	29.22	0.0044512	285.48	0.0002150	0.75	0.0000454	1.19	316.64	0.16
	Kaufman	0.0059718	240.53	0.0366343	2349.57	0.0017695	6.14	0.0003738	9.80	2606.04	1.30
	Parker	0.0000012	0.05	0.0000075	0.48	0.0000004	0.00	0.0000001	0.00	0.54	0.00
	Henderson	0.0006908	27.82	0.0042376	271.78	0.0002047	0.71	0.0000432	1.13	301.45	0.15
	Hood	0.00050771	204.49	0.0311454	1997.53	0.0015044	5.22	0.0003178	8.33	2215.58	1.11
	Hunt	0.0088463	356.30	0.0047066	301.86	0.0002273	0.79	0.0052823	1711.79	2370.75	1.19
San Antonio Area	Bexar	0.0138906	559.47	0.0009368	60.08	0.0000452	0.16	0.1109355	2908.88	3528.60	1.76
	Guadalupe	0.0032029	129.00	0.0002160	13.85	0.0000104	0.04	0.0255795	670.73	813.62	0.41
Austin Area	Bastrop	0.0033782	136.06	0.0002278	14.61	0.0000110	0.04	0.0269798	707.45	858.16	0.43
	Hays	0.0008331	33.56	0.0000562	3.60	0.0000027	0.01	0.0066537	174.47	211.64	0.11
	Travis	0.0051785	208.58	0.0003493	22.40	0.0000169	0.06	0.0413577	1084.46	1315.49	0.66
Corpus Christi Area	Nueces	0.0128578	517.87	0.0008672	55.62	0.0000419	0.15	0.1026870	2692.60	3266.23	1.63
	San Patricio	0.0015100	60.82	0.0001018	6.53	0.0000049	0.02	0.0120591	316.21	383.57	0.19
Victoria Area	Victoria	0.0021192	85.35	0.0001429	9.17	0.0000069	0.02	0.0169244	443.78	538.32	0.27
Other ERCOT counties	Andrews	0.0000037	0.15	0.0000230	1.47	0.0039003	13.54	0.0000002	0.01	15.17	0.01
	Bosque	0.0022204	89.43	0.0136212	873.60	0.0006579	2.28	0.0001390	3.64	968.96	0.48
	Brazos	0.0024089	97.02	0.0112305	720.28	0.0005425	1.88	0.0047829	125.41	944.60	0.47
	Calhoun	0.0009466	38.13	0.0000638	4.09	0.0000031	0.01	0.0075598	198.23	240.46	0.12
	Cameron	0.0063536	255.90	0.0004285	27.48	0.0000207	0.07	0.0507425	1330.54	1614.00	0.81
	Cherokee	0.0027392	110.32	0.0168033	1077.69	0.0008116	2.82	0.0001714	4.50	1195.33	0.60
	Ector	0.0019215	77.39	0.0006604	42.35	0.0911346	316.43	0.0146527	384.21	820.39	0.41
	Fannin	0.0000041	0.16	0.0000249	1.60	0.0000012	0.00	0.0000003	0.01	1.77	0.00
	Fayette	0.0051867	208.90	0.0103217	661.99	0.0004986	1.73	0.0283993	744.67	1617.29	0.81
	Freestone	0.0047643	191.89	0.0292268	1874.48	0.0014117	4.90	0.0002982	7.82	2079.10	1.04
	Hidalgo	0.0053716	216.35	0.0003623	23.23	0.0000175	0.06	0.0428994	1124.88	1364.53	0.68
	Howard	0.0002411	9.71	0.0007641	49.00	0.1283942	445.80	0.0009490	24.88	529.40	0.26
	Jack	0.0030783	123.98	0.0188839	1211.13	0.0009121	3.17	0.0001927	5.05	1343.34	0.67
	Lamar	0.0040001	161.11	0.0245388	1573.82	0.0011853	4.12	0.0002504	6.56	1745.61	0.87
	Llano	0.0040314	162.37	0.0002719	17.44	0.0000131	0.05	0.0321966	844.24	1024.10	0.51
	McLennan	0.0056576	227.87	0.0347066	2225.94	0.0016764	5.82	0.0003541	9.28	2468.91	1.23
	Milam	0.0012686	51.10	0.0000856	5.49	0.0000041	0.01	0.0101316	265.66	322.26	0.16
	Mitchell	0.0000311	1.25	0.0001910	12.25	0.0324260	112.59	0.0000019	0.05	126.14	0.06
	Nolan	0.0000293	1.18	0.0001795	11.51	0.0304745	105.81	0.0000018	0.05	118.55	0.06
	Palo Pinto	0.0036129	145.52	0.0221635	1421.48	0.0010705	3.72	0.0002261	5.93	1576.64	0.79
	Pecos	0.0000020	0.08	0.0000121	0.78	0.0020520	7.12	0.0000001	0.00	7.98	0.00
	Robertson	0.0039506	159.12	0.0055755	357.59	0.0002693	0.94	0.0246170	645.49	1163.13	0.58
	Upton	0.0000025	0.10	0.0000156	1.00	0.0026494	9.20	0.0000002	0.00	10.31	0.01
	Ward	0.0001995	8.04	0.0012239	78.50	0.2078335	721.62	0.0000125	0.33	808.48	0.40
	Webb	0.0042017	169.23	0.0002834	18.17	0.0000137	0.05	0.0335565	879.90	1067.35	0.53
	Wharton	0.0021095	84.96	0.0001423	9.12	0.0000069	0.02	0.0168474	441.76	535.87	0.27
	Wichita	0.0000121	0.49	0.0000743	4.77	0.0126190	43.81	0.0000008	0.02	49.09	0.02
	Wilbarger	0.0179710	723.82	0.1102430	7070.52	0.0053249	18.49	0.0011247	29.49	7842.32	3.92
	Wise	0.0010202	41.09	0.0062583	401.38	0.0003023	1.05	0.0000638	1.67	445.19	0.22
	Young	0.0071054	286.18	0.0435880	2795.55	0.0021054	7.31	0.0004447	11.66	3100.71	1.55
<b>Total</b>		<b>0.4414501</b>	<b>17780.25</b>	<b>0.4812863</b>	<b>30867.67</b>	<b>0.5345786</b>	<b>1856.11</b>	<b>0.6829349</b>	<b>17907.50</b>	<b>68411.54</b>	<b>34.21</b>
<b>Energy Savings by PCA (MWh)</b>		40,277		64,136		3,472		26,221			

#### 4.3 2015 Results for New Residential Construction (Single-family and Multi-family)

Table 16 presents the individual and combined annual electricity savings and NO<sub>x</sub> emissions reductions resulted from the new single-family and multi-family Construction in 2015. In addition, Table 16 includes the combined natural gas savings from the new Construction for both single-family and multi-family and the corresponding NO<sub>x</sub> emissions reductions<sup>30</sup>.

The total NO<sub>x</sub> reductions from electricity and natural gas savings from total new single-family and multi-family Construction in 2015 are 66.6 tons NO<sub>x</sub>/year, including 19.83 tons NO<sub>x</sub>/year (29.78 %) from single-family residential electricity savings, 34.21 tons NO<sub>x</sub>/year (51.36 %) from multi-family residential electricity savings, and 12.56 tons NO<sub>x</sub>/year (18.86 %) from natural gas savings from both single-family and multi-family residences. Figure 8 through Figure 11 show the electricity savings and NO<sub>x</sub> reductions tabulated in Table 16. Figure 8 shows the annual electricity savings by county using a stacked bar chart and Figure 9 shows the spatial distribution of the electricity savings by county across the state. Figure 10 shows the annual NO<sub>x</sub> reductions by using a stacked bar chart and Figure 11 shows the spatial distribution of the NO<sub>x</sub> reductions by county across the state.

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

Table 16: 2015 Annual NOx Reductions from New Single-family and Multi-family Residences

County	Electricity Savings and Resultant NOx Reductions (Single Family Houses)		Electricity Savings and Resultant NOx Reductions (Multifamily Houses)		Total Electricity Savings and Resultant NOx Reductions (Single and Multi-Family Houses)		Total Natural Gas Savings and Resultant NOx Reductions (Single and Multi-Family Houses)		Total NOx Reductions
	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual NOx Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual NOx Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual NOx Reductions (Tons)	Total Annual N.G. Savings (Therm/County)	Annual NOx Reductions (Tons)	Annual NOx Reductions (Tons)
HARRIS	12,806.57	2.28	25,967.64	3.01	38,774.20	5.29	259,962.66	1.20	6.49
TARRANT	6,972.60	0.05	8,355.15	0.10	15,327.75	0.15	184,927.72	0.85	1.00
COLLIN	9,403.21	0.13	16,765.28	0.28	26,168.49	0.42	297,466.82	1.37	1.78
DALLAS	5,728.26	0.26	45,033.58	0.54	50,761.84	0.80	493,940.01	2.27	3.07
BEKAR	2,909.03	1.15	2,232.96	1.76	5,141.99	2.91	56,004.61	0.26	3.17
TRAVIS	5,835.11	0.43	19,509.56	0.66	25,344.67	1.09	265,245.41	1.22	2.31
DENTON	7,870.62	0.01	3,463.41	0.03	11,334.04	0.04	154,774.21	0.71	0.75
WILLIAMSON	3,868.40		4,244.74		8,113.13	0.00	99,481.40	0.46	0.46
EL PASO	2,501.45		4,434.99		6,936.44	0.00	118,240.06	0.54	0.54
MONTGOMERY	3,806.51		3,091.31		6,897.82	0.00	78,185.81	0.36	0.36
GALVESTON	1,815.00	0.35	112.75	0.46	1,927.76	0.81	38,609.18	0.18	0.98
BRAZORIA	2,276.40	0.86	586.32	1.14	2,862.73	2.00	48,383.21	0.22	2.22
COMAL	1,474.83		144.84		1,619.67	0.00	21,557.50	0.10	0.10
ROCKWALL	1,248.51		0.00		1,248.51	0.00	19,654.64	0.09	0.09
HAYS	2,144.29	0.07	1,310.66	0.11	3,454.95	0.17	45,984.00	0.21	0.39
NUECES	1,020.03	1.06	21.04	1.63	1,041.06	2.70	14,895.49	0.07	2.77
PORT BEND	6,966.60	0.48	273.91	0.64	7,240.51	1.12	144,160.96	0.66	1.78
ELLIS	1,581.65	0.31	26.66	0.65	1,608.31	0.96	25,205.09	0.12	1.08
JOHNSON	665.08	0.08	503.87	0.16	1,168.95	0.25	15,013.10	0.07	0.20
GUADALUPE	1,057.11	0.26	233.35	0.41	1,290.46	0.67	16,348.64	0.08	0.75
KAUFMAN	316.31	0.62	838.40	1.30	1,154.70	1.92	12,452.47	0.06	1.98
PARKER	457.15	0.00	32.14	0.00	489.29	0.00	7,483.19	0.03	0.03
SMITH	394.70		87.52		482.22	0.00	9,462.56	0.04	0.04
BASTROP	96.61	0.28	33.39	0.43	130.00	0.71	4,103.29	0.02	0.73
CHAMBERS	229.65	0.31	0.00	0.41	229.65	0.73	4,955.08	0.02	0.75
GREGG	196.10		41.11		237.21	0.00	4,637.72	0.02	0.02
SAN PATRICIO	190.46	0.12	932.65	0.19	1,123.11	0.32	2,770.24	0.01	0.33
LIBERTY	234.82		0.00		234.82	0.00	4,930.03	0.02	0.02
VICTORIA	111.10	0.18	0.00	0.27	111.10	0.44	2,191.12	0.01	0.45
CALDWELL	276.60		0.00		276.60	0.00	4,417.34	0.02	0.02
WILSON	42.39		96.56		138.95	0.00	1,259.40	0.01	0.01
WALLER	7.66		240.80		248.46	0.00	110.83	0.00	0.00
UPSHUR	1.99		10.72		12.71	0.00	172.93	0.00	0.00
RUSK	10.25	0.00	0.00	0.00	10.25	0.00	287.09	0.00	0.00
HARRISON	52.02		35.16		87.18	0.00	762.44	0.00	0.00
WISE	95.69	0.11	5.36	0.22	100.85	0.33	1,599.97	0.01	0.32
HOOD	166.87	0.53	10.66	1.11	177.53	1.63	2,729.52	0.01	1.65
HUNT	121.64	0.75	0.00	1.19	121.64	1.93	1,978.26	0.01	1.94
HENDERSON	44.17	0.07	0.00	0.15	44.17	0.22	1,059.87	0.00	0.23
HIDALGO	2,608.63	0.44	2,554.15	0.68	5,162.77	1.13	27,659.05	0.13	1.25
CAMERON	1,005.51	0.53	289.36	0.81	1,294.87	1.33	10,689.61	0.05	1.38
BELL	1,501.94		909.21		2,411.14	0.00	42,693.35	0.20	0.20
WEBB	794.87	0.35	1,430.53	0.53	2,225.41	0.88	9,258.23	0.04	0.92
BRAZOS	866.23	0.24	729.94	0.47	1,596.17	0.71	17,787.14	0.08	0.79
KENDALL	150.36		0.00		150.36	0.00	2,335.42	0.01	0.01
BURNET	314.88		4.77		319.66	0.00	5,103.08	0.02	0.02
GRAYSON	383.99		48.18		432.17	0.00	6,540.11	0.03	0.03
CORYELL	126.95		271.25		398.20	0.00	5,555.98	0.03	0.03
MIDLAND	723.62		743.20		1,466.81	0.00	24,430.49	0.11	0.11
LLANO	78.46	0.33	0.00	0.51	78.46	0.85	1,261.13	0.01	0.85
MAVERICK	60.85		28.05		88.90	0.00	709.69	0.00	0.00
MCMEHLEN	0.00		0.00		0.00	0.00	0.00	0.00	0.00
MRANSAS	149.83		3.51		153.34	0.00	2,187.96	0.01	0.01
WICHITA	79.85	0.01	0.00	0.02	79.85	0.04	1,907.81	0.01	0.05
TAYLOR	279.66		645.28		924.94	0.00	13,130.83	0.06	0.06
TOM GREEN	221.19		0.00		221.19	0.00	4,623.43	0.02	0.02
MCLENNAN	524.78	0.59	2,298.13	1.23	2,822.92	1.82	34,755.60	0.16	1.98
MCCULLOCH	0.00		0.00		0.00	0.00	0.00	0.00	0.00
JIM HOGG	0.00		0.00		0.00	0.00	0.00	0.00	0.00
VAL VERDE	69.77		0.00		69.77	0.00	972.34	0.00	0.00
ECTOR	445.01	0.25	405.38	0.41	850.39	0.66	14,495.20	0.07	0.73
WHARTON	56.37	0.17	3.21	0.27	59.57	0.44	1,112.61	0.01	0.45
KERR	65.04		0.00		65.04	0.00	1,045.41	0.00	0.00
PRESDID	6.56		0.00		6.56	0.00	137.14	0.00	0.00
JIM WELLS	10.16		0.00		10.16	0.00	148.34	0.00	0.00
CALHOUN	56.37	0.08	19.23	0.12	75.60	0.20	1,117.31	0.01	0.20
GILLESPIE	42.33		0.00		42.33	0.00	680.35	0.00	0.00
MAYAGORDA	69.44		0.00		69.44	0.00	1,369.45	0.01	0.01
NAVARRO	85.83		5.02		90.85	0.00	1,969.50	0.01	0.01
ANGELINA	42.59		0.00		42.59	0.00	1,192.52	0.01	0.01
NACOGDOCHES	10.25		12.06		22.32	0.00	284.70	0.00	0.00
FANNIN	13.12	0.00	26.77	0.00	39.88	0.00	443.08	0.00	0.00
ATASCOSA	33.85		0.00		33.85	0.00	537.67	0.00	0.00
WASHINGTON	39.06		120.40		159.46	0.00	784.74	0.00	0.00
LAMAR	17.36	0.41	53.57	0.87	70.93	1.29	932.92	0.00	1.29
VAN ZANDT	20.29		0.00		20.29	0.00	319.43	0.00	0.00
WILLACY	48.09		148.39		196.48	0.00	505.81	0.00	0.00
BROWN	59.00		150.70		209.70	0.00	2,828.99	0.01	0.01
ERATH	28.06		522.90		550.96	0.00	6,016.53	0.03	0.03
AUSTIN	14.55		0.00		14.55	0.00	301.24	0.00	0.00
COOKE	47.70		0.00		47.70	0.00	760.10	0.00	0.00
MEDINA	31.79		0.00		31.79	0.00	443.09	0.00	0.00
TITUS	17.36	0.00	326.79	0.00	344.14	0.00	3,368.22	0.02	0.02
UVALDE	17.66		16.09		33.76	0.00	357.60	0.00	0.00
PAYETTE	6.13	0.46	0.00	0.81	6.13	1.27	126.84	0.00	1.27
CALLAHAN	3.74		0.00		3.74	0.00	87.12	0.00	0.00
HOPKINS	11.94		16.07		28.01	0.00	321.16	0.00	0.00
LAMPASAS	16.09		0.00		16.09	0.00	0.00	0.00	0.00
BLANCO	10.32		0.00		10.32	0.00	165.94	0.00	0.00
FREESTONE	2.68	0.49	0.00	1.04	2.68	1.53	59.97	0.00	1.53
GRIMES	13.02	0.00	0.00	0.00	13.02	0.00	269.53	0.00	0.00
LEE	8.26		0.00		8.26	0.00	131.86	0.00	0.00
SOMERVELL	10.73		0.00		10.73	0.00	169.33	0.00	0.00
ANDREWS	20.92	0.00	0.00	0.01	20.92	0.01	486.28	0.00	0.01
BORDEN	0.00		0.00		0.00	0.00	0.00	0.00	0.00

Non-attainment and Affected Counties

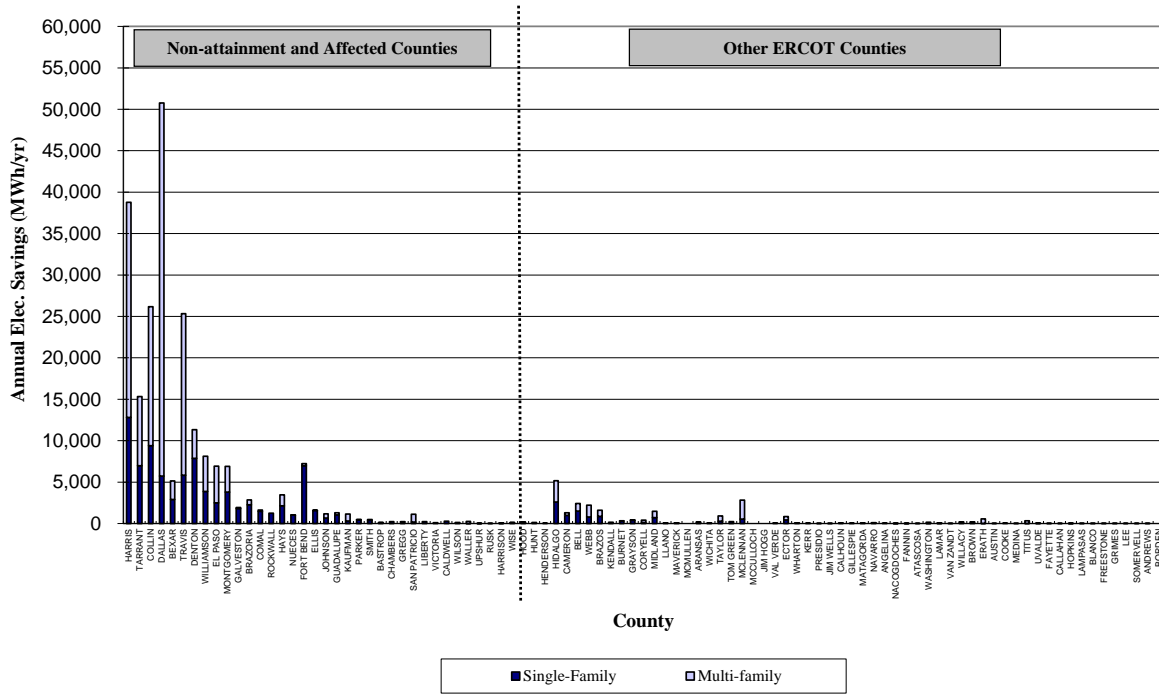
Other ERCOT Counties

Table 16: 2015 Annual NOx Reductions from New Single-family and Multi-family Residences (Continued)

County	Electricity Savings and Resultant NOx Reductions (Single Family Houses)		Electricity Savings and Resultant NOx Reductions (Multifamily Houses)		Total Electricity Savings and Resultant NOx Reductions (Single and Multi-Family Houses)		Total Natural Gas Savings and Resultant NOx Reductions (Single and Multi-Family Houses)		Total NOx Reductions
	Total Annual Electricity Savings per County w/ 7% T&D Loss (MW h/County)	Annual NOx Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MW h/County)	Annual NOx Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MW h/County)	Annual NOx Reductions (Tons)	Total Annual N.G. Savings (Therm/County)	Annual NOx Reductions (Tons)	Annual NOx Reductions (Tons)
CHEROKEE	3.94	0.28	0.00	0.00	3.94	0.88	110.42	0.00	0.88
DIMMIT	4.62	0.00	0.00	0.00	4.62	0.00	53.93	0.00	0.00
FALLS	4.47	0.00	0.00	0.00	4.47	0.00	99.98	0.00	0.00
COLORADO	3.83	0.00	0.00	0.00	3.83	0.00	79.27	0.00	0.00
FRIO	4.72	0.00	4.02	0.00	8.74	0.00	102.35	0.00	0.00
MILAM	2.90	0.10	15.05	0.16	17.95	0.27	46.09	0.00	0.27
JACKSON	10.62	0.00	0.00	0.00	10.62	0.00	209.45	0.00	0.00
ANDERSON	5.52	0.00	0.00	0.00	5.52	0.00	154.59	0.00	0.00
HILL	6.26	0.00	0.00	0.00	6.26	0.00	139.94	0.00	0.00
CYLERBERSON	0.76	0.00	0.00	0.00	0.76	0.00	23.60	0.00	0.00
MASON	3.10	0.00	0.00	0.00	3.10	0.00	49.78	0.00	0.00
PECOS	6.56	0.00	0.00	0.00	6.56	0.01	137.14	0.00	0.01
RAINS	2.39	0.00	0.00	0.00	2.39	0.00	37.58	0.00	0.00
LAVACA	14.89	0.00	0.00	0.00	14.89	0.00	308.91	0.00	0.00
PALO PINTO	6.55	0.37	0.00	0.79	6.55	1.16	152.47	0.00	1.16
KIMBLE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MADISON	2.30	0.00	0.00	0.00	2.30	0.00	47.56	0.00	0.00
ARCHER	6.65	0.00	0.00	0.00	6.65	0.00	158.98	0.00	0.00
REFUGIO	3.27	0.00	0.00	0.00	3.27	0.00	64.44	0.00	0.00
LIMESTONE	1.79	0.00	0.00	0.00	1.79	0.00	39.98	0.00	0.00
CLAY	2.22	0.00	0.00	0.00	2.22	0.00	52.99	0.00	0.00
BEE	5.72	0.00	0.00	0.00	5.72	0.00	112.78	0.00	0.00
MARTIN	4.75	0.00	0.00	0.00	4.75	0.00	110.52	0.00	0.00
GONZALES	15.90	0.00	0.00	0.00	15.90	0.00	221.58	0.00	0.00
BURLESON	2.30	0.00	9.03	0.00	11.33	0.00	45.78	0.00	0.00
KARNES	34.98	0.00	0.00	0.00	34.98	0.00	553.12	0.00	0.00
KLEBERG	36.25	0.00	19.15	0.00	55.40	0.00	543.68	0.00	0.00
BREWSTER	3.75	0.00	18.85	0.00	22.59	0.00	257.79	0.00	0.00
WINKLER	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FRANKLIN	1.19	0.00	0.00	0.00	1.19	0.00	18.79	0.00	0.00
YOING	11.22	0.74	0.00	1.55	11.22	2.29	263.37	0.00	2.29
HORSTON	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SCURRY	4.87	0.00	0.00	0.00	4.87	0.00	388.58	0.00	0.00
BOSQUE	0.89	0.23	10.05	0.48	10.94	0.71	120.63	0.00	0.71
COMANCHE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BRISCOE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CONCHO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ZAVALA	3.85	0.00	0.00	0.00	3.85	0.00	44.94	0.00	0.00
NOLAN	0.00	0.03	0.00	0.06	0.00	0.09	0.00	0.00	0.09
BROOKS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROBERTSON	57.44	0.35	18.06	0.58	75.50	0.93	1,183.53	0.01	0.93
LIVE OAK	8.46	0.00	0.00	0.00	8.46	0.00	123.62	0.00	0.00
HAMILTON	5.36	0.00	0.00	0.00	5.36	0.00	119.95	0.00	0.00
JONES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
REAGAN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WARD	38.04	0.23	0.00	0.40	38.04	0.64	884.14	0.00	0.64
RED RIVER	7.81	0.00	0.00	0.00	7.81	0.00	204.93	0.00	0.00
HASKELL	1.87	0.00	0.00	0.00	1.87	0.00	43.56	0.00	0.00
HOWARD	95.09	0.15	0.00	0.26	95.09	0.42	2,210.35	0.01	0.43
SAN SABA	2.06	0.00	0.00	0.00	2.06	0.00	31.19	0.00	0.00
JACK	0.00	0.32	0.00	0.67	0.00	0.99	0.00	0.00	0.99
STEPHENS	1.87	0.00	0.00	0.00	1.87	0.00	43.56	0.00	0.00
RUNNELS	1.87	0.00	0.00	0.00	1.87	0.00	39.18	0.00	0.00
REEVES	2.85	0.00	0.00	0.00	2.85	0.00	66.31	0.00	0.00
DE WITT	10.62	0.00	0.00	0.00	10.62	0.00	209.45	0.00	0.00
CHILDRESS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CROSBY	4.06	0.00	0.00	0.00	4.06	0.00	323.82	0.00	0.00
DANSON	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MITCHELL	0.94	0.04	0.00	0.06	0.94	0.10	21.78	0.00	0.10
WILBARGER	2.22	1.86	0.00	3.92	2.22	5.78	52.99	0.00	5.78
COLEMAN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UPTON	0.95	0.00	0.00	0.01	0.95	0.01	22.11	0.00	0.01
COKE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CROCKETT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HARDEN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BANDERA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BAYLOR	1.11	0.00	0.00	0.00	1.11	0.00	26.50	0.00	0.00
COTTLE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRANE	1.90	0.00	0.00	0.00	1.90	0.00	44.22	0.00	0.00
DELTA	3.58	0.00	0.00	0.00	3.58	0.00	56.77	0.00	0.00
BREKENS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DUVAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EASTLAND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EDWARDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FISHER	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FOARD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GLASSCOCK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COLLAD	2.45	0.00	0.00	0.00	2.45	0.00	48.31	0.00	0.00
HALL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HUBBARD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IRION	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
JEFF DAVIS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
KENEDY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
KENT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
KING	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
KINNEY	1.77	0.00	0.00	0.00	1.77	0.00	24.62	0.00	0.00
KNOX	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LA SALLE	8.47	0.00	19.28	0.00	27.76	0.00	98.63	0.00	0.00
LEON	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LOVING	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MENARD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MILLS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MONTAGUE	2.39	0.00	0.00	0.00	2.39	0.00	38.01	0.00	0.00
MOTLEY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
REAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SCHLEICHER	1.87	0.00	0.00	0.00	1.87	0.00	39.18	0.00	0.00
SHACKELFORD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STARR	5.34	0.00	5.56	0.00	10.91	0.00	26.65	0.00	0.00
STERLING	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
STONEWALL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SUTTON	9.37	0.00	0.00	0.00	9.37	0.00	195.91	0.00	0.00
TERRELL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
THROCKMORTON	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ZAPATA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>TOTAL</b>	<b>96,803.11</b>	<b>19.83</b>	<b>150,577.70</b>	<b>34.21</b>	<b>247,380.81</b>	<b>54.04</b>	<b>2,730,858.95</b>	<b>12.56</b>	<b>66.60</b>

Other ERCOT Counties

### Annual Elec. Savings w/ 7% T&D Loss (Single and Multi-family Residences)



### Annual Elec. Savings w/ 7% T&D Loss (Single and Multi-family Residences)

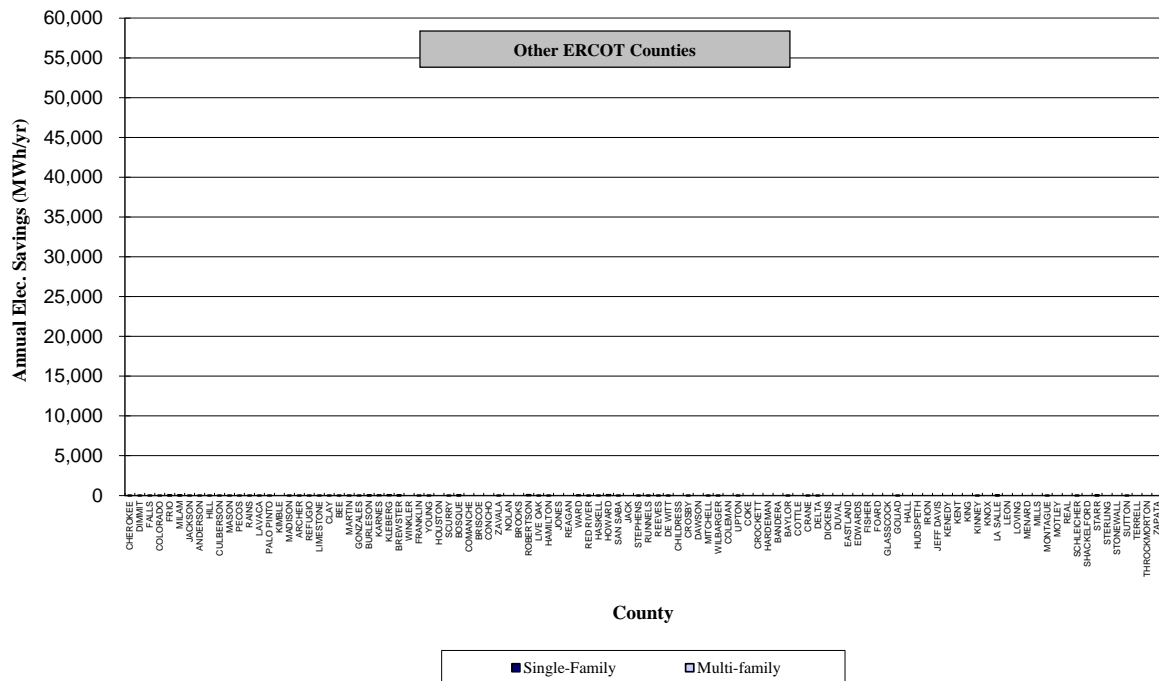


Figure 8: 2015 Annual Electricity Savings by County from New Single-family and Multi-family Residences

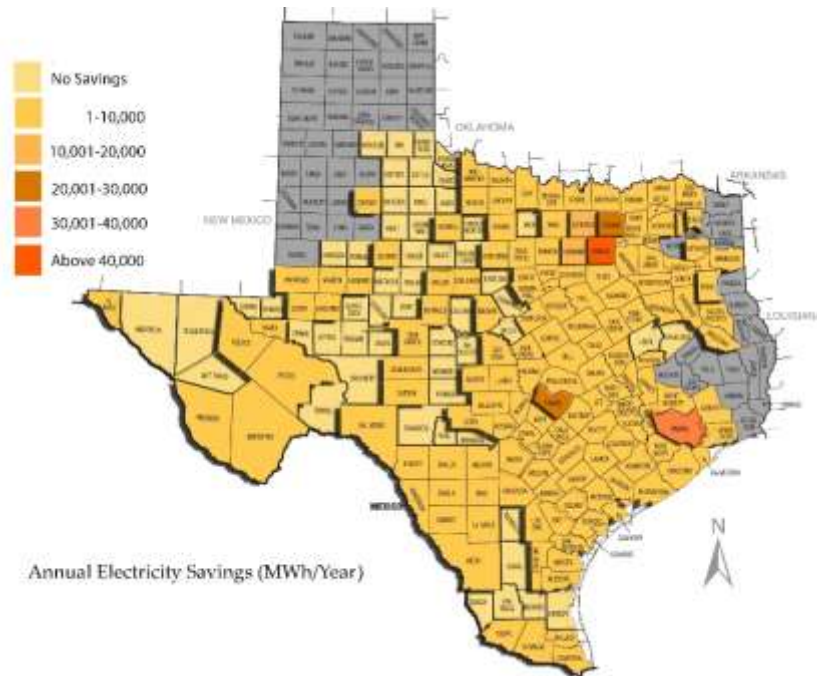
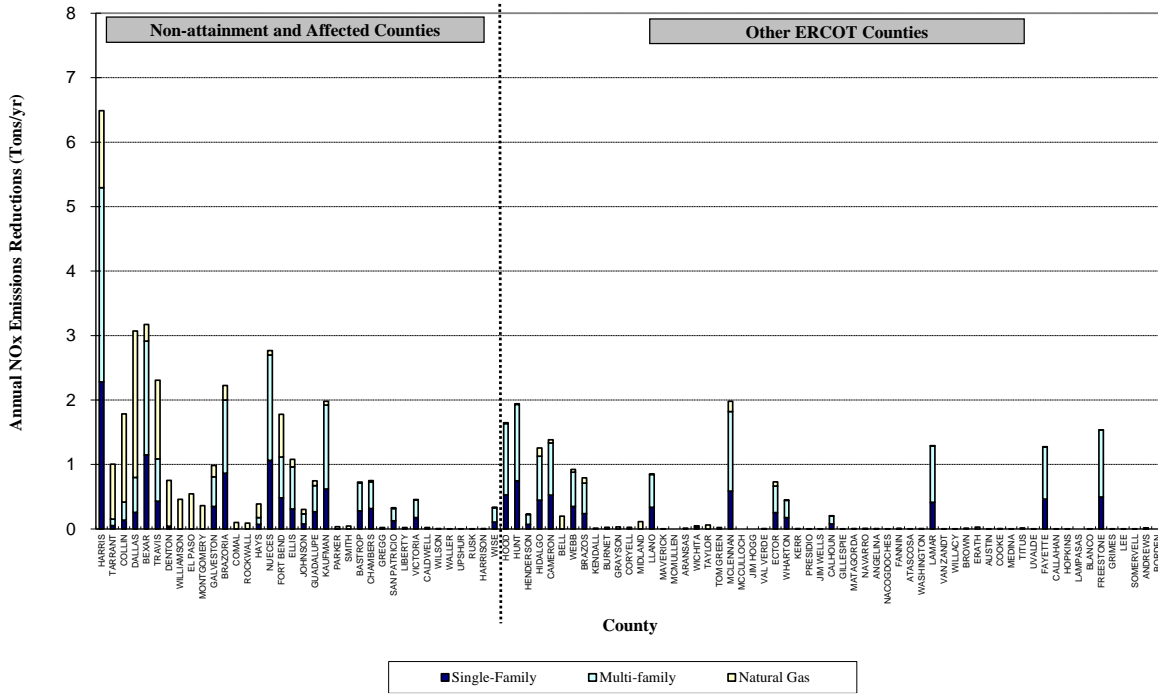


Figure 9: Map of 2015 Annual Electricity Savings by County from New Single-family and Multi-family Residences

**Total Annual NOx Emissions Reductions  
(Single and Multi-Family Residences)**



**Total Annual NOx Emissions Reductions  
(Single and Multi-Family Residences)**

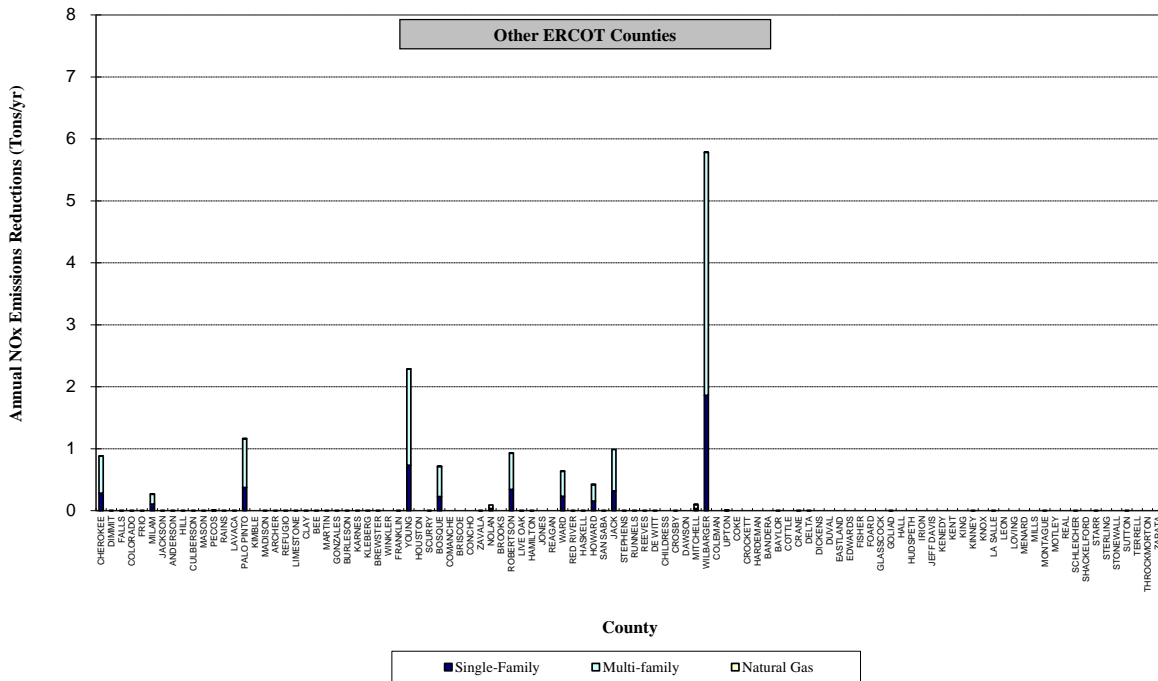


Figure 10: 2015 Annual NOx Reductions by County from New Single-family and Multi-family Residences



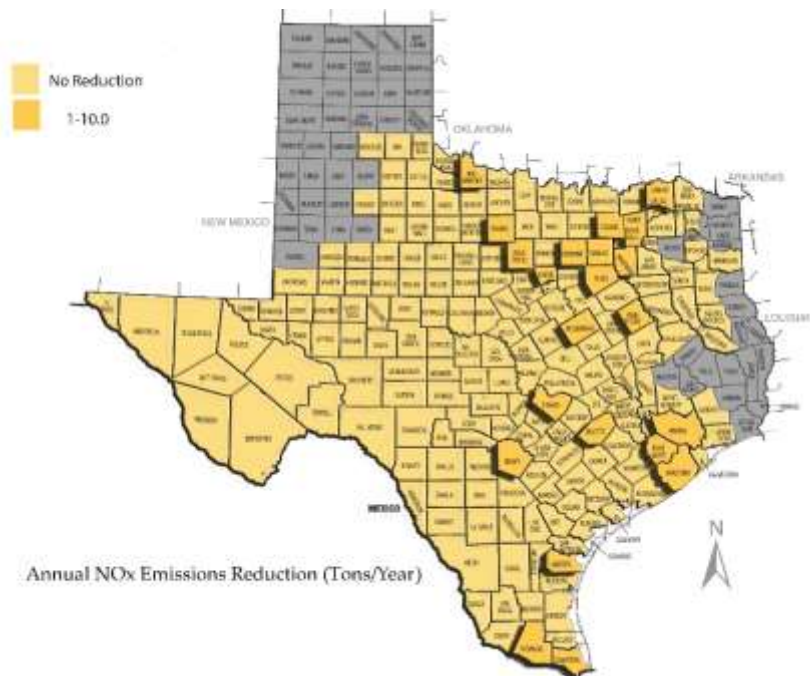


Figure 11: Map of 2015 Annual NOx Reductions by County from New Single-family and Multi-family Residences

#### 4.4 2015 Results for Commercial Construction

This section reports the calculated energy savings and emissions reductions from new commercial Construction in 2015 that were built to meet ASHRAE Standard 90.1-2007.

To determine the energy savings and emissions reductions from new commercial Construction in all counties in the ERCOT region as well as the 36 non-attainment and affected counties, data from two sources (i.e., Dodge and DOE) were merged into one analysis as shown in Figure 12. Beginning in the upper left of Figure 12, the Dodge database of the square footage of new commercial Construction per county in Texas (Dodge 2016) was categorized by the building types in the report published by the US Department of Energy (DOE) (USDOE 2011). This allowed for the new Construction to be tracked by county and building type. The next block in Figure 12 and Table 17 show the categories from the Dodge database and the DOE report. The Dodge “stores and restaurant” category had to be split into two categories to match the two DOE categories for “retail” and “food”. To accomplish this, information published in the 1999 and 2003 CBECS database (Table 18) by the US DOE’s EIA was used to determine the percentages used to split the Dodge conditioned area for each county as shown in Table 19 (i.e., 21.06% for food and 78.94% for retail). As a result, six Dodge building types were categorized into seven DOE building types and the resultant square footage of new commercial Construction by the seven DOE building types is shown in Figure 13 for all building types and in Figure 14 for each building type.

In the next step, the annual energy savings were 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 90.1-2004 and 2007, by seven building types (DOE 2011). The annual energy use for each building type was calculated by multiplying the annual EUI value by the resultant square footage. Then, the annual energy savings were calculated by subtracting the annual energy use from ASHRAE Standard 90.1-2004 to the annual energy use from ASHRAE Standard 90.1-2007. From Table 20 to Table 22 show the annual energy use calculated for new commercial Construction, by building type, for ASHRAE Standard 90.1-2004 and ASHRAE Standard 90.1-2007. Table 23 shows the county-wide annual electricity and natural gas savings by building type<sup>31</sup>.

<sup>31</sup> In this table (-) values are savings, (+) values are increased energy use.

In the next calculation step, CM Zones were assigned to each county as shown in Table 24. In the case where more than one provider was shown in a county, a percentage of electricity use was allocated. In Table 25, the total electricity savings by CM Zones are shown for 2015 for all estimated new commercial Construction. In addition, Table 25 shows the calculated annual NO<sub>x</sub> emissions reductions from electricity savings, using the 2010 eGRID for Texas.

Table 26 shows the transformation of the annual county-wide electricity and natural gas savings, along with the associated 2015 NO<sub>x</sub> emissions reductions with 7% T&D losses<sup>32</sup>. Figure 15 shows the bar chart of the annual electricity savings for 2015. Figure 16 presents the NO<sub>x</sub> emissions reductions resulted from the electricity and natural gas savings. The total NO<sub>x</sub> reductions from electricity and natural gas savings from new commercial Construction in 2015 are calculated to be 47.28 tons NO<sub>x</sub>/year which represents 10.70 tons NO<sub>x</sub>/year from electricity savings and 36.57 tons NO<sub>x</sub>/year from natural gas savings.

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<sup>32</sup> 0.092 lb-NO<sub>x</sub>/MMBtu of emission rate was used for the calculation.

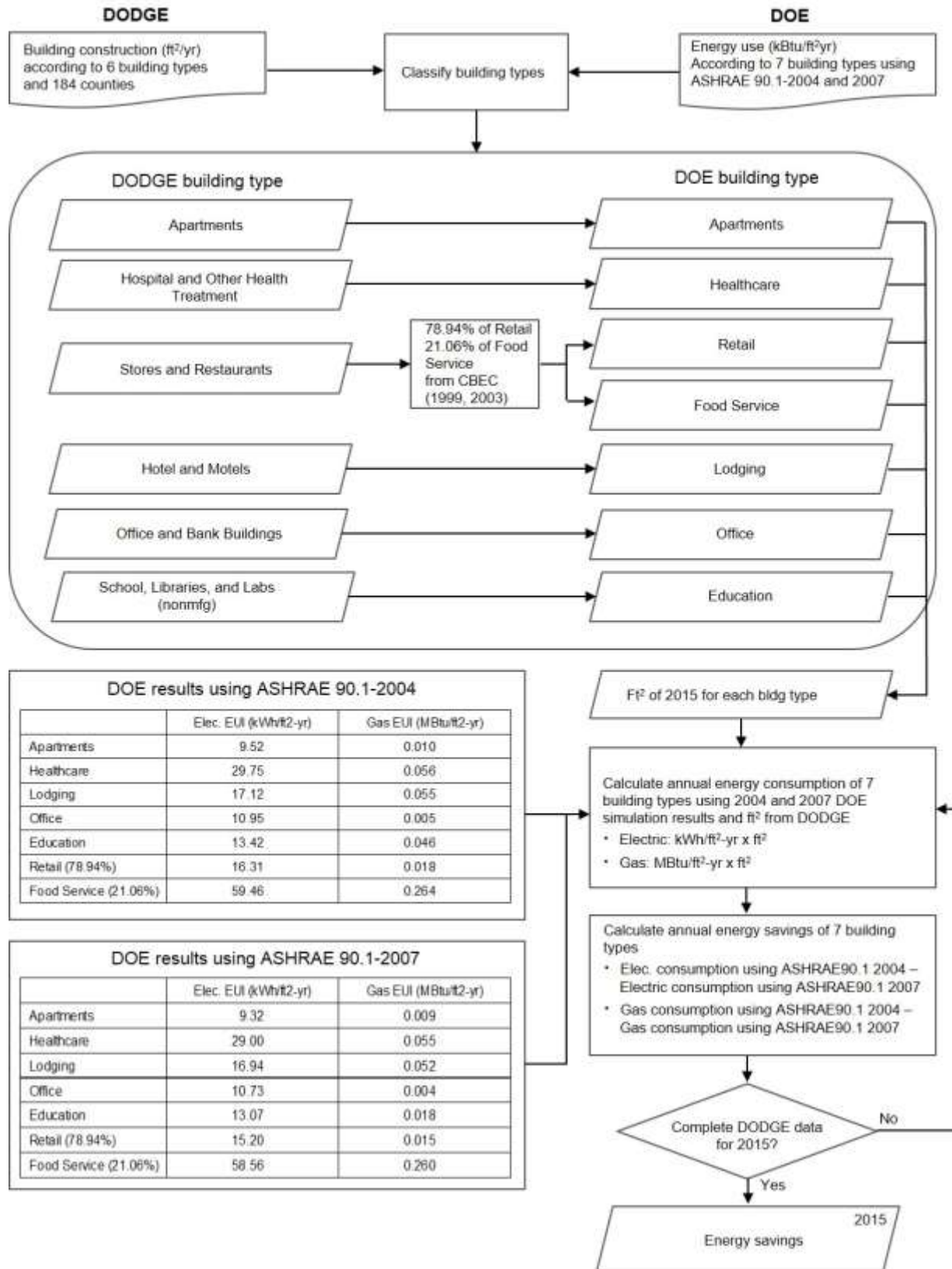


Figure 12: Calculation Method for 2015 Energy Savings from New Commercial Buildings

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

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

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

		CBECS (1999)		CBECS (2003)	
		All (million square feet)	South (million square feet)	All (million square feet)	South (million square feet)
Food	Food Sales	994	392	1,255	487
	Food Service	1,851	676	1,654	764
Retail	Retail (Other Than Mall)	4,766	1,566	4,317	1,844
	Enclosed and Strip Malls	5,631	2,513	6,875	3,251

Table 19: Resultant % Distribution of Commercial Building Floor Area for Retail and Food Service Types

	South		All	
	Food %	Retail %	Food %	Retail %
CBECS (1999)	20.75	79.25	21.48	78.52
CBECS (2003)	19.71	80.29	20.63	79.37
Average	20.23	79.77	21.06	78.94

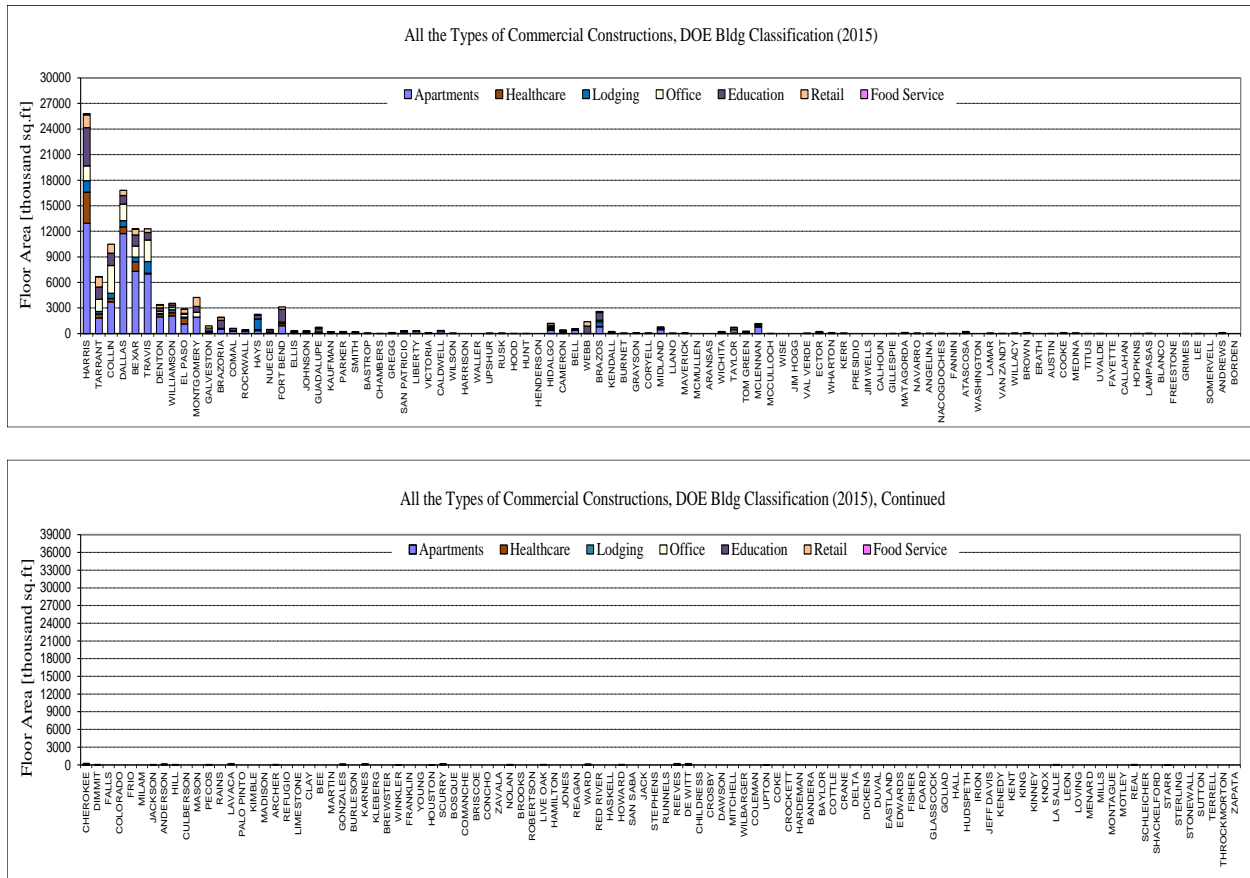


Figure 13: All the Types of 2015 New Commercial Building Construction (Dodge 2016)

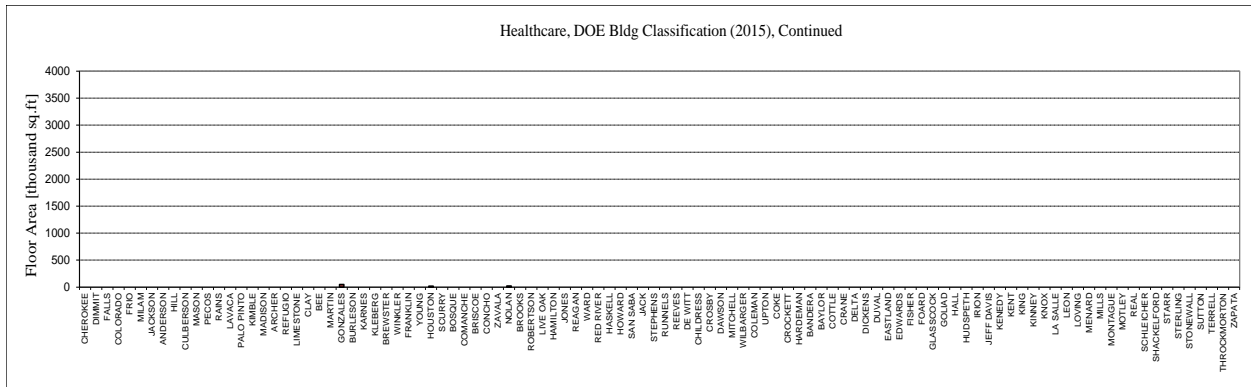
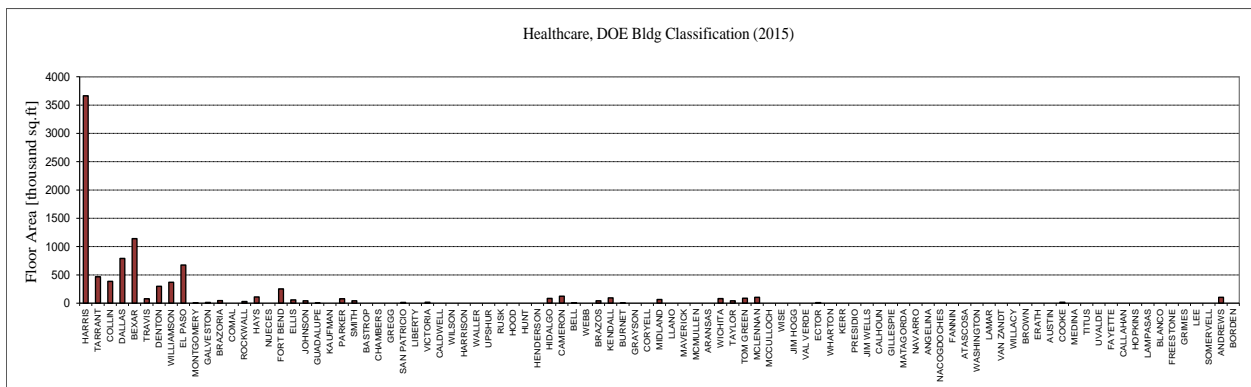
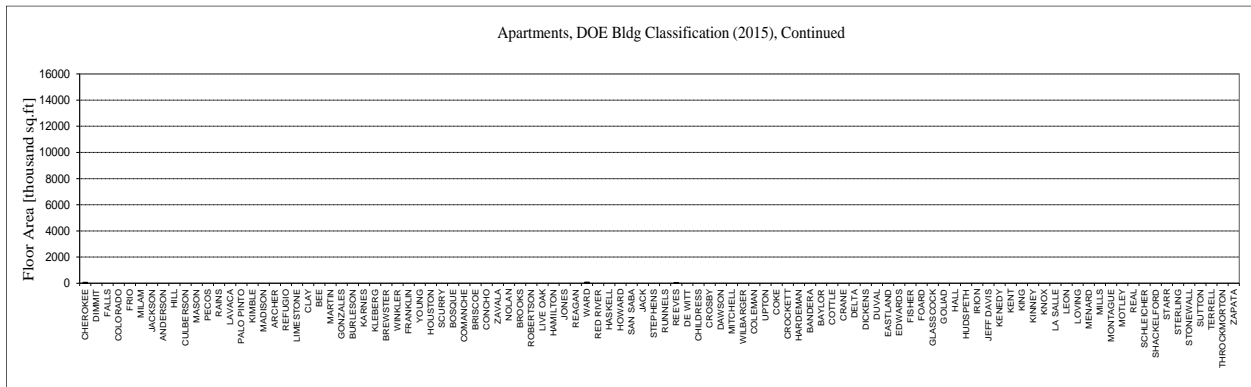
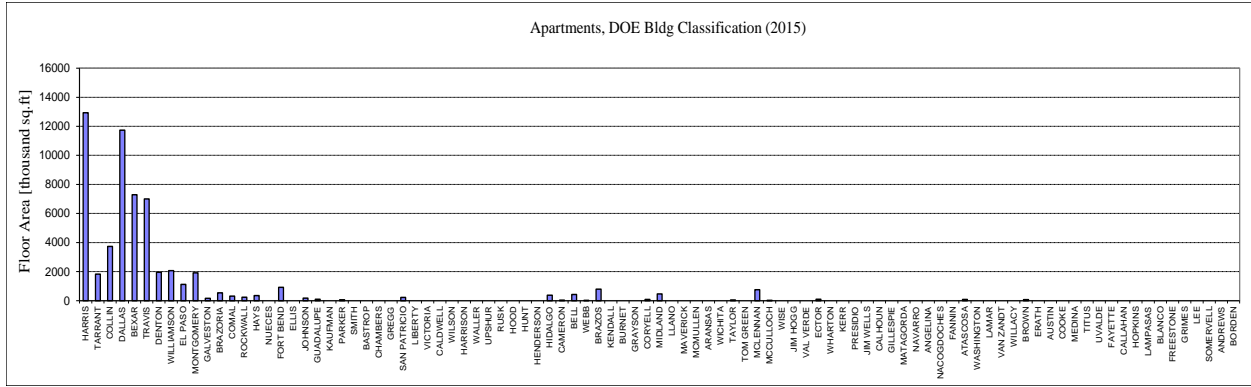


Figure 14: 2015 New Commercial Building Construction by Type (Dodge 2016)

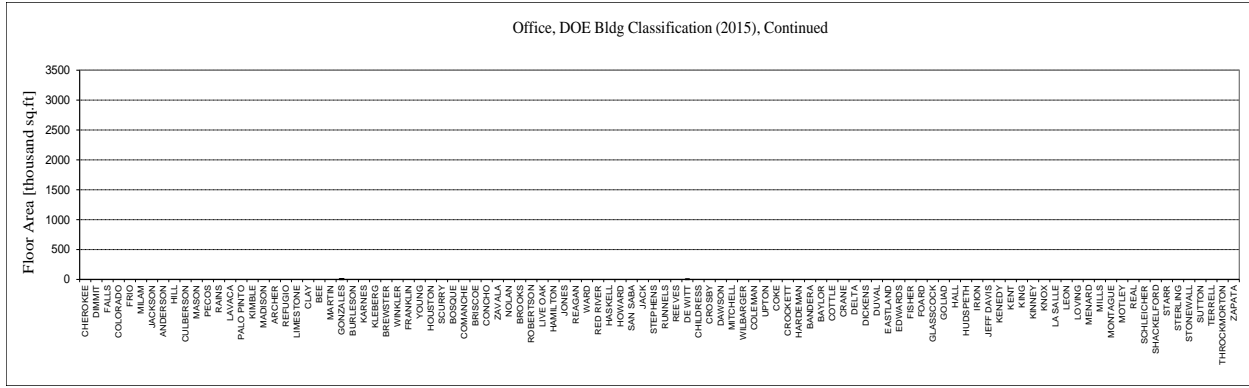
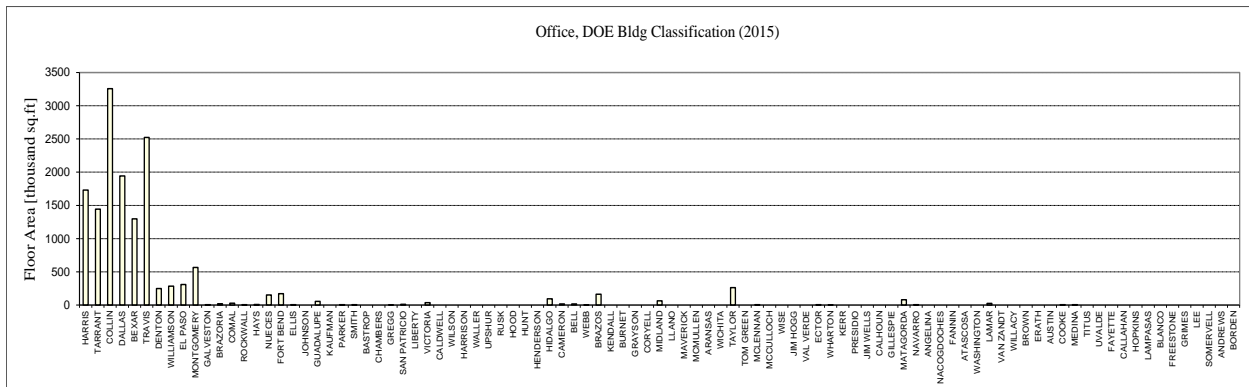
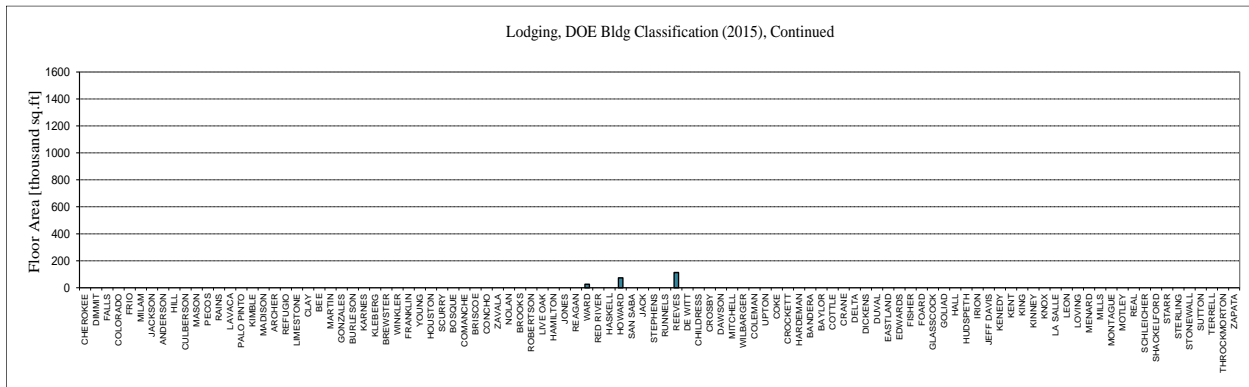
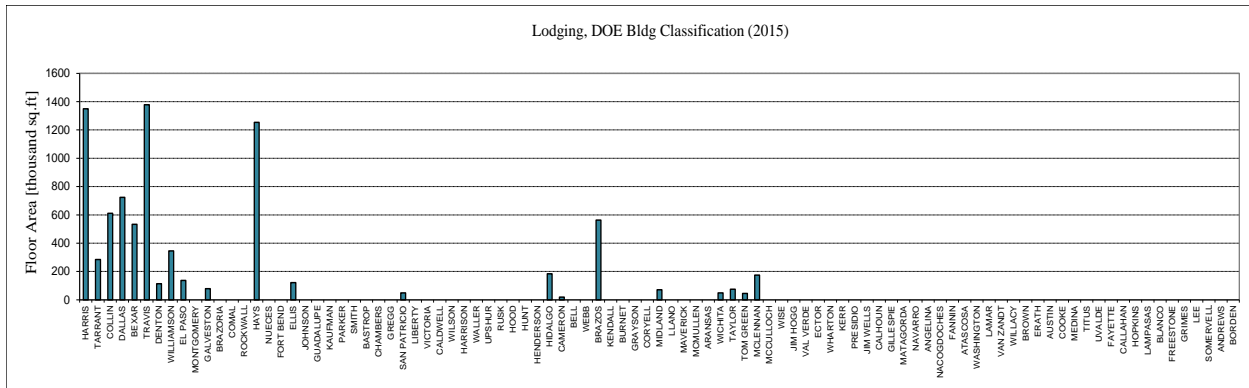


Figure 14: 2015 New Commercial Building Construction by Type (Dodge 2016) (Continued)



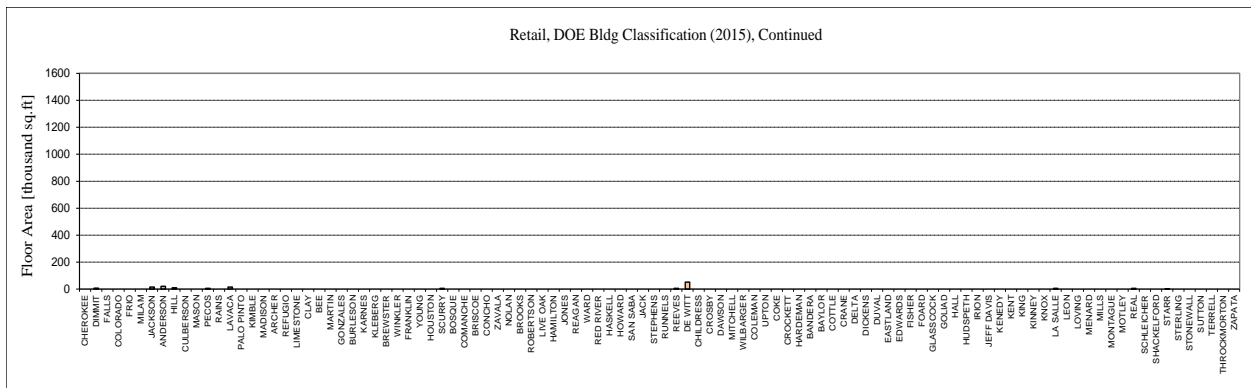
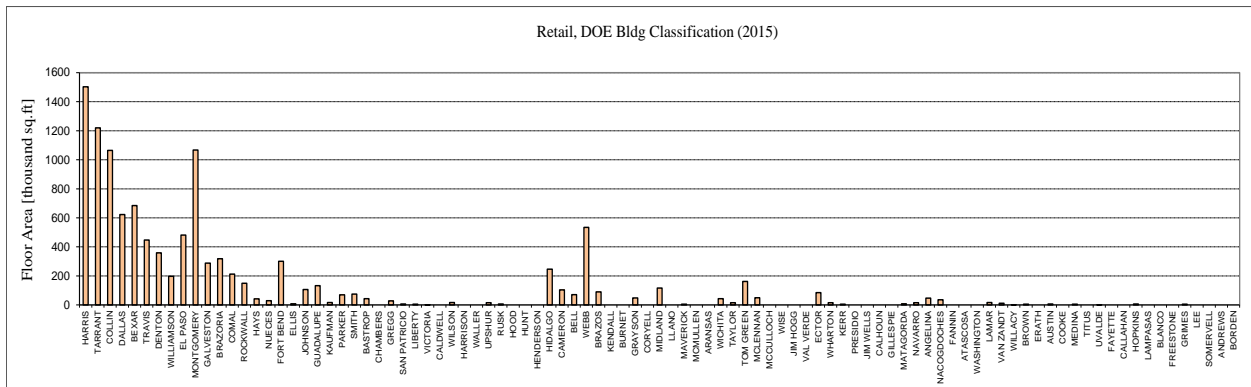
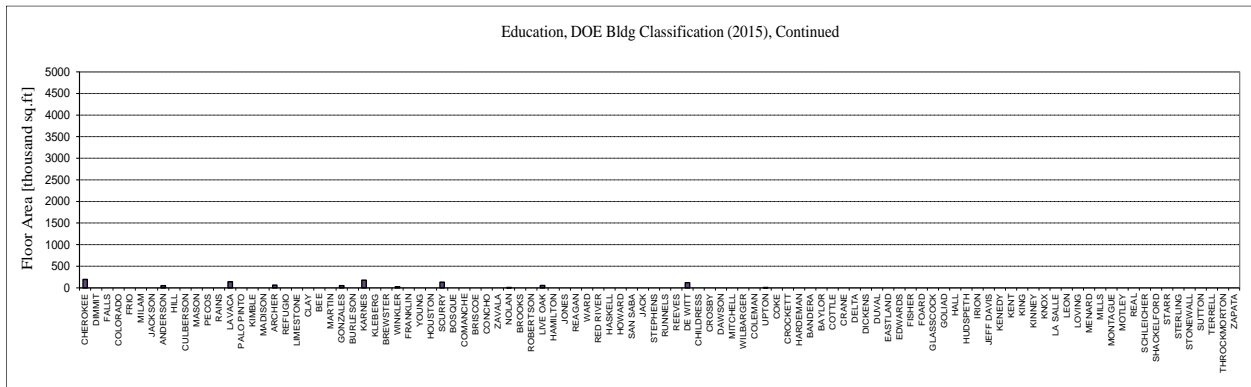
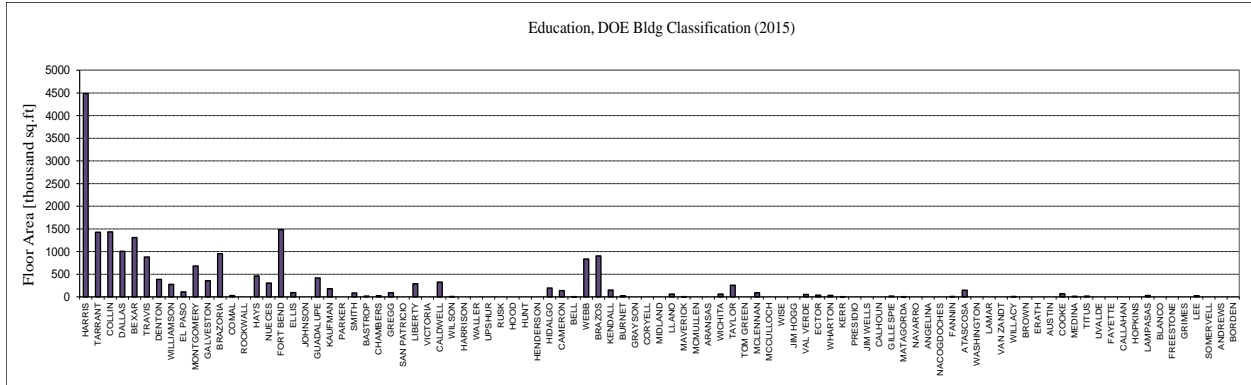


Figure 14: 2015 New Commercial Building Construction by Type (Dodge 2016) (Continued)

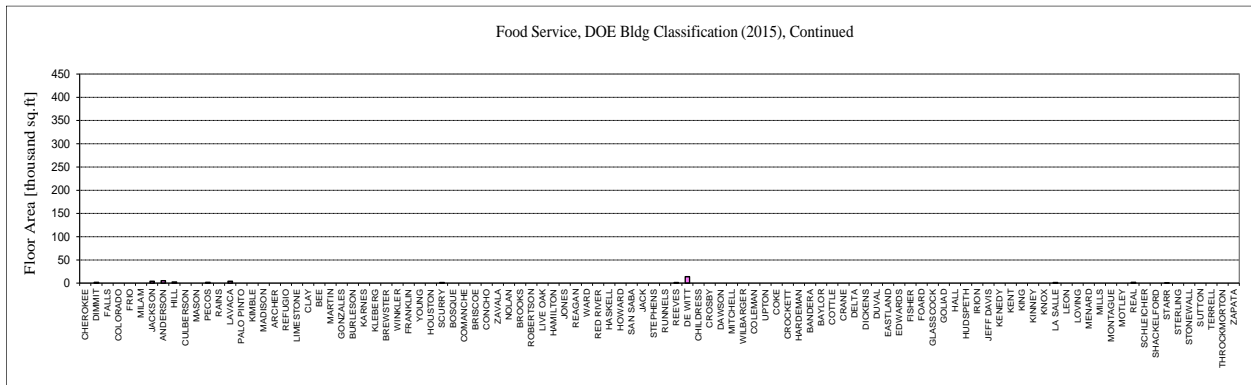
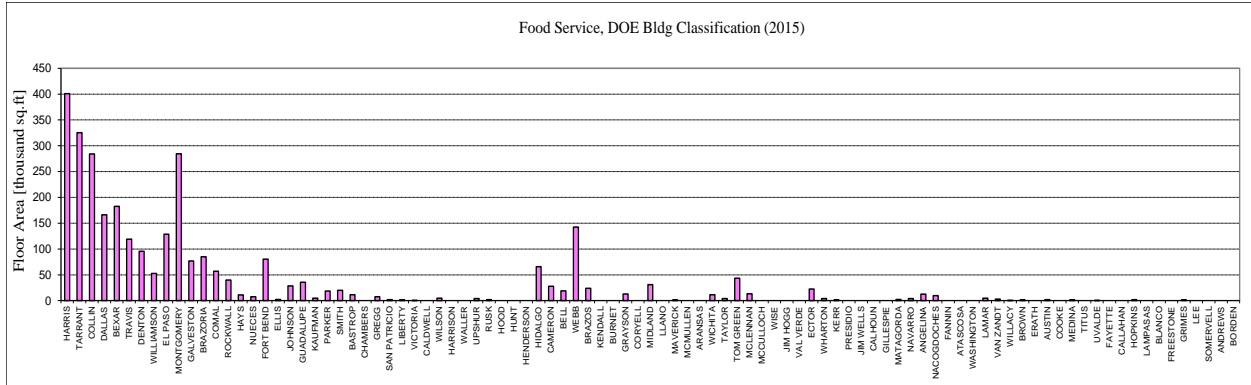


Figure 14: 2015 New Commercial Building Construction by Type (Dodge 2016) (Continued)

Table 20: Energy Use of ASHRAE Standard 90.1-2004 and 90.1-2007 Code-Compliant Apartment, Healthcare, and Lodging Building Types

Non-attainment Counties	Apartments				Healthcare				Lodging			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)
Brazoria	5156734	5045666	5468	4873	1412970	1377471	2667	2589	0	0	0	0
Chambers	0	0	0	0	0	0	0	0	0	0	0	0
Collin	35506603	34741845	37651	33550	11506034	11216966	21719	21081	10457484	10350044	33758	31711
Dallas	111750837	109343896	118499	105593	23514788	22924023	44387	43082	12393231	12265904	40007	37581
Denton	18560053	18160298	19681	17537	8900221	8676619	16800	16306	1946016	1926023	6282	5901
El Paso	10702081	10471575	11348	10112	20052269	19548493	37851	36738	2351650	2327489	7591	7131
Ellis	0	0	0	0	1784804	1739964	3369	3270	2086362	2064927	6735	6327
Fort Bend	8729492	8541473	9257	8249	7534846	7345547	14223	13805	0	0	0	0
Galveston	1523970	1491146	1616	1440	434302	423391	820	796	1348690	1334834	4354	4090
Harris	123206331	120552656	130647	116418	108941441	106204489	205638	199595	23090330	22853101	74538	70018
Johnson	1666843	1630941	1768	1575	1237464	1206375	2336	2267	0	0	0	0
Kaufman	0	0	0	0	0	0	0	0	0	0	0	0
Liberty	0	0	0	0	0	0	0	0	0	0	0	0
Montgomery	18243829	17850885	19346	17239	237974	231995	449	436	0	0	0	0
Parker	602921	589935	639	570	2329169	2270653	4397	4267	0	0	0	0
Rockwall	2201185	2153774	2334	2080	898351	875782	1696	1646	0	0	0	0
Tarrant	17406598	17031687	18458	16448	13856026	13507919	26155	25386	4865896	4815904	15708	14755
Waller	0	0	0	0	0	0	0	0	0	0	0	0
Wise	0	0	0	0	0	0	0	0	0	0	0	0
Affected Counties	Apartments				Healthcare				Lodging			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)
Bastrop	0	0	0	0	0	0	0	0	0	0	0	0
Bexar	69453994	67958062	73648	65627	33908295	33056412	64005	62125	9131044	9037232	29476	27689
Caldwell	0	0	0	0	0	0	0	0	0	0	0	0
Comal	2955550	2891892	3134	2793	0	0	0	0	0	0	0	0
Cregg	0	0	0	0	0	0	0	0	0	0	0	0
Guadalupe	876283	857409	929	828	136835	133397	258	251	0	0	0	0
Harrison	0	0	0	0	0	0	0	0	0	0	0	0
Hays	3284156	3213420	3482	3103	3257267	3175434	6148	5968	21462660	21242153	69284	65083
Nueces	0	0	0	0	0	0	0	0	0	0	0	0
Rusk	0	0	0	0	0	0	0	0	0	0	0	0
San Patricio	2090697	2045666	2217	1976	383733	374092	724	703	835230	826648	2696	2533
Smith	0	0	0	0	1225565	1194775	2313	2245	0	0	0	0
Travis	66680368	65244175	70707	63006	2287523	2230054	4318	4191	23588387	23346041	76146	71529
Upshur	0	0	0	0	0	0	0	0	0	0	0	0
Victoria	0	0	0	0	458100	446591	865	839	0	0	0	0
Williamson	19682076	19258155	20871	18598	10973568	10697877	20714	20105	5921914	5861073	19117	17957
Wilson	0	0	0	0	0	0	0	0	0	0	0	0

Table 20: Energy Use of ASHRAE Standard 90.1-2004 and 90.1-2007 Code-Compliant Apartment, Healthcare, and Lodging Building Types (Continued)

Other ERCOT Counties	Apartments				Healthcare				Lodging			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)
ANDERSON	0	0	0	0	0	0	0	0	0	0	0	0
ANDREWS	0	0	0	0	3093660	3015937	5840	5668	0	0	0	0
ANGELINA	0	0	0	0	0	0	0	0	0	0	0	0
ARANSAS	0	0	0	0	0	0	0	0	0	0	0	0
ARCHER	0	0	0	0	0	0	0	0	0	0	0	0
ATASCOSA	819134	801491	869	774	0	0	0	0	0	0	0	0
AUSTIN	0	0	0	0	0	0	0	0	0	0	0	0
BANDERA	0	0	0	0	0	0	0	0	0	0	0	0
BAYLOR	0	0	0	0	0	0	0	0	0	0	0	0
BEE	0	0	0	0	0	0	0	0	0	0	0	0
BELL	4048046	3960857	4293	3825	193354	188496	365	354	0	0	0	0
BLANCO	0	0	0	0	0	0	0	0	0	0	0	0
BORDEN	0	0	0	0	0	0	0	0	0	0	0	0
BOSQUE	0	0	0	0	0	0	0	0	0	0	0	0
BRAZOS	7546510	7383970	8002	7131	1267211	1235374	2392	2322	9646216	9547111	31139	29251
BREWSTER	0	0	0	0	0	0	0	0	0	0	0	0
BRISCOE	0	0	0	0	0	0	0	0	0	0	0	0
BROOKS	0	0	0	0	0	0	0	0	0	0	0	0
BROWN	662927	648649	703	626	0	0	0	0	0	0	0	0
BURLESON	0	0	0	0	0	0	0	0	0	0	0	0
BURNET	0	0	0	0	89240	86998	168	164	0	0	0	0
CALHOUN	0	0	0	0	0	0	0	0	0	0	0	0
CALLAHAN	0	0	0	0	0	0	0	0	0	0	0	0
CAMERON	275267	269338	292	260	3646949	3555326	6884	6682	325192	321851	1050	986
CHEROKEE	526722	515377	559	498	0	0	0	0	0	0	0	0
CHILDRESS	0	0	0	0	0	0	0	0	0	0	0	0
CLAY	0	0	0	0	0	0	0	0	0	0	0	0
COKE	0	0	0	0	0	0	0	0	0	0	0	0
COLEMAN	0	0	0	0	0	0	0	0	0	0	0	0
COLORADO	0	0	0	0	0	0	0	0	0	0	0	0
COMANCHE	0	0	0	0	0	0	0	0	0	0	0	0
CONCHO	0	0	0	0	0	0	0	0	0	0	0	0
COOKE	0	0	0	0	535441	521989	1011	981	0	0	0	0
CORYELL	781035	764212	828	738	0	0	0	0	0	0	0	0
COTTLE	0	0	0	0	0	0	0	0	0	0	0	0
CRANE	0	0	0	0	0	0	0	0	0	0	0	0
CROCKETT	0	0	0	0	0	0	0	0	0	0	0	0
CROSBY	0	0	0	0	0	0	0	0	0	0	0	0
CULBERSON	0	0	0	0	0	0	0	0	0	0	0	0
DAWSON	0	0	0	0	0	0	0	0	0	0	0	0
DEWITT	0	0	0	0	0	0	0	0	0	0	0	0
DELTA	0	0	0	0	0	0	0	0	0	0	0	0
DICKENS	0	0	0	0	0	0	0	0	0	0	0	0
DIMMIT	0	0	0	0	0	0	0	0	0	0	0	0
DUVAL	0	0	0	0	0	0	0	0	0	0	0	0
EASTLAND	0	0	0	0	0	0	0	0	0	0	0	0
ECTOR	970579	949674	1029	917	297467	289994	562	545	0	0	0	0
EDWARDS	0	0	0	0	0	0	0	0	0	0	0	0
ERATH	0	0	0	0	0	0	0	0	0	0	0	0
FALLS	0	0	0	0	0	0	0	0	0	0	0	0
FANNIN	0	0	0	0	0	0	0	0	0	0	0	0
FAYETTE	0	0	0	0	0	0	0	0	0	0	0	0
FISHER	0	0	0	0	0	0	0	0	0	0	0	0
FOARD	0	0	0	0	0	0	0	0	0	0	0	0
FRANKLIN	0	0	0	0	0	0	0	0	0	0	0	0
FREESTONE	0	0	0	0	0	0	0	0	0	0	0	0
FRIO	0	0	0	0	0	0	0	0	0	0	0	0
GILLESPIE	0	0	0	0	0	0	0	0	0	0	0	0
GLASCOCK	0	0	0	0	0	0	0	0	0	0	0	0
GOLIAD	0	0	0	0	0	0	0	0	0	0	0	0
GONZALES	0	0	0	0	1487336	1449970	2808	2725	0	0	0	0
GRAYSON	0	0	0	0	0	0	0	0	0	0	0	0
GRIMES	0	0	0	0	0	0	0	0	0	0	0	0
HALL	0	0	0	0	0	0	0	0	0	0	0	0
HAMILTON	0	0	0	0	0	0	0	0	0	0	0	0
HARDEMAN	0	0	0	0	0	0	0	0	0	0	0	0
HASKELL	0	0	0	0	0	0	0	0	0	0	0	0
HENDERSON	0	0	0	0	446201	434991	842	818	0	0	0	0
HIDALGO	3539421	3463187	3753	3344	2528472	2464949	4773	4633	3135534	3103319	10122	9508
HILL	0	0	0	0	0	0	0	0	0	0	0	0
HOOD	0	0	0	0	0	0	0	0	0	0	0	0
HOPKINS	0	0	0	0	0	0	0	0	0	0	0	0
HOUSTON	0	0	0	0	535441	521989	1011	981	0	0	0	0
HOWARD	0	0	0	0	0	0	0	0	1263113	1250136	4077	3830
HUDSPETH	0	0	0	0	0	0	0	0	0	0	0	0
HUNT	0	0	0	0	0	0	0	0	0	0	0	0
IRION	0	0	0	0	0	0	0	0	0	0	0	0
JACK	0	0	0	0	0	0	0	0	0	0	0	0
JACKSON	0	0	0	0	0	0	0	0	0	0	0	0
JEFF DAVIS	0	0	0	0	0	0	0	0	0	0	0	0
JIM HOGG	0	0	0	0	0	0	0	0	0	0	0	0

Table 20: Energy Use of ASHRAE Standard 90.1-2004 and 90.1-2007 Code-Compliant Apartment, Healthcare, and Lodging Building Types (Continued)

Other ERCOT Counties	Apartments				Healthcare				Lodging			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)
JIM WELLS	0	0	0	0	0	0	0	0	0	0	0	0
JONES	0	0	0	0	0	0	0	0	0	0	0	0
KARNES	0	0	0	0	0	0	0	0	0	0	0	0
KENDALL	0	0	0	0	2808091	2737543	5301	5145	0	0	0	0
KENEDY	0	0	0	0	0	0	0	0	0	0	0	0
KENT	0	0	0	0	0	0	0	0	0	0	0	0
KERR	0	0	0	0	0	0	0	0	0	0	0	0
KIMBLE	0	0	0	0	0	0	0	0	0	0	0	0
KING	0	0	0	0	0	0	0	0	0	0	0	0
KINNEY	0	0	0	0	0	0	0	0	0	0	0	0
KLEBERG	0	0	0	0	0	0	0	0	0	0	0	0
KNOX	0	0	0	0	0	0	0	0	0	0	0	0
LA SALLE	0	0	0	0	0	0	0	0	0	0	0	0
LAMAR	0	0	0	0	0	0	0	0	0	0	0	0
LAMPASAS	0	0	0	0	0	0	0	0	0	0	0	0
LAVACA	0	0	0	0	0	0	0	0	0	0	0	0
LEE	0	0	0	0	0	0	0	0	0	0	0	0
LEON	0	0	0	0	0	0	0	0	0	0	0	0
LIMESTONE	0	0	0	0	0	0	0	0	0	0	0	0
LIVE OAK	0	0	0	0	0	0	0	0	0	0	0	0
LLANO	0	0	0	0	0	0	0	0	0	0	0	0
LOVING	0	0	0	0	0	0	0	0	0	0	0	0
MADISON	0	0	0	0	0	0	0	0	0	0	0	0
MARTIN	0	0	0	0	0	0	0	0	0	0	0	0
MASON	0	0	0	0	0	0	0	0	0	0	0	0
MATAGORDA	0	0	0	0	0	0	0	0	0	0	0	0
MAVERICK	0	0	0	0	0	0	0	0	0	0	0	0
MCCULLOCH	155254	151911	165	147	0	0	0	0	0	0	0	0
MCLENNAN	7121704	6968313	7552	6729	3093660	3015937	5840	5668	2988342	2957639	9647	9062
MCMULLEN	0	0	0	0	0	0	0	0	0	0	0	0
MEDINA	0	0	0	0	0	0	0	0	0	0	0	0
MENARD	0	0	0	0	0	0	0	0	0	0	0	0
MIDLAND	4368080	4273998	4632	4127	1963284	1913960	3706	3597	1218614	1206094	3934	3695
MILAM	0	0	0	0	0	0	0	0	0	0	0	0
MILLS	0	0	0	0	0	0	0	0	0	0	0	0
MITCHELL	0	0	0	0	0	0	0	0	0	0	0	0
MONTAGUE	0	0	0	0	0	0	0	0	0	0	0	0
MOTLEY	0	0	0	0	0	0	0	0	0	0	0	0
NACOGDOCHES	0	0	0	0	0	0	0	0	0	0	0	0
NAVARRO	0	0	0	0	0	0	0	0	0	0	0	0
NOLAN	0	0	0	0	624681	608987	1179	1145	0	0	0	0
PALO PINTO	0	0	0	0	0	0	0	0	0	0	0	0
PECOS	0	0	0	0	0	0	0	0	0	0	0	0
PRESIDIO	0	0	0	0	0	0	0	0	0	0	0	0
RAINS	0	0	0	0	0	0	0	0	0	0	0	0
REAGAN	0	0	0	0	0	0	0	0	0	0	0	0
REAL	0	0	0	0	0	0	0	0	0	0	0	0
RED RIVER	0	0	0	0	0	0	0	0	0	0	0	0
REEVES	362895	355079	385	343	0	0	0	0	1939170	1919247	6260	5880
REFUGIO	0	0	0	0	0	0	0	0	0	0	0	0
ROBERTSON	0	0	0	0	0	0	0	0	0	0	0	0
RUNNELS	0	0	0	0	0	0	0	0	0	0	0	0
SAN SABA	0	0	0	0	0	0	0	0	0	0	0	0
SCHLEICHER	0	0	0	0	0	0	0	0	0	0	0	0
SCURRY	0	0	0	0	0	0	0	0	0	0	0	0
SHACKELFORD	0	0	0	0	0	0	0	0	0	0	0	0
SOMERVELL	0	0	0	0	0	0	0	0	0	0	0	0
STARR	0	0	0	0	0	0	0	0	0	0	0	0
STEPHENS	0	0	0	0	0	0	0	0	0	0	0	0
STERLING	0	0	0	0	0	0	0	0	0	0	0	0
STONEWALL	0	0	0	0	0	0	0	0	0	0	0	0
SUTTON	0	0	0	0	0	0	0	0	0	0	0	0
TAYLOR	491480	480895	521	464	1293983	1261474	2443	2371	1287075	1273852	4155	3903
TERRELL	0	0	0	0	0	0	0	0	0	0	0	0
THROCKMORTON	0	0	0	0	0	0	0	0	0	0	0	0
TITUS	0	0	0	0	0	0	0	0	0	0	0	0
TOM GREEN	0	0	0	0	2623661	2557747	4952	4807	777037	769054	2508	2356
UPTON	0	0	0	0	0	0	0	0	0	0	0	0
UVALDE	0	0	0	0	0	0	0	0	0	0	0	0
VAL VERDE	0	0	0	0	0	0	0	0	0	0	0	0
VAN ZANDT	0	0	0	0	0	0	0	0	0	0	0	0
WARD	681977	667288	723	644	0	0	0	0	453557	448897	1464	1375
WASHINGTON	0	0	0	0	0	0	0	0	0	0	0	0
WEBB	232405	227400	246	220	0	0	0	0	0	0	0	0
WHARTON	0	0	0	0	0	0	0	0	0	0	0	0
WICHITA	0	0	0	0	2424358	2363451	4576	4442	838653	830036	2707	2543
WILBARGER	0	0	0	0	0	0	0	0	0	0	0	0
WILLACY	0	0	0	0	0	0	0	0	0	0	0	0
WINKLER	0	0	0	0	0	0	0	0	0	0	0	0
YOUNG	0	0	0	0	0	0	0	0	0	0	0	0
ZAPATA	0	0	0	0	0	0	0	0	0	0	0	0
ZAVALA	0	0	0	0	0	0	0	0	0	0	0	0
<b>Total</b>	<b>552864038</b>	<b>540956198</b>	<b>586250</b>	<b>522401</b>	<b>284224035</b>	<b>277083432</b>	<b>536502</b>	<b>520737</b>	<b>143351398</b>	<b>141878610</b>	<b>462752</b>	<b>434694</b>

Table 21: Energy Use of ASHRAE Standard 90.1-2004 and 90.1-2007 Code-Compliant Office and Education Building Types

<i>Non-attainment Counties</i>	Office				Education			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)
Brazoria	219022	214528	90	81	12783743	12448798	43620	17381
Chambers	0	0	0	0	335567	326774	1145	456
Collin	35679760	34947704	14661	13250	19260177	18755543	65718	26187
Dallas	21288927	20852134	8748	7906	13483063	13129795	46006	18332
Denton	2725727	2669803	1120	1012	5201281	5065003	17748	7072
El Paso	3394839	3325186	1395	1261	1507365	1467871	5143	2049
Ellis	55851	54705	23	21	1261730	1228672	4305	1716
Fort Bend	1879208	1840651	772	698	19908491	19386872	67931	27068
Galveston	52565	51487	22	20	4798601	4672874	16374	6524
Harris	18951964	18563119	7788	7038	60243589	58665154	205560	81910
Johnson	0	0	0	0	0	0	0	0
Kaufman	0	0	0	0	2418764	2355390	8253	3289
Liberty	0	0	0	0	3892572	3790583	13282	5293
Montgomery	6197224	6070073	2547	2301	9156940	8917020	31245	12450
Parker	67897	66504	28	25	0	0	0	0
Rockwall	44899	43978	18	17	0	0	0	0
Tarrant	15804619	15480350	6494	5869	19167561	18665354	65402	26061
Waller	0	0	0	0	0	0	0	0
Wise	0	0	0	0	0	0	0	0
<i>Affected Counties</i>	Office				Education			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)
Bastrop	0	0	0	0	232212	226128	792	316
Bexar	14205759	13914294	5837	5275	17591740	17130821	60025	23918
Caldwell	0	0	0	0	4338204	4224539	14803	5898
Comal	282538	276741	116	105	402680	392129	1374	548
Gregg	25188	24671	10	9	1191932	1160703	4067	1621
Guadalupe	600120	587807	247	223	5606646	5459747	19131	7623
Harrison	0	0	0	0	0	0	0	0
Hays	96370	94392	40	36	6228115	6064933	21251	8468
Nueces	1656901	1622905	681	615	4099281	3991876	13987	5574
Rusk	0	0	0	0	0	0	0	0
San Patricio	128128	125499	53	48	0	0	0	0
Smith	54755	53632	23	20	1134215	1104497	3870	1542
Travis	27618660	27051997	11349	10256	11786439	11477624	40217	16025
Upshur	0	0	0	0	0	0	0	0
Victoria	387669	379715	159	144	0	0	0	0
Williamson	3096969	3033428	1273	1150	3716735	3619353	12682	5053
Wilson	0	0	0	0	147649	143781	504	201

Table 21: Energy Use of ASHRAE Standard 90.1-2004 and 90.1-2007 Code-Compliant Office and Education Building Types (Continued)

Other ERCOT Counties	Office				Education			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)
ANDERSON	0	0	0	0	657710	640478	2244	894
ANDREWS	0	0	0	0	0	0	0	0
ANGELINA	0	0	0	0	0	0	0	0
ARANSAS	0	0	0	0	0	0	0	0
ARCHER	0	0	0	0	805360	784259	2748	1095
AT ASCOSA	0	0	0	0	1973131	1921433	6733	2683
AUSTIN	0	0	0	0	0	0	0	0
BANDERA	0	0	0	0	0	0	0	0
BAYLOR	0	0	0	0	0	0	0	0
BEE	0	0	0	0	0	0	0	0
BELL	180693	176986	74	67	59060	57512	202	80
BLANCO	0	0	0	0	0	0	0	0
BORDEN	0	0	0	0	0	0	0	0
BOSQUE	0	0	0	0	0	0	0	0
BRAZOS	1774077	1737678	729	659	12150193	11831847	41458	16520
BREWSTER	0	0	0	0	0	0	0	0
BRISCOE	0	0	0	0	0	0	0	0
BROOKS	0	0	0	0	0	0	0	0
BROWN	0	0	0	0	0	0	0	0
BURLESON	0	0	0	0	0	0	0	0
BURNET	0	0	0	0	355701	346381	1214	484
CALHOUN	0	0	0	0	0	0	0	0
CALLAHAN	0	0	0	0	0	0	0	0
CAMERON	164266	160896	68	61	1873804	1824708	6394	2548
CHEROKEE	0	0	0	0	2593258	2525313	8849	3526
CHILDRESS	0	0	0	0	0	0	0	0
CLAY	0	0	0	0	0	0	0	0
COKE	0	0	0	0	0	0	0	0
COLEMAN	0	0	0	0	0	0	0	0
COLORADO	0	0	0	0	0	0	0	0
COMANCHE	0	0	0	0	0	0	0	0
CONCHO	0	0	0	0	0	0	0	0
COOKE	42709	41833	18	16	910056	886212	3105	1237
CORYELL	0	0	0	0	0	0	0	0
COTTLE	0	0	0	0	0	0	0	0
CRANE	0	0	0	0	0	0	0	0
CROCKETT	0	0	0	0	0	0	0	0
CROSBY	0	0	0	0	0	0	0	0
CULBERSON	0	0	0	0	0	0	0	0
DAWSON	0	0	0	0	0	0	0	0
DEWITT	32853	32179	14	12	1547633	1507084	5281	2104
DELTA	0	0	0	0	0	0	0	0
DICKENS	0	0	0	0	0	0	0	0
DIMMIT	0	0	0	0	0	0	0	0
DUVAL	0	0	0	0	0	0	0	0
EASTLAND	0	0	0	0	0	0	0	0
ECTOR	48185	47196	20	18	477847	465327	1630	650
EDWARDS	0	0	0	0	0	0	0	0
ERATH	0	0	0	0	0	0	0	0
FALLS	0	0	0	0	0	0	0	0
FANNIN	0	0	0	0	147649	143781	504	201
FAYETTE	0	0	0	0	0	0	0	0
FISHER	0	0	0	0	0	0	0	0
FOARD	0	0	0	0	0	0	0	0
FRANKLIN	0	0	0	0	0	0	0	0
FREESTONE	0	0	0	0	0	0	0	0
FRIO	0	0	0	0	0	0	0	0
GILLESPIE	0	0	0	0	225501	219592	769	307
GLASSCOCK	0	0	0	0	0	0	0	0
GOLIAD	0	0	0	0	0	0	0	0
GONZALES	106226	104046	44	39	637576	620871	2176	867
GRAYSON	0	0	0	0	0	0	0	0
GRIMES	0	0	0	0	0	0	0	0
HALL	0	0	0	0	0	0	0	0
HAMILTON	0	0	0	0	0	0	0	0
HARDEMAN	0	0	0	0	0	0	0	0
HASKELL	0	0	0	0	0	0	0	0
HENDERSON	0	0	0	0	0	0	0	0
HIDALGO	1035974	1014718	426	385	2618761	2550147	8936	3561
HILL	0	0	0	0	0	0	0	0
HOOD	151125	148024	62	56	0	0	0	0
HOPKINS	0	0	0	0	0	0	0	0
HOUSTON	0	0	0	0	0	0	0	0
HOWARD	0	0	0	0	0	0	0	0
HUDSPETH	0	0	0	0	0	0	0	0
HUNT	0	0	0	0	3216070	3131806	10974	4373
IRION	0	0	0	0	0	0	0	0
JACK	0	0	0	0	0	0	0	0
JACKSON	0	0	0	0	0	0	0	0
JEFF DAVIS	0	0	0	0	0	0	0	0
JIM HOGG	0	0	0	0	0	0	0	0

Table 21: Energy Use of ASHRAE Standard 90.1-2004 and 90.1-2007 Code-Compliant Office and Education Building Types (Continued)

Other ERCOT Counties	Office				Education			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)
JIM WELLS	0	0	0	0	0	0	0	0
JONES	0	0	0	0	0	0	0	0
KARNES	0	0	0	0	2350308	2288728	8020	3196
KENDALL	0	0	0	0	2001319	1948883	6829	2721
KENEDY	0	0	0	0	0	0	0	0
KENT	0	0	0	0	0	0	0	0
KERR	0	0	0	0	53691	52284	183	73
KIMBLE	0	0	0	0	0	0	0	0
KING	0	0	0	0	0	0	0	0
KINNEY	0	0	0	0	0	0	0	0
KLEBERG	0	0	0	0	0	0	0	0
KNOX	0	0	0	0	0	0	0	0
LA SALLE	0	0	0	0	0	0	0	0
LAMAR	273777	268160	113	102	0	0	0	0
LAMPASAS	0	0	0	0	402680	392129	1374	548
LAVACA	0	0	0	0	1860381	1811637	6348	2529
LEE	0	0	0	0	351674	342460	1200	478
LEON	0	0	0	0	0	0	0	0
LIMESTONE	0	0	0	0	0	0	0	0
LIVE OAK	0	0	0	0	711401	692762	2427	967
LLANO	0	0	0	0	805360	784259	2748	1095
LOVING	0	0	0	0	0	0	0	0
MADISON	0	0	0	0	0	0	0	0
MARTIN	0	0	0	0	0	0	0	0
MASON	0	0	0	0	0	0	0	0
MATAGORDA	876088	858113	360	325	67113	65355	229	91
MAVERICK	0	0	0	0	56375	54898	192	77
MCCULLOCH	0	0	0	0	0	0	0	0
MCLENNAN	49280	48269	20	18	1208040	1176388	4122	1643
MCMULLEN	0	0	0	0	0	0	0	0
MEDINA	67897	66504	28	25	161072	156852	550	219
MENARD	0	0	0	0	0	0	0	0
MIDLAND	700870	686490	288	260	0	0	0	0
MILAM	0	0	0	0	0	0	0	0
MILLS	0	0	0	0	0	0	0	0
MITCHELL	0	0	0	0	0	0	0	0
MONTAGUE	0	0	0	0	0	0	0	0
MOTLEY	0	0	0	0	0	0	0	0
NACOGDOCHES	0	0	0	0	0	0	0	0
NAVARRO	39424	38615	16	15	0	0	0	0
NOLAN	0	0	0	0	115435	112410	394	157
PALO PINTO	0	0	0	0	0	0	0	0
PECOS	0	0	0	0	0	0	0	0
PRESIDIO	0	0	0	0	0	0	0	0
RAINS	0	0	0	0	0	0	0	0
REAGAN	0	0	0	0	0	0	0	0
REAL	0	0	0	0	0	0	0	0
RED RIVER	0	0	0	0	0	0	0	0
REEVES	0	0	0	0	0	0	0	0
REFUGIO	0	0	0	0	0	0	0	0
ROBERTSON	0	0	0	0	0	0	0	0
RUNNELS	0	0	0	0	0	0	0	0
SAN SABA	0	0	0	0	0	0	0	0
SCHLEICHER	0	0	0	0	0	0	0	0
SCURRY	0	0	0	0	1744946	1699227	5954	2373
SHACKELFORD	0	0	0	0	0	0	0	0
SOMERVELL	0	0	0	0	0	0	0	0
STARR	0	0	0	0	0	0	0	0
STEPHENS	0	0	0	0	0	0	0	0
STERLING	0	0	0	0	0	0	0	0
STONEWALL	0	0	0	0	0	0	0	0
SUTTON	0	0	0	0	0	0	0	0
TAYLOR	2875757	2816754	1182	1068	3444255	3354012	11752	4683
TERRELL	0	0	0	0	0	0	0	0
THROCKMORTON	0	0	0	0	0	0	0	0
TITUS	0	0	0	0	225501	219592	769	307
TOM GREEN	0	0	0	0	0	0	0	0
UPTON	0	0	0	0	100670	98032	344	137
UVALDE	0	0	0	0	0	0	0	0
VAL VERDE	0	0	0	0	740931	721518	2528	1007
VAN ZANDT	0	0	0	0	0	0	0	0
WARD	0	0	0	0	0	0	0	0
WASHINGTON	0	0	0	0	0	0	0	0
WEBB	25188	24671	10	9	11209265	10915572	38248	15241
WHARTON	38329	37542	16	14	469793	457484	1603	639
WICHITA	0	0	0	0	832205	810401	2840	1132
WILBARGER	0	0	0	0	0	0	0	0
WILLACY	0	0	0	0	140938	137245	481	192
WINKLER	0	0	0	0	335567	326774	1145	456
YOUNG	0	0	0	0	0	0	0	0
ZAPATA	0	0	0	0	0	0	0	0
ZAVALA	0	0	0	0	0	0	0	0
<b>Total</b>	<b>162998277</b>	<b>159653977</b>	<b>66979</b>	<b>60529</b>	<b>289533519</b>	<b>281947488</b>	<b>987929</b>	<b>393662</b>



Table 22: Energy Use of ASHRAE Standard 90.1-2004 and 90.1-2007 Code-Compliant Retail and Food Service Building Types

<i>Non-attainment Counties</i>	Retail				Food Service			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)
Brazoria	5187197	4832995	5582	4803	5045577	4968488	22409	22040
Chambers	0	0	0	0	0	0	0	0
Collin	17364041	16178356	18685	16076	16889972	16631919	75014	73778
Dallas	10161962	9468063	10935	9408	9884522	9733502	43900	43177
Denton	5850241	5450764	6295	5416	5690519	5603577	25273	24857
El Paso	7854824	7318466	8452	7272	7640374	7523640	33933	33375
Ellis	130034	121155	140	120	126484	124551	562	553
Fort Bend	4916829	4581089	5291	4552	4782591	4709520	21241	20891
Galveston	4694098	4373566	5051	4346	4565940	4496180	20279	19945
Harris	24508185	22834670	26372	22691	23839068	23474843	105877	104133
Johnson	1740653	1621794	1873	1612	1693130	1667261	7520	7396
Kaufman	283242	263901	305	262	275509	271300	1224	1203
Liberty	87548	81570	94	81	85157	83856	378	372
Montgomery	17392365	16204747	18715	16103	16917523	16659049	75136	73899
Parker	1141982	1064003	1229	1057	1110803	1093832	4933	4852
Rockwall	2437171	2270752	2623	2256	2370632	2334413	10529	10355
Tarrant	19893910	18535476	21407	18419	19350771	19055121	85943	84528
Waller	0	0	0	0	0	0	0	0
Wise	0	0	0	0	0	0	0	0
<i>Affected Counties</i>	Retail				Food Service			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)
Bastrop	708106	659754	762	656	688773	678250	3059	3009
Bexar	11172622	10409711	12022	10344	10867589	10701549	48267	47472
Caldwell	0	0	0	0	0	0	0	0
Comal	3471006	3233992	3735	3214	3376241	3324657	14995	14748
Gregg	457050	425841	492	423	444572	437779	1974	1942
Guadalupe	2174528	2026043	2340	2013	2115160	2082844	9394	9239
Harrison	0	0	0	0	0	0	0	0
Hays	678494	632164	730	628	659970	649887	2931	2883
Nueces	473787	441435	510	439	460852	453811	2047	2013
Rusk	106860	99563	115	99	103942	102354	462	454
San Patricio	108147	100762	116	100	105194	103587	467	460
Smith	1224379	1140774	1318	1134	1190952	1172756	5289	5202
Travis	7284477	6787065	7839	6744	7085598	6977341	31469	30951
Upshur	245906	229114	265	228	239192	235538	1062	1045
Victoria	34762	32388	37	32	33813	33296	150	148
Williamson	3226387	3006077	3472	2987	3138301	3090353	13938	13709
Wilson	283242	263901	305	262	275509	271300	1224	1203

Table 22: Energy Use of ASHRAE Standard 90.1-2004 and 90.1-2007 Code-Compliant Retail and Food Service Building Types (Continued)

Other ERCOT Counties	Retail				Food Service			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)
ANDERSON	334741	311883	360	310	325602	320627	1446	1422
ANDREWS	0	0	0	0	0	0	0	0
ANGELINA	762179	710135	820	706	741370	730043	3293	3238
ARANSAS	0	0	0	0	0	0	0	0
ARCHER	0	0	0	0	0	0	0	0
AT ASCOSA	0	0	0	0	0	0	0	0
AUSTIN	106860	99563	115	99	103942	102354	462	454
BANDERA	0	0	0	0	0	0	0	0
BAYLOR	0	0	0	0	0	0	0	0
BEE	0	0	0	0	0	0	0	0
BELL	1165156	1085594	1254	1079	1133345	1116029	5034	4951
BLANCO	0	0	0	0	0	0	0	0
BORDEN	0	0	0	0	0	0	0	0
BOSQUE	0	0	0	0	0	0	0	0
BRAZOS	1466423	1366290	1578	1358	1426387	1404594	6335	6231
BREWSTER	0	0	0	0	0	0	0	0
BRISCOE	0	0	0	0	0	0	0	0
BROOKS	0	0	0	0	0	0	0	0
BROWN	86260	80370	93	80	83905	82623	373	367
BURLESON	0	0	0	0	0	0	0	0
BURNET	0	0	0	0	0	0	0	0
CALHOUN	0	0	0	0	0	0	0	0
CALLAHAN	0	0	0	0	0	0	0	0
CAMERON	1693017	1577411	1822	1567	1646794	1621634	7314	7193
CHEROKEE	0	0	0	0	0	0	0	0
CHILDRESS	0	0	0	0	0	0	0	0
CLAY	0	0	0	0	0	0	0	0
COKE	0	0	0	0	0	0	0	0
COLEMAN	0	0	0	0	0	0	0	0
COLORADO	0	0	0	0	0	0	0	0
COMANCHE	0	0	0	0	0	0	0	0
CONCHO	0	0	0	0	0	0	0	0
COOKE	0	0	0	0	0	0	0	0
CORYELL	0	0	0	0	0	0	0	0
COTTLE	0	0	0	0	0	0	0	0
CRANE	0	0	0	0	0	0	0	0
CROCKETT	0	0	0	0	0	0	0	0
CROSBY	0	0	0	0	0	0	0	0
CULBERSON	0	0	0	0	0	0	0	0
DAWSON	0	0	0	0	0	0	0	0
DEWITT	860027	801301	925	796	836546	823765	3715	3654
DELTA	0	0	0	0	0	0	0	0
DICKENS	0	0	0	0	0	0	0	0
DIMMIT	108147	100762	116	100	105194	103587	467	460
DUVAL	0	0	0	0	0	0	0	0
EASTLAND	0	0	0	0	0	0	0	0
ECTOR	1385312	1290718	1491	1283	1347491	1326903	5985	5886
EDWARDS	0	0	0	0	0	0	0	0
ERATH	0	0	0	0	0	0	0	0
FALLS	0	0	0	0	0	0	0	0
FANNIN	0	0	0	0	0	0	0	0
FAYETTE	0	0	0	0	0	0	0	0
FISHER	0	0	0	0	0	0	0	0
FOARD	0	0	0	0	0	0	0	0
FRANKLIN	0	0	0	0	0	0	0	0
FREESTONE	0	0	0	0	0	0	0	0
FRIO	0	0	0	0	0	0	0	0
GILLESPIE	0	0	0	0	0	0	0	0
GLASSCOCK	0	0	0	0	0	0	0	0
GOLIAD	0	0	0	0	0	0	0	0
GONZALES	0	0	0	0	0	0	0	0
GRAYSON	786641	732926	846	728	765164	753474	3398	3342
GRIMES	87548	81570	94	81	85157	83856	378	372
HALL	0	0	0	0	0	0	0	0
HAMILTON	0	0	0	0	0	0	0	0
HARDEMAN	0	0	0	0	0	0	0	0
HASKELL	0	0	0	0	0	0	0	0
HENDERSON	0	0	0	0	0	0	0	0
HIDALGO	4020753	3746201	4327	3723	3910980	3851226	17370	17084
HILL	166083	154742	179	154	161549	159080	717	706
HOOD	95272	88767	103	88	92671	91255	412	405
HOPKINS	106860	99563	115	99	103942	102354	462	454
HOUSTON	0	0	0	0	0	0	0	0
HOWARD	0	0	0	0	0	0	0	0
HUDSPETH	0	0	0	0	0	0	0	0
HUNT	776341	723330	835	719	755146	743608	3354	3299
IRION	0	0	0	0	0	0	0	0
JACK	0	0	0	0	0	0	0	0
JACKSON	245906	229114	265	228	239192	235538	1062	1045
JEFF DAVIS	0	0	0	0	0	0	0	0
JIM HOGG	0	0	0	0	0	0	0	0

Table 22: Energy Use of ASHRAE Standard 90.1-2004 and 90.1-2007 Code-Compliant Retail and Food Service Building Types (Continued)

Other ERCOT Counties	Retail				Food Service			
	Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE		Electricity (kWh/yr), DOE		Gas (mBtu/yr), DOE	
	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)	2004 (Annual)	2007 (Annual)
JIM WELLS	0	0	0	0	0	0	0	0
JONES	0	0	0	0	0	0	0	0
KARNES	0	0	0	0	0	0	0	0
KENDALL	0	0	0	0	0	0	0	0
KENEDY	0	0	0	0	0	0	0	0
KENT	0	0	0	0	0	0	0	0
KERR	99135	92365	107	92	96428	94955	428	421
KIMBLE	0	0	0	0	0	0	0	0
KING	0	0	0	0	0	0	0	0
KINNEY	0	0	0	0	0	0	0	0
KLEBERG	0	0	0	0	0	0	0	0
KNOX	0	0	0	0	0	0	0	0
LA SALLE	87548	81570	94	81	85157	83856	378	372
LAMAR	283242	263901	305	262	275509	271300	1224	1203
LAMPASAS	0	0	0	0	0	0	0	0
LAVACA	245906	229114	265	228	239192	235538	1062	1045
LEE	0	0	0	0	0	0	0	0
LEON	0	0	0	0	0	0	0	0
LIMESTONE	0	0	0	0	0	0	0	0
LIVE OAK	0	0	0	0	0	0	0	0
LLANO	0	0	0	0	0	0	0	0
LOVING	0	0	0	0	0	0	0	0
MADISON	0	0	0	0	0	0	0	0
MARTIN	0	0	0	0	0	0	0	0
MASON	0	0	0	0	0	0	0	0
MATAGORDA	128747	119955	139	119	125231	123318	556	547
MAVERICK	87548	81570	94	81	85157	83856	378	372
MCCULLOCH	0	0	0	0	0	0	0	0
MCLENNAN	814965	759316	877	755	792715	780604	3521	3463
MCMULLEN	0	0	0	0	0	0	0	0
MEDINA	86260	80370	93	80	83905	82623	373	367
MENARD	0	0	0	0	0	0	0	0
MIDLAND	1893861	1764541	2038	1753	1842155	1814010	8182	8047
MILAM	0	0	0	0	0	0	0	0
MILLS	0	0	0	0	0	0	0	0
MITCHELL	0	0	0	0	0	0	0	0
MONTAGUE	0	0	0	0	0	0	0	0
MOTLEY	0	0	0	0	0	0	0	0
NACOGDOCHES	592234	551794	637	548	576065	567264	2558	2516
NAVARRO	257493	239910	277	238	250463	246636	1112	1094
NOLAN	0	0	0	0	0	0	0	0
PALO PINTO	0	0	0	0	0	0	0	0
PECOS	106860	99563	115	99	103942	102354	462	454
PRESIDIO	0	0	0	0	0	0	0	0
RAINS	0	0	0	0	0	0	0	0
REAGAN	0	0	0	0	0	0	0	0
REAL	106860	99563	115	99	103942	102354	462	454
RED RIVER	0	0	0	0	0	0	0	0
REEVES	87548	81570	94	81	85157	83856	378	372
REFUGIO	0	0	0	0	0	0	0	0
ROBERTSON	0	0	0	0	0	0	0	0
RUNNELS	0	0	0	0	0	0	0	0
SAN SABA	0	0	0	0	0	0	0	0
SCHLEICHER	0	0	0	0	0	0	0	0
SCURRY	87548	81570	94	81	85157	83856	378	372
SHACKELFORD	0	0	0	0	0	0	0	0
SOMERVELL	0	0	0	0	0	0	0	0
STARR	27037	25191	29	25	26299	25897	117	115
STEPHENS	0	0	0	0	0	0	0	0
STERLING	0	0	0	0	0	0	0	0
STONEWALL	0	0	0	0	0	0	0	0
SUTTON	0	0	0	0	0	0	0	0
TAYLOR	245906	229114	265	228	239192	235538	1062	1045
TERRELL	0	0	0	0	0	0	0	0
THROCKMORTON	0	0	0	0	0	0	0	0
TITUS	0	0	0	0	0	0	0	0
TOM GREEN	2652178	2471077	2854	2456	2579769	2540354	11458	11269
UPTON	0	0	0	0	0	0	0	0
UVALDE	23174	21592	25	21	22542	22197	100	98
VAL VERDE	0	0	0	0	0	0	0	0
VAN ZANDT	189257	176334	204	175	184090	181278	818	804
WARD	0	0	0	0	0	0	0	0
WASHINGTON	0	0	0	0	0	0	0	0
WEBB	8714851	8119767	9378	8069	8476920	8347406	37649	37029
WHARTON	248481	231514	267	230	241697	238004	1073	1056
WICHITA	708106	659754	762	656	688773	678250	3059	3009
WILBARGER	0	0	0	0	0	0	0	0
WILLACY	29612	27590	32	27	28803	28363	128	126
WINKLER	0	0	0	0	0	0	0	0
YOUNG	0	0	0	0	0	0	0	0
ZAPATA	0	0	0	0	0	0	0	0
ZAVALA	0	0	0	0	0	0	0	0
<b>Total</b>	<b>187351914</b>	<b>174558792</b>	<b>201603</b>	<b>173459</b>	<b>182236874</b>	<b>179452575</b>	<b>809374</b>	<b>796043</b>

Table 23: Annual Electricity and Natural Gas Savings from New Commercial Construction

Counties	Apartments		Healthcare		Lodging		Office		Education		Retail		Food Service		Total		Total*1.07 (T & D loss) for eGrid	
	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	MWh/yr	Therm/yr
<b>Non-attainment Counties</b>																		
(square feet in thousands)																		
BRAZORIA	-111068	-596	-35498	-78	0	0	-4494	-9	-334945	-26239	-354202	-779	-77089	-369	-917296	-28070	982	300344
CHAMBERS	0	0	0	0	0	0	0	0	-8792	-689	0	0	0	0	-8792	-689	9	7370
COLLIN	-764758	-4101	-289068	-638	-107440	-2047	-732056	-1412	-504633	-39531	-1185685	-2608	-258053	-1236	-3841692	-51573	4111	551831
DALLAS	-2406941	-12906	-590766	-1304	-127328	-2426	-436793	-842	-353268	-27674	-693899	-1527	-151020	-723	-4760015	-47402	5093	507200
DENTON	-399755	-2143	-223602	-494	-19993	-381	-55925	-108	-136278	-10676	-399477	-879	-86942	-416	-1321973	-15097	1415	161534
EL PASO	-230506	-1236	-503776	-1112	-24161	-460	-69653	-134	-39494	-3094	-536358	-1180	-116733	-559	-1520682	-7776	1627	83199
ELLIS	0	0	-44840	-99	-21435	-408	-1146	-2	-33058	-2590	-8879	-20	-1932	-9	-111291	-3128	119	33470
FORT BEND	-188020	-1008	-189299	-418	0	0	-38556	-74	-521620	-40862	-335740	-739	-73071	-350	-1346306	-43451	1441	464927
GALVESTON	-32824	-176	-10911	-24	-13856	-264	-1079	-2	-125728	-9849	-320531	-705	-69761	-334	-574689	-11354	615	121492
HARRIS	-2653675	-14229	-2736952	-6043	-237229	-4519	-388845	-750	-1578435	-123650	-1673515	-3682	-364224	-1744	-9632875	-154616	10307	1654396
JOHNSON	-35901	-193	-31089	-69	0	0	0	0	0	0	-118859	-261	-25868	-124	-211717	-646	227	6917
KAUFMAN	0	0	0	0	0	0	0	0	-63374	-4965	-19341	-43	-4209	-20	-86924	-5027	93	53794
LIBERTY	0	0	0	0	0	0	0	0	-101989	-7990	-5978	-13	-1301	-6	-109268	-8009	117	85695
MONTGOMERY	-392944	-2107	-5979	-13	0	0	-127151	-245	-239920	-18795	-1187619	-2613	-258474	-1238	-2212086	-25010	2367	267609
PARKER	-12986	-70	-58516	-129	0	0	-1393	-3	0	0	-77979	-172	-16971	-81	-167845	-454	180	4861
ROCKWALL	-47410	-254	-22569	-50	0	0	-921	-2	0	0	-166420	-366	-36220	-173	-273540	-845	293	9045
TARRANT	-374911	-2010	-348107	-769	-49992	-952	-324270	-625	-502207	-39341	-1358434	-2988	-295650	-1416	-3253571	-48102	3481	514692
WALLER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WISE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Affected Counties</b>																		
(square feet in thousands)																		
BASTROP	0	0	0	0	0	0	0	0	-6084	-477	-48352	-106	-10523	-50	-64960	-633	70	6777
BEXAR	-1495932	-8021	-851883	-1881	-93812	-1787	-291465	-562	-460919	-36107	-762910	-1678	-166040	-795	-4122962	-50832	4412	543899
CALDWELL	0	0	0	0	0	0	0	0	-113665	-8904	0	0	0	0	-113665	-8904	122	95275
COMAL	-63658	-341	0	0	0	0	-5797	-11	-10551	-827	-237014	-521	-51584	-247	-368603	-1947	394	20837
GREGG	0	0	0	0	0	0	-517	-1	-31230	-2446	-31209	-69	-6792	-33	-69748	-2549	75	22720
GUADALUPE	-18874	-101	-3438	-8	0	0	-12313	-24	-146899	-11508	-148485	-327	-32316	-155	-362325	-12122	388	129701
HARRISON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HAYS	-70736	-379	-81833	-181	-220507	-4201	-1977	-4	-163182	-12783	-46330	-102	-10083	-48	-594648	-17698	636	189369
NUECES	0	0	0	0	0	0	-33995	-66	-107405	-8414	-32352	-71	-7041	-34	-180793	-8584	193	91851
RUSK	0	0	0	0	0	0	0	0	0	0	-7297	-16	-1588	-8	-8885	-24	10	253
SAN PATRICIO	-45030	-241	-9641	-21	-8581	-163	-2629	-5	0	0	-7385	-16	-1607	-8	-74873	-455	80	4871
SMITH	0	0	-30790	-68	0	0	-1123	-2	-29717	-2328	-83605	-184	-18196	-87	-163432	-2669	175	28560
TRAVIS	-1436193	-7701	-57470	-127	-242346	-4617	-566663	-1093	-308815	-24192	-497413	-1094	-108257	-518	-3217156	-39342	3442	420957
UPSHUR	0	0	0	0	0	0	0	0	0	0	-16791	-37	-3654	-17	-20446	-54	22	582
VICTORIA	0	0	-11509	-25	0	0	-7954	-15	0	0	-2374	-5	-517	-2	-22353	-48	24	518
WILLIAMSON	-423922	-2273	-275691	-609	-60842	-1159	-63542	-123	-97382	-7629	-220310	-485	-47948	-230	-1189636	-12506	1273	133816
WILSON	0	0	0	0	0	0	0	0	-3869	-303	-19341	-43	-4209	-20	-27419	-366	29	3914

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

Table 23: Annual Electricity and Natural Gas Savings from New Commercial Construction (Continued)

Counties	Apartments		Healthcare		Lodging		Office		Education		Retail		Food Service		Total		Total*1.07 (T&D loss) for eGrid	
	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	MWh/yr	Therm/yr
<i>Other ERCOT Counties</i>																		
(Square Feet in Thousands)																		
ANDERSON	0	0	0	0	0	0	0	0	-17233	-1350	-22857	-50	-4975	-24	-45065	-1424	48	15237
ANDREWS	0	0	-77722	-172	0	0	0	0	0	0	0	0	0	0	-77722	-172	83	1836
ANGELINA	0	0	0	0	0	0	0	0	0	0	0	-52045	-114	-11327	-54	-63372	-169	1805
ARANSAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ARCHER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-21101	-1653	23	17687
ATASCOSA	-17643	-95	0	0	0	0	0	0	-51698	-4050	0	0	0	0	-69341	-4144	74	44346
AUSTIN	0	0	0	0	0	0	0	0	0	0	0	-7297	-16	-1588	-8	-8885	-24	10
BANDERA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BAYLOR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BEE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BELL	-87189	-468	-4858	-11	0	0	-3707	-7	-1547	-121	-79561	-175	-17316	-83	-194178	-865	208	9250
BLANCO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BORDEN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BOSQUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BRAZOS	-162540	-872	-31836	-70	-99105	-1888	-36399	-70	-318346	-24938	-100133	-220	-21793	-104	-770153	-28163	824	301344
BREWSTER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BROCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BROOKS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BROWN	-14278	-77	0	0	0	0	0	0	0	0	0	-5890	-13	-1282	-6	-21451	-96	23
BURLESON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BURNET	0	0	-2242	-5	0	0	0	0	-9320	-730	0	0	0	0	-11562	-735	12	7865
CALHOUN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CALLAHAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAMERON	-5929	-32	-91633	-202	-3341	-64	-3370	-7	-49095	-3846	-115606	-254	-25160	-120	-294125	-4325	315	48418
CHEROKEE	-11345	-61	0	0	0	0	0	0	-67946	-5323	0	0	0	0	-79290	-5383	85	57603
CHILDRESS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLAY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COKE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COLEMAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COLORADO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COMANCHE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CONCHO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COOKE	0	0	-13452	-30	0	0	0	0	-876	-2	-23844	-1868	0	0	0	-38173	-1899	41
CORYELL	-16822	-90	0	0	0	0	0	0	0	0	0	0	0	0	-16822	-90	18	965
COTTLE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CRANE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CROCKETT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CROSBY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CULBERSON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DAWSON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEWITT	0	0	0	0	0	0	0	0	-674	-1	-40549	-3177	-58726	-129	-12781	-61	-112731	-3368
DELTA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DICKENS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DIMMIT	0	0	0	0	0	0	0	0	0	0	0	-7385	-16	-1607	-8	-8992	-24	10
DUVAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EASTLAND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ECTOR	-20905	-112	-7473	-17	0	0	-989	-2	-12520	-981	-94595	-208	-20588	-99	-157069	-1418	168	15172
EDWARDS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ERATH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FALLS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FANNIN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FAYETTE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FISHER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FOARD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FRANKLIN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FREESTONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FRIO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GILLESPIE	0	0	0	0	0	0	0	0	-5908	-463	0	0	0	0	-5908	-463	6	4952
GLASSCOCK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GOLIAD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GONZALES	0	0	-37367	-83	0	0	-2179	-4	-16705	-1309	0	0	0	0	-56251	-1395	60	14930
GRAYSON	0	0	0	0	0	0	0	0	0	0	0	-53715	-118	-11691	-56	-65405	-174	70
CRIMES	0	0	0	0	0	0	0	0	0	0	0	-5978	-13	-1301	-6	-7279	-19	8
HALL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HAMILTON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HARDEMAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HASKELL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HENDERSON	0	0	-11210	-25	0	0	0	0	0	0	0	0	0	0	-11210	-25	12	265
HIDALGO	-76234	-409	-63523	-140	-32214	-614	-21255	-41	-68614	-5375	-274553	-604	-59754	-286	-596147	-7469	638	79916
HILL	0	0	0	0	0	0	0	0	0	0	0	-11341	-25	-2468	-12	-13809	-37	15
HOOD	0	0	0	0	0	0	0	0	-3101	-6	0	-6506	-14	-1416	-7	-11022	-27	12
HOPKINS	0	0	0	0	0	0	0	0	0	0	0	-7297	-16	-1588	-8	-8885	-24	10
HOUSTON	0	0	-13452	-30	0	0	0	0	0	0	0	0	0	0	-13452	-30	14	318
HOWARD	0	0	0	0	-12977	-247	0	0	0	0	0	0	0	0	-12977	-247	14	2645
HUDSPETH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HUNT	0	0	0	0	0	0	0	0	0	-84264	-6601	-53012	-117	-11537	-55	-148813	-6773	159
IRION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JACKSON	0	0	0	0	0	0	0	0	0	0	0	-16791	-37	-3654	-17	-20446	-54	22
JEFF DAVIS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JIM HOGG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JIM WELLS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JONES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KARNES	0	0	0	0	0	0	0	0	0	-61880	-4824	0	0	0	-61880	-4824	66	51617

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

Table 23: Annual Electricity and Natural Gas Savings from New Commercial Construction (Continued)

Counties	Apartments		Healthcare		Lodging		Office		Education		Retail		Food Service		Total		Total*1.07 (T&D loss) for eCrid	
	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	kWh/yr	MBtu/yr	MWh/yr	Therm/yr
<i>Other ERCOT Counties</i>																		
(square feet in thousands)																		
KENDALL	0	0	-70548	-156	0	0	0	0	-52436	-4108	0	0	0	0	-122984	-4263	132	45619
KENEDY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KENT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KERR	0	0	0	0	0	0	0	0	-1407	-110	-6769	-15	-1473	-7	-9649	-132	10	1414
KIMBLE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KINNEY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KLEBERG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KNOX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LA SALLE	0	0	0	0	0	0	0	0	0	0	-5978	-13	-1301	-6	-7279	-19	8	207
LAMAR	0	0	0	0	0	0	-5617	-11	0	0	-19341	-43	-4209	-20	-29167	-74	31	787
LAMPASAS	0	0	0	0	0	0	0	0	-10551	-827	0	0	0	0	-10551	-827	11	8844
LAVACA	0	0	0	0	0	0	0	0	-48744	-3818	-16791	-37	-3654	-17	-69190	-3873	74	41440
LEE	0	0	0	0	0	0	0	0	-9214	-722	0	0	0	0	-9214	-722	10	7723
LEON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIMESTONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVE OAK	0	0	0	0	0	0	0	0	-18639	-1460	0	0	0	0	-18639	-1460	20	15624
LLANO	0	0	0	0	0	0	0	0	-21101	-1653	0	0	0	0	-21101	-1653	23	17687
LOVING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MADISON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MARTIN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MASON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MATAGORDA	0	0	0	0	0	0	-17975	-35	-1758	-138	-8791	-19	-1913	-9	-30438	-201	33	2180
MAVERICK	0	0	0	0	0	0	0	0	-1477	-116	-5978	-13	-1301	-6	-8756	-135	9	1445
MCCULLOCH	-3344	-18	0	0	0	0	0	0	0	0	0	0	0	0	-3344	-18	4	192
MCLENNAN	-15391	-822	-77722	-172	-30702	-585	-1011	-2	-31652	-2480	-55649	-122	-12111	-58	-362238	-4241	388	45377
MCMLLEN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MEDINA	0	0	0	0	0	0	-1393	-3	-4220	-331	-5890	-13	-1283	-6	-12785	-352	14	3770
MENARD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MIDLAND	-94082	-504	-49324	-109	-12520	-239	-14380	-28	0	0	-129320	-284	-28145	-135	-327771	-1299	351	13898
MILAM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MILLS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MITCHELL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MONTAGUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOTLEY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NACOGDOCHES	0	0	0	0	0	0	0	0	0	0	-40440	-89	-8801	-42	-49241	-131	53	1403
NAVARRO	0	0	0	0	0	0	-809	-2	0	0	-17583	-39	-3827	-18	-22216	-59	24	627
NAVASO	0	0	-15694	-35	0	0	0	0	-3024	-237	0	0	0	0	-18718	-272	20	2906
PALO PINTO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PECOS	0	0	0	0	0	0	0	0	0	0	-7297	-16	-1588	-8	-8885	-24	10	253
PRESIDIO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RAINS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REAGAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REAL	0	0	0	0	0	0	0	0	0	0	-7297	-16	-1588	-8	-8885	-24	10	253
RED RIVER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REEVES	-7816	-42	0	0	-19923	-380	0	0	0	0	-5978	-13	-1301	-6	-35018	-441	37	4717
REFUGO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ROBERTSON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RUNNELS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SAN SABA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCHLEICHER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCURRY	0	0	0	0	0	0	0	0	-45719	-3582	-5978	-13	-1301	-6	-52998	-3601	57	38529
SHACKELFORD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOMERVELL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STARR	0	0	0	0	0	0	0	0	0	0	-1846	-4	-402	-2	-2248	-6	2	64
STEPHENS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STERLING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STONEWALL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SUTTON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TAYLOR	-10586	-57	-32509	-72	-13223	-252	-59003	-114	-90242	-7069	-16791	-37	-3654	-17	-226009	-7618	242	81513
TERRELL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
THROCKMORTON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TITUS	0	0	0	0	0	0	0	0	-5908	-463	0	0	0	0	-5908	-463	6	4952
TOM GREEN	0	0	-65915	-146	-7983	-153	0	0	0	0	-181101	-398	-39415	-189	-294414	-885	315	9467
UPTON	0	0	0	0	0	0	0	0	-2638	-207	0	0	0	0	-2638	-207	3	2211
UVALDE	0	0	0	0	0	0	0	0	0	0	-1582	-3	-344	-2	-1927	-5	2	55
VAL VERDE	0	0	0	0	0	0	0	0	-19413	-1521	0	0	0	0	-19413	-1521	21	16272
VAN ZANDT	0	0	0	0	0	0	0	0	0	0	-12923	-28	-2813	-13	-15736	-42	17	448
WARD	-14689	-79	0	0	-4660	-89	0	0	0	0	0	0	0	0	-19349	-168	21	1793
WASHINGTON	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WEBB	-5006	-27	0	0	0	0	-517	-11	-293693	-23007	-595084	-1309	-129514	-620	-1023813	-24964	1095	267116
WHAARTON	0	0	0	0	0	0	-786	-2	-12309	-964	-16967	-37	-3693	-18	-33753	-1021	36	10922
WICHTA	0	0	-60908	-134	-8616	-164	0	0	-21804	-1708	-48352	-106	-10523	-50	-150204	-2163	161	23149
WILBARGER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WILLACY	0	0	0	0	0	0	0	0	-3693	-289	-3022	-4	-440	-2	-6153	-296	7	3165
WINKLER	0	0	0	0	0	0	0	0	-8792	-689	0	0	0	0	-8792	-689	9	7370
YOUNG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ZAPATA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ZAVALA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Total</b>	<b>-11907841</b>	<b>-63849</b>	<b>-7140604</b>	<b>-15765</b>	<b>-1472788</b>	<b>-28058</b>	<b>-3344300</b>	<b>-6450</b>	<b>-7586031</b>	<b>-594267</b>	<b>-12793123</b>	<b>-28144</b>	<b>-2784299</b>	<b>-13331</b>	<b>-47028986</b>	<b>-749865</b>	<b>50321</b>	<b>8023556</b>

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

Table 24: 2015 Totalized Annual Electricity Savings by CM Zone from New Commercial Construction

<b>CM Zone</b>	<b>Total Electricity Savings by CM Zone (MWh) 2015-TRY 2008</b>
<b>Houston (H)</b>	16,631
<b>North (N)</b>	13,155
<b>West (W)</b>	1,154
<b>South (S)</b>	10,424
<b>Total</b>	41,365

Table 25: 2015 Annual NOx Reductions from New Commercial Construction Using 2010 eGRID

Area	County	H	NOx Reductions (lbs)	N	NOx Reductions (lbs)	W	NOx Reductions (lbs/year)	S	NOx Reductions (lbs)	Total Nox Reductions (lbs)	Total Nox Reductions (Tons)	
Houston-Galveston Area	Brazoria	0.0562032	934.7249787	0.0000071	0.0938058	0.0000003	0.0003974	0.0005265	5.4888674	940.3080493	0.4701540	
	Chambers	0.0204500	340.1075342	0.0000026	0.0341320	0.0000001	0.0001446	0.0001916	1.9971705	342.1389813	0.1710695	
	Fort Bend	0.0313463	521.3260465	0.0000040	0.0523185	0.0000002	0.0002216	0.0002937	3.0613171	524.4399037	0.2622200	
	Galveston	0.0226620	376.8950256	0.0000029	0.0378239	0.0000001	0.0001602	0.0002123	2.2131930	379.1462027	0.1895731	
	Harris	0.1486911	2472.9074585	0.000189	0.2481726	0.0000009	0.0010512	0.0013930	14.5213420	2487.6780243	1.2438390	
Dallas/ Fort Worth Area	Collin	0.0012932	21.5068987	0.0079329	104.3614772	0.0003832	0.4420701	0.0000809	0.8436927	127.1541387	0.0635771	
	Dallas	0.0024826	41.2886844	0.0152295	200.3519039	0.0007356	0.8486808	0.0001554	1.6197111	244.1089802	0.1220545	
	Denton	0.0001267	2.1065630	0.0007770	10.2220236	0.0000375	0.0433000	0.0000079	0.0826382	12.4545248	0.0062273	
	Tarrant	0.0004742	7.8862130	0.0029089	38.2675743	0.0001405	0.1620996	0.0000297	0.3093677	46.6252546	0.0233126	
	Ellis	0.0029920	49.7603333	0.0183544	241.4602855	0.0008865	1.0228138	0.0001873	1.9520449	294.1954776	0.1470977	
	Johnson	0.0007256	12.0675599	0.0044512	58.5574145	0.0002150	0.2480463	0.0000454	0.4733975	71.3464183	0.0356732	
	Kaufman	0.00059718	99.3188304	0.0366343	481.9411677	0.0017695	2.0414790	0.0003738	3.8961720	587.1976491	0.2935988	
	Parker	0.0000012	0.0204484	0.0000075	0.0992250	0.0000004	0.0004203	0.0000001	0.0008022	0.1208950	0.0000604	
	Henderson	0.0006908	11.4884174	0.0042376	55.7471456	0.0002047	0.2361422	0.0000432	0.4506784	67.9223836	0.0339612	
	Hood	0.00050771	84.4380434	0.0311454	409.7326663	0.0015044	1.7356073	0.0003178	3.3124146	499.2187315	0.2496094	
San Antonio Area	Hunt	0.0008463	147.1249212	0.0047066	61.9180649	0.0002273	0.2622819	0.0652823	680.5265432	889.8318112	0.4449159	
	Bexar	0.0138906	231.0170239	0.0009368	12.3242353	0.0000452	0.0522049	0.1109355	1156.4326919	1399.8261559	0.6999131	
Austin Area	Gadalupe	0.0032029	53.2677967	0.0002160	2.8417164	0.0000104	0.0120374	0.0255795	266.6497063	322.7712568	0.1613856	
	Bastrop	0.0033782	56.1838197	0.0002278	2.9972796	0.0000110	0.0126963	0.0269798	281.2468308	340.4406263	0.1702203	
Corpus Christi Area	Hays	0.0008331	13.8559083	0.0000562	0.7391813	0.0000027	0.0031311	0.0066537	69.3603658	83.9558565	0.0419793	
	Travis	0.0051785	86.1251032	0.0003493	4.5945793	0.0000169	0.0194624	0.0413577	431.1279024	521.8670473	0.2609373	
Victoria Area	Nueces	0.0128578	213.8399107	0.0008672	11.4078752	0.0000419	0.0483232	0.1026870	1070.469282	1295.7430373	0.6478715	
	San Patricio	0.0015100	25.1122965	0.0001018	1.3396842	0.0000049	0.0056748	0.0120591	125.7079681	152.1656236	0.0760828	
Other ERCOT counties	Victoria	0.0021192	35.2440416	0.0001429	1.8801898	0.0000069	0.0079644	0.0169244	176.4257942	213.5579900	0.1067790	
	Andrews	0.0000037	0.0622712	0.0000230	0.3021687	0.0003903	4.4997727	0.0000002	0.0024428	4.8666554	0.0024333	
	Bosque	0.0022204	36.9282522	0.0136212	179.1930585	0.0006579	0.7590529	0.0001390	1.4486560	218.3290196	0.1091645	
	Brazos	0.0024089	40.0624505	0.0112305	147.7428319	0.0005425	0.6258313	0.0047829	49.8587916	238.2899054	0.1191450	
	Calhoun	0.0009466	15.7427804	0.0000638	0.8398417	0.0000031	0.0035575	0.0075598	78.8057333	95.3919129	0.0476960	
	Cameron	0.0063536	105.6683148	0.0004285	5.6371654	0.0000207	0.0238788	0.0507425	528.9579600	640.2873189	0.3201437	
	Cherokee	0.0027392	45.5535888	0.0168033	221.0557930	0.0008116	0.9363814	0.0001714	1.7870882	269.3346215	0.1346673	
	Ector	0.0019215	31.9569342	0.0006604	8.6872865	0.0911346	105.1462275	0.0146527	152.7449420	298.5317903	0.1492659	
	Fannin	0.0000041	0.0674380	0.0000249	0.3272406	0.0000012	0.0013862	0.0000003	0.0026455	0.3987102	0.0001994	
	Fayette	0.0051867	86.2609302	0.0103217	135.7866084	0.0004986	0.5751854	0.0283993	296.0447626	518.6674865	0.2593337	
	Freestone	0.0047643	79.2365320	0.0292268	384.4925133	0.0014117	1.6286913	0.0002982	3.1083648	468.4661014	0.2342331	
	Hidalgo	0.0053716	89.3355894	0.0003623	4.7658515	0.0000175	0.0201879	0.0428994	447.1990610	541.3206898	0.2706603	
	Howard	0.0002411	4.0100709	0.0007641	10.0517105	0.1283942	148.1291833	0.0009490	9.8926302	172.0835950	0.0860418	
	Jack	0.0030783	51.1959550	0.0188839	248.4265897	0.0009121	1.0523227	0.0001927	2.0083628	302.6832303	0.1513416	
	Lamar	0.0040001	66.5270409	0.0245388	322.8201504	0.0011853	1.3674502	0.0002504	2.6097850	393.3244265	0.1966622	
	Llano	0.0040314	67.0476905	0.0002719	3.5768425	0.0000131	0.0151513	0.0321966	335.6295563	406.2692406	0.2031346	
	McLennan	0.0056576	94.0928821	0.0347066	456.5824354	0.0016764	1.9340606	0.0003541	3.6911636	556.3005417	0.2781503	
	Milam	0.0012686	21.0984069	0.0000856	1.1255522	0.0000041	0.0047678	0.0101316	105.6151062	127.8438331	0.0639219	
	Mitchell	0.0000311	0.5177079	0.0001910	2.5121596	0.0324260	37.4100502	0.0000019	0.0203091	40.4602268	0.0202301	
	Nolan	0.0000293	0.4865507	0.0001795	2.3609705	0.0304745	35.1586042	0.0000018	0.0190869	38.0252122	0.0190126	
	Palo Pinto	0.0036129	60.0873974	0.0221635	291.5720044	0.0010705	1.2350846	0.0002261	2.3571646	355.2516510	0.1776258	
	Pecos	0.0000020	0.0327624	0.0000121	0.1589784	0.0002520	2.3674406	0.0000001	0.0012852	2.5604666	0.0012802	
	Robertson	0.0039506	65.7026701	0.0055755	73.3480321	0.0002693	0.3106986	0.0246170	256.6161810	395.9775818	0.1979888	
	Upton	0.0000025	0.0423004	0.0000156	0.2052611	0.0026494	3.0566644	0.0000002	0.0016594	3.3058853	0.0016529	
	Ward	0.0001995	3.3182374	0.0012239	16.1016316	0.2078335	239.7788964	0.0000125	0.1301709	259.3289364	0.1296645	
	Webb	0.0042017	69.8796233	0.0002834	3.7279197	0.0000137	0.0157913	0.0335565	349.8057397	423.4290740	0.2117145	
	Wharton	0.0021095	35.0836728	0.0001423	1.8716345	0.0000069	0.0079282	0.0168474	175.6230149	212.5862504	0.1062931	
	Wichita	0.0000121	0.2014728	0.0000743	0.9776396	0.0126190	14.5586075	0.0000008	0.0079036	15.7456234	0.0078728	
	Wilbarger	0.0179710	298.8789092	0.1102430	1450.2995037	0.0053249	6.1433970	0.0011247	11.7247015	1767.0465114	0.8835233	
	Wise	0.0010202	16.9667970	0.0062583	82.3307920	0.0003023	0.3487492	0.0000638	0.6655894	100.3119276	0.0501560	
	Young	0.0071054	118.1711401	0.0435880	573.4213439	0.0021054	2.4289845	0.0004447	4.6357280	698.6571965	0.3493286	
	<b>Total</b>		<b>0.4414501</b>	<b>7341.831997</b>	<b>0.4812863</b>	<b>6331.551453</b>	<b>0.5345786</b>	<b>616.7467962</b>	<b>0.6829349</b>	<b>7119.163127</b>	<b>21409.2933732</b>	<b>10.7046467</b>
	<b>Energy Savings by PCA (MWh)</b>			16,631		13,155		1,154		10,424		



Table 26: 2015 Annual Electricity and Natural Gas Savings and NOx Reductions from New Commercial Construction

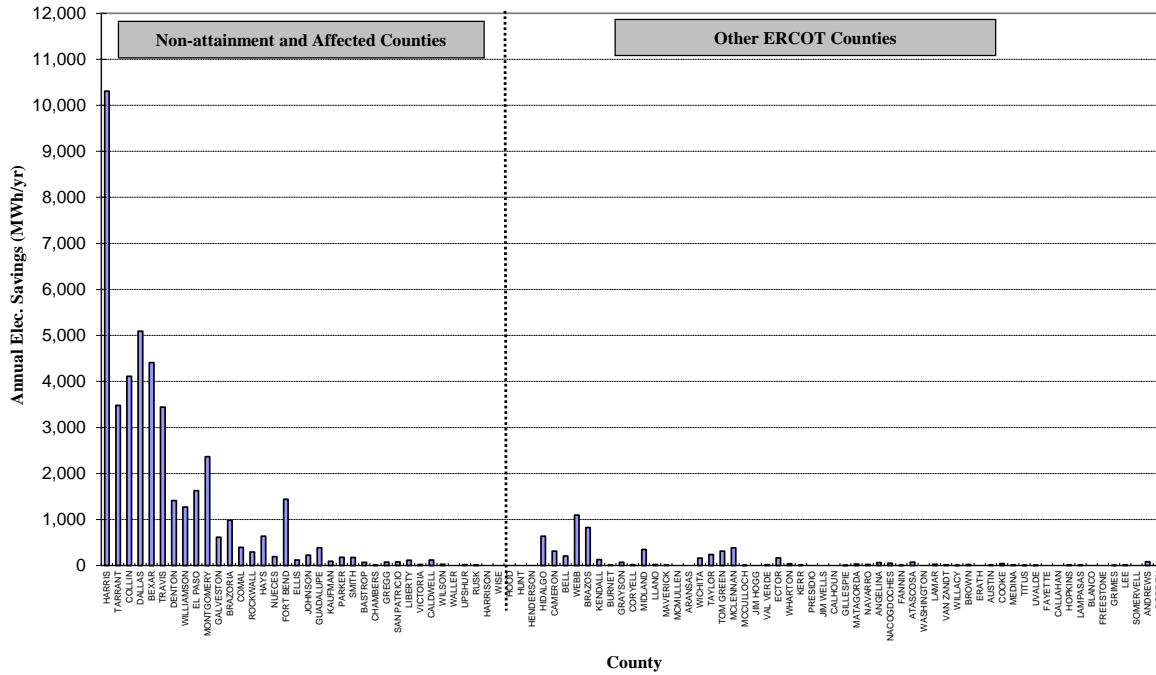
	County	Electricity Savings and Resultant NOx Reductions (Commercial)		Total Natural Gas Savings and Resultant NOx Reductions (Commercial)		Total Nox Reductions
		Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual Nox Reductions (Tons)	Total Annual N.G. Savings (Therm/County)	Annual Nox Reductions (Tons)	Annual Nox Reductions (Tons)
Non-attainment and Affected Counties	HARRIS	10,307.18	1.24	1,654,396.26	7.61	8.85
	TARRANT	3,481.32	0.02	514,691.91	2.37	2.39
	COLLIN	4,110.61	0.06	551,830.80	2.54	2.60
	DALLAS	5,093.22	0.12	507,200.44	2.33	2.46
	BEXAR	4,411.57	0.70	543,898.67	2.50	3.20
	TRAVIS	3,442.36	0.26	420,956.79	1.94	2.20
	DENTON	1,414.51	0.01	161,533.84	0.74	0.75
	WILLIAMSON	1,272.91		133,816.47	0.62	0.62
	EL PASO	1,627.13		83,198.75	0.38	0.38
	MONTGOMERY	2,366.93		267,609.43	1.23	1.23
	GALVESTON	614.92	0.19	121,492.47	0.56	0.75
	BRAZORIA	981.51	0.47	300,343.90	1.38	1.85
	COMAL	394.41		20,837.26	0.10	0.10
	ROCKWALL	292.69		9,045.23	0.04	0.04
	HAYS	636.27	0.04	189,369.36	0.87	0.91
	NUECES	193.45	0.65	91,851.14	0.42	1.07
	FORT BEND	1,440.55	0.26	464,926.59	2.14	2.40
	ELLIS	119.08	0.15	33,470.26	0.15	0.30
	JOHNSON	226.54	0.04	6,917.32	0.03	0.07
	GUADALUPE	387.69	0.16	129,700.70	0.60	0.76
	KAUFMAN	93.01	0.29	53,791.18	0.25	0.54
	PARKER	179.59	0.00	4,861.21	0.02	0.02
	SMITH	174.87		28,560.12	0.13	0.13
	BASTROP	69.51	0.17	6,777.09	0.03	0.20
	CHAMBERS	9.41	0.17	7,369.63	0.03	0.20
	GREGG	74.63		27,270.20	0.13	0.13
	SAN PATRICIO	80.11	0.08	4,870.92	0.02	0.10
	LIBERTY	116.92		85,695.03	0.39	0.39
	VICTORIA	23.92	0.11	518.37	0.00	0.11
	CALDWELL	121.62		95,274.51	0.44	0.44
	WILSON	29.34		3,913.56	0.02	0.02
	WALLER	0.00		0.00	0.00	0.00
	UPSHUR	21.88		582.48	0.00	0.00
	RUSK	9.51	0.00	253.12	0.00	0.00
	HARRISON	0.00		0.00	0.00	0.00
	WISE	0.00	0.05	0.00	0.00	0.05
	HOOD	0.00	0.25	0.00	0.00	0.25
	HUNT	0.00	0.44	0.00	0.00	0.44
	HENDERSON	0.00	0.03	0.00	0.00	0.03
	HIDALGO	637.88	0.27	79,916.45	0.37	0.64
	CAMERON	314.71	0.32	48,417.54	0.22	0.54
	BELL	207.77		9,250.50	0.04	0.04
	WEBB	1,095.48	0.21	267,115.89	1.23	1.44
	BRAZOS	824.06	0.12	301,343.79	1.39	1.51
	KENDALL	131.59		45,619.88	0.21	0.21
BURNET	12.37		7,864.77	0.04	0.04	
GRAYSON	69.98		1,863.34	0.01	0.01	
CORYELL	18.00		965.14	0.00	0.00	
MIDLAND	380.72		13,897.90	0.06	0.06	
LLANO	22.58	0.20	17,687.10	0.08	0.28	
MAVERICK	9.37		1,445.47	0.01	0.01	
MCMULLEN	0.00		0.00	0.00	0.00	
ARANSAS	0.00		0.00	0.00	0.00	
WICHITA	160.72	0.01	23,149.26	0.11	0.11	
TAYLOR	241.83		81,512.77	0.37	0.37	
TOM GREEN	315.02		9,466.81	0.04	0.04	
MCLENNAN	387.60	0.28	45,377.03	0.21	0.49	
MCCULLOCH	3.58		191.85	0.00	0.00	
JIM HOGG	0.00		0.00	0.00	0.00	
VAL VERDE	20.77		16,272.13	0.07	0.07	
ECTOR	168.06	0.15	15,172.08	0.07	0.22	
WHARTON	36.12	0.11	10,922.29	0.05	0.16	
KERR	10.32		1,413.96	0.01	0.01	
PRESIDIO	0.00		0.00	0.00	0.00	
Other ERCOT Counties	JIM WELLS	0.00		0.00	0.00	0.00
	CALHOUN	0.00	0.05	0.00	0.00	0.05
	GILLESPIE	6.32		4,952.39	0.02	0.02
	MATAGORDA	32.57		2,149.82	0.01	0.01
	NAVARRO	23.77		626.62	0.00	0.00
	ANGELINA	67.81		1,805.39	0.01	0.01
	NACOGDOCHES	52.69		1,402.84	0.01	0.01
	FANNIN	4.14	0.00	3,242.64	0.01	0.02
	ATASCOSA	74.19		44,345.62	0.20	0.20
	WASHINGTON	0.00		0.00	0.00	0.00
	LAMAR	31.21	0.20	786.84	0.00	0.20
	VAN ZANDT	16.84		448.30	0.00	0.00
	WILLACY	6.59		3,165.38	0.01	0.01
	BROWN	22.95		1,023.52	0.00	0.00
	ERATH	0.00		0.00	0.00	0.00
	AUSTIN	9.51		253.12	0.00	0.00
	COOKE	40.84		20,322.30	0.09	0.09
	MEDINA	13.68		3,770.49	0.02	0.02
	TITUS	6.32	0.00	4,952.39	0.02	0.02
	UVALDE	2.06		54.89	0.00	0.00
	FAYETTE	0.00	0.26	0.00	0.00	0.26
	CALLAHAN	0.00		0.00	0.00	0.00
	HOPKINS	9.51		253.12	0.00	0.00
	LAMPASAS	11.29		8,843.55	0.04	0.04
	BLANCO	0.00		0.00	0.00	0.00
	FREESTONE	0.00	0.23	0.00	0.00	0.23
	GRIMES	7.79	0.00	207.38	0.00	0.00
	LEE	9.86		7,723.37	0.04	0.04
	SOMERVELL	0.00		0.00	0.00	0.00
	ANDREWS	83.16	0.00	1,836.12	0.01	0.01
BORDEN	0.00		0.00	0.00	0.00	

Table 26: 2015 Annual Electricity and Natural Gas Savings and NOx Reductions from New Commercial Construction (Continued)

	County	Electricity Savings and Resultant NOx Reductions (Commercial)		Total Natural Gas Savings and Resultant NOx Reductions (Commercial)		Total NOx Reductions
		Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual NOx Reductions (Tons)	Total Annual N.G. Savings (Therm/County)	Annual NOx Reductions (Tons)	Annual NOx Reductions (Tons)
	CHEROKEE	84.84	0.13	57,603.34	0.26	0.40
	DIMMIT	9.62		256.17	0.00	0.00
	FALLS	0.00		0.00	0.00	0.00
	COLORADO	0.00		0.00	0.00	0.00
	FRIO	0.00	0.00	0.00	0.00	0.00
	MILAM	0.00	0.06	0.00	0.00	0.06
	JACKSON	21.88		582.48	0.00	0.00
	ANDERSON	48.22		15,237.37	0.07	0.07
	HILL	14.78		393.40	0.00	0.00
	CULBERSON	0.00		0.00	0.00	0.00
	MASON	0.00		0.00	0.00	0.00
	PECOS	9.51	0.00	253.12	0.00	0.00
	RAINS	0.00		0.00	0.00	0.00
	LAVACA	74.03		41,439.68	0.19	0.19
	PALO PINTO	0.00	0.18	0.00	0.00	0.18
	KIMBLE	0.00		0.00	0.00	0.00
	MADISON	0.00		0.00	0.00	0.00
	ARCHER	22.58		17,687.10	0.08	0.08
	REFUGIO	0.00		0.00	0.00	0.00
	LIMESTONE	0.00	0.00	0.00	0.00	0.00
	CLAY	0.00		0.00	0.00	0.00
	BEE	0.00		0.00	0.00	0.00
	MARTIN	0.00		0.00	0.00	0.00
	GONZALES	60.19		14,930.01	0.07	0.07
	BURLESON	0.00		0.00	0.00	0.00
	KARNES	65.89		51,616.85	0.24	0.24
	KLEBERG	0.00		0.00	0.00	0.00
	BREWSTER	0.00		0.00	0.00	0.00
	WINKLER	9.41		7,369.63	0.03	0.03
	FRANKLIN	0.00		0.00	0.00	0.00
	YOUNG	0.00	0.35	0.00	0.00	0.35
	HOUSTON	14.39		317.79	0.00	0.00
	SCURRY	56.71		38,529.43	0.18	0.18
	BOSQUE	0.00	0.11	0.00	0.00	0.11
	COMANCHE	0.00		0.00	0.00	0.00
	BRISCOE	0.00		0.00	0.00	0.00
	CONCHO	0.00		0.00	0.00	0.00
	ZAVALA	0.00		0.00	0.00	0.00
	NOLAN	20.03	0.02	2,905.91	0.01	0.03
	BROOKS	0.00		0.00	0.00	0.00
	ROBERTSON	0.00	0.20	0.00	0.00	0.20
	LIVE OAK	19.94		15,623.61	0.07	0.07
	HAMILTON	0.00		0.00	0.00	0.00
	JONES	0.00		0.00	0.00	0.00
	REAGAN	0.00		0.00	0.00	0.00
	WARD	20.70	0.13	1,792.62	0.01	0.14
	RED RIVER	0.00		0.00	0.00	0.00
	HASKELL	0.00		0.00	0.00	0.00
	HOWARD	13.89	0.09	2,645.36	0.01	0.10
	SAN SABA	0.00		0.00	0.00	0.00
	JACK	0.00	0.15	0.00	0.00	0.15
	STEPHENS	0.00		0.00	0.00	0.00
	RUNNELS	0.00		0.00	0.00	0.00
	REEVES	37.47		4,717.05	0.02	0.02
	DEWITT	120.62		36,039.79	0.17	0.17
	CHILDRESS	0.00		0.00	0.00	0.00
	CROSBY	0.00		0.00	0.00	0.00
	DAWSON	0.00		0.00	0.00	0.00
	MITCHELL	0.00	0.02	0.00	0.00	0.02
	WILBARGER	0.00	0.88	0.00	0.00	0.88
	COLEMAN	0.00		0.00	0.00	0.00
	UPTON	2.82	0.00	2,210.89	0.01	0.01
	COKE	0.00	0.00	0.00	0.00	0.00
	CROCKETT	0.00		0.00	0.00	0.00
	HARDEMAN	0.00		0.00	0.00	0.00
	BANDERA	0.00		0.00	0.00	0.00
	BAYLOR	0.00		0.00	0.00	0.00
	COTTLE	0.00		0.00	0.00	0.00
	CRANE	0.00		0.00	0.00	0.00
	DELTA	0.00		0.00	0.00	0.00
	DICKENS	0.00		0.00	0.00	0.00
	DUVAL	0.00		0.00	0.00	0.00
	EASTLAND	0.00		0.00	0.00	0.00
	EDWARDS	0.00		0.00	0.00	0.00
	FISHER	0.00		0.00	0.00	0.00
	FOARD	0.00		0.00	0.00	0.00
	GLASSCOCK	0.00		0.00	0.00	0.00
	GOLIAD	0.00		0.00	0.00	0.00
	HALL	0.00		0.00	0.00	0.00
	HUDSPETH	0.00		0.00	0.00	0.00
	IRION	0.00		0.00	0.00	0.00
	JEFF DAVIS	0.00		0.00	0.00	0.00
	KENEDY	0.00		0.00	0.00	0.00
	KENT	0.00		0.00	0.00	0.00
	KING	0.00		0.00	0.00	0.00
	KINNEY	0.00		0.00	0.00	0.00
	KNOX	0.00		0.00	0.00	0.00
	LA SALLE	7.79		207.38	0.00	0.00
	LEON	0.00		0.00	0.00	0.00
	LOVING	0.00		0.00	0.00	0.00
	MENARD	0.00		0.00	0.00	0.00
	MILLS	0.00		0.00	0.00	0.00
	MONTAGUE	0.00		0.00	0.00	0.00
	MOTLEY	0.00		0.00	0.00	0.00
	REAL	9.51		253.12	0.00	0.00
	SCHLEICHER	0.00		0.00	0.00	0.00
	SHACKELFORD	0.00		0.00	0.00	0.00
	STARR	2.41		64.04	0.00	0.00
	STERLING	0.00		0.00	0.00	0.00
	STONEWALL	0.00		0.00	0.00	0.00
	SUTTON	0.00		0.00	0.00	0.00
	TERRELL	0.00		0.00	0.00	0.00
	THROCKMORTON	0.00		0.00	0.00	0.00
	ZAPATA	0.00		0.00	0.00	0.00
	<b>TOTAL</b>	<b>50,138.00</b>	<b>10.70</b>	<b>7,950,532.36</b>	<b>36.57</b>	<b>47.28</b>

Other ERCOT Counties

Annual Elec. Savings w/ 7% T&D Loss  
(Commercial Buildings)



Annual Elec. Savings w/ 7% T&D Loss  
(Commercial Buildings)

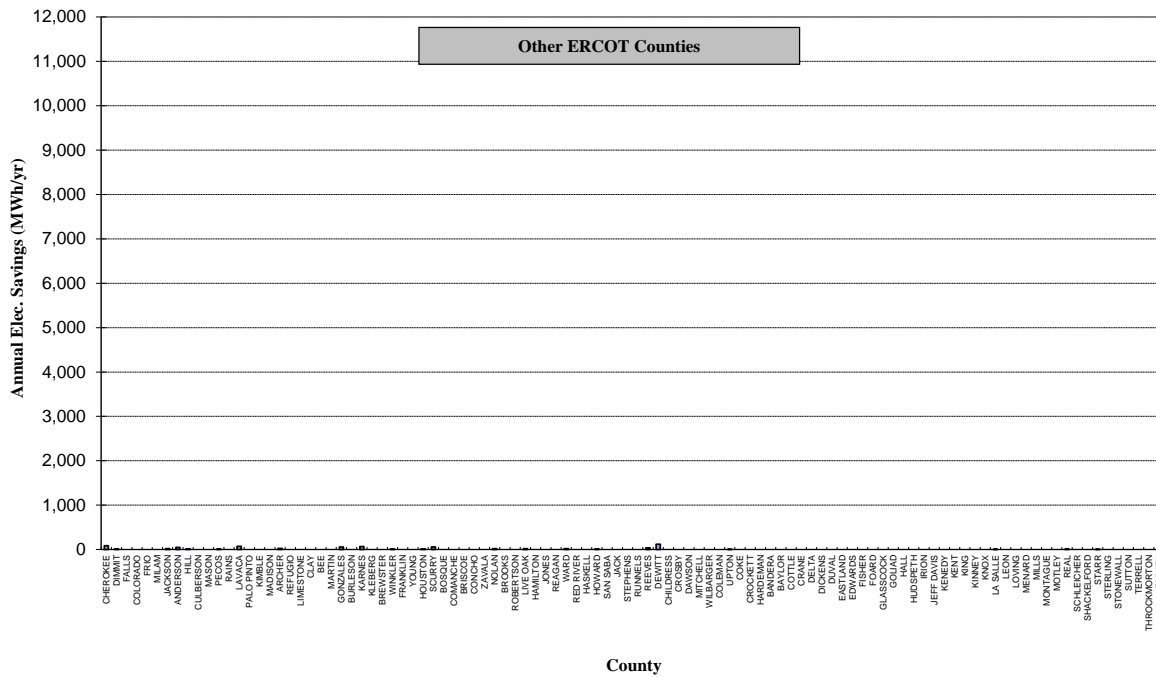


Figure 15: 2015 Annual Electricity Savings by County from New Commercial Construction



#### 4.5 2015 Results for New Residential (Single-family and Multi-family) and Commercial Construction

Figure 17 shows the bar chart and Figure 18 shows the spatial distribution of the 2015 annual electricity savings, and Figure 19 shows the bar chart and Figure 20 shows the spatial distribution of the 2015 annual NO<sub>x</sub> reductions for new residential and commercial Construction, respectively. As shown in Table 27, the total annual electricity savings in 2015 resulted in 297,518.80 MWh/yr which includes 96,803.11 MWh/yr (i.e., 32.54 %) for single-family buildings, 150,577.70 MWh/yr (i.e., 50.61 %) for multi-family buildings, and 50,138.00 MWh/yr (i.e., 16.85 %) for new commercial buildings. In addition, the total annual natural gas savings from new residential and commercial Construction in 2015 resulted in 1,068,175.12 MMBtu<sup>33</sup> (10,681,751.16 therms).

The total NO<sub>x</sub> reductions<sup>34</sup> from electricity and natural gas savings from new residential (single-family and multi-family) and commercial Construction in 2015 resulted in 113.88 tons NO<sub>x</sub>/year which represents 64.74 tons NO<sub>x</sub>/year from electricity savings and 49.14 tons NO<sub>x</sub>/year from natural gas savings.

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<sup>33</sup> 1 Therm = 0.10 MMBtu, source from [www.eia.gov/tools/faqs/faq.cfm?id=45&t=8](http://www.eia.gov/tools/faqs/faq.cfm?id=45&t=8)

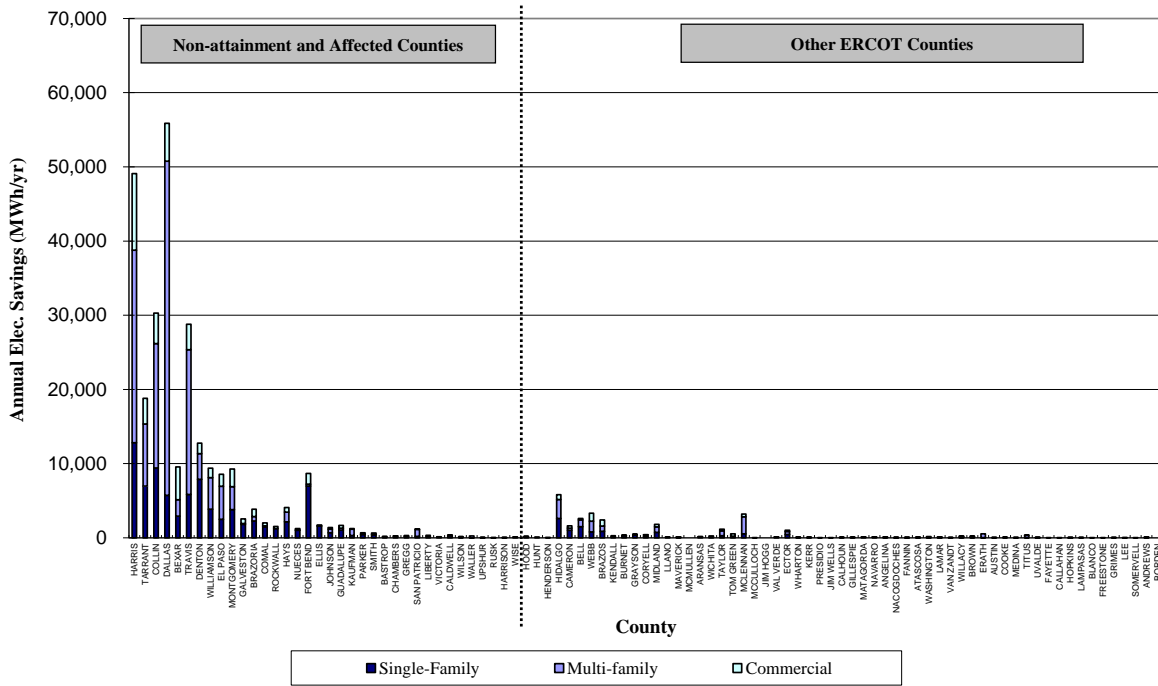
<sup>34</sup> 0.092 lb-NO<sub>x</sub>/MMBtu of emission rate was used for the calculation.

Table 27: 2015 Annual NOx Reductions from New Residential and Commercial Construction

County	Electricity Savings and Resultant NOx Reductions (Single Family Houses)		Electricity Savings and Resultant NOx Reductions (Multifamily Houses)		Electricity Savings and Resultant NOx Reductions (Commercial Buildings)		Total Electricity Savings and Resultant NOx Reductions (SF, MF and Commercial Buildings)		Total Natural Gas Savings and Resultant NOx Reductions (Single and Multi-Family Houses)		Total Natural Gas Savings and Resultant NOx Reductions (SF, MF and Commercial Buildings)		Total NOx Reductions
	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual NOx Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual NOx Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual NOx Reductions (Tons)	Total Annual Electricity Savings per County w/ 7% T&D Loss (MWh/County)	Annual NOx Reductions (Tons)	Total Annual N.G. Savings (Therm/County)	Annual NOx Reductions (Tons)	Total Annual N.G. Savings (Therm/County)	Annual NOx Reductions (Tons)	Annual NOx Reductions (Tons)
HARRIS	12,806.57	2.28	25,967.64	3.01	10,307.18	1.24	49,081.38	6.54	259,962.66	1.20	1,914,388.93	8.81	15.34
TARRANT	6,972.60	0.05	8,355.15	0.10	3,481.32	0.02	18,809.08	0.18	184,927.72	0.85	699,619.63	3.22	3.39
COLLIN	9,403.21	0.13	16,765.28	0.28	4,110.61	0.06	30,279.10	0.48	297,466.82	1.37	849,297.63	3.91	4.39
DALLAS	5,728.26	0.26	45,033.38	0.54	5,093.22	0.12	55,855.06	0.92	493,940.01	2.27	1,001,140.45	4.61	5.53
BEXAR	2,909.03	1.15	2,232.96	1.76	4,411.57	0.70	9,553.56	3.61	56,004.61	0.26	599,903.28	2.76	6.37
TRAVIS	5,835.11	0.43	19,509.56	0.66	3,442.36	0.26	28,787.03	1.35	265,245.41	1.22	686,202.20	3.16	4.50
DENTON	7,870.62	0.01	3,463.41	0.03	1,414.51	0.01	12,748.55	0.05	154,774.21	0.71	316,308.05	1.46	1.50
WILLIAMSON	3,868.40	0.44	4,244.74	0.66	1,272.91	0.00	9,386.04	0.00	99,481.40	0.46	233,297.87	1.07	1.07
EL PASO	2,501.45	0.44	4,434.99	0.66	1,627.13	0.00	8,563.57	0.00	118,240.06	0.54	201,438.81	0.93	0.93
MONTGOMERY	3,806.51	0.31	3,091.31	0.46	2,366.93	0.00	9,264.75	0.36	78,185.81	0.36	345,795.24	1.59	1.59
GALVESTON	1,815.00	0.35	112.75	0.46	614.92	0.19	2,542.67	1.00	38,609.18	0.18	160,101.64	0.74	1.73
BRAZORIA	2,276.40	0.86	586.32	1.14	981.51	0.47	3,844.23	2.47	48,383.21	0.22	348,727.11	1.60	4.08
COMAL	1,474.83	0.00	144.84	0.00	394.41	0.00	2,014.07	0.00	21,557.50	0.10	42,394.76	0.20	0.20
ROCKWALL	1,248.51	0.00	0.00	0.00	292.69	0.00	1,541.20	0.00	28,698.47	0.09	28,698.47	0.13	0.13
HAYS	2,144.29	0.07	1,310.66	0.11	636.27	0.04	4,091.23	0.22	45,984.00	0.21	235,353.35	1.08	1.30
NUECES	1,030.03	1.06	21.44	1.63	193.45	0.65	1,234.51	3.34	14,895.49	0.07	106,746.63	0.49	3.84
FORT BEND	6,966.60	0.48	273.91	0.64	1,440.55	0.25	8,681.06	1.38	144,160.96	0.66	609,987.55	2.80	4.18
ELLIS	1,581.65	0.31	26.66	0.65	119.08	0.15	1,727.99	1.11	25,205.09	0.12	58,675.35	0.27	1.38
JOHNSON	665.08	0.08	503.87	0.16	226.54	0.04	1,395.48	0.27	15,013.10	0.07	21,910.42	0.10	0.70
GUADALUPE	1,057.11	0.26	233.35	0.41	387.69	0.16	1,678.15	0.83	16,348.64	0.08	146,099.34	0.67	1.50
KAUFMAN	316.31	0.62	838.40	1.30	93.01	0.29	1,247.71	2.22	12,452.47	0.06	66,243.65	0.30	2.52
PARKER	457.15	0.00	32.14	0.00	179.59	0.00	668.89	0.00	7,483.19	0.03	12,344.40	0.06	0.06
SMITH	394.70	0.00	87.52	0.00	174.87	0.00	657.10	0.00	9,462.56	0.04	38,022.68	0.17	0.17
BASTROP	96.61	0.28	33.39	0.43	69.51	0.17	199.51	0.88	4,103.29	0.02	10,880.37	0.05	0.93
CHAMBERS	229.65	0.31	0.00	0.41	9.61	0.17	239.06	0.90	4,955.08	0.02	12,324.70	0.06	0.96
GREGG	196.10	0.12	41.11	0.19	74.63	0.00	311.84	0.00	4,637.72	0.02	31,907.92	0.15	0.15
SAN PATRICIO	190.46	0.00	932.65	0.11	80.11	0.08	1,203.23	0.39	2,770.24	0.01	7,641.16	0.04	0.43
LIBERTY	234.82	0.00	0.00	0.00	116.92	0.00	351.74	0.00	4,930.03	0.02	90,625.05	0.42	0.42
VICTORIA	111.10	0.18	0.00	0.27	23.92	0.11	135.02	0.55	2,191.12	0.01	2,709.49	0.01	0.56
CALDWELL	276.60	0.00	0.00	0.00	121.62	0.00	398.22	0.00	4,417.34	0.02	99,691.85	0.46	0.46
WILSON	42.39	0.00	96.56	0.00	168.29	0.00	168.29	0.00	1,259.40	0.01	5,172.96	0.02	0.02
WALLER	7.66	0.00	240.80	0.00	0.00	0.00	248.46	0.00	110.83	0.00	110.83	0.00	0.00
UPSHUR	1.99	0.00	10.72	0.00	21.88	0.00	34.58	0.00	172.93	0.00	755.41	0.00	0.00
RUSK	10.25	0.00	0.00	0.00	9.51	0.00	19.76	0.00	287.09	0.00	540.21	0.00	0.00
HARRISON	32.02	0.00	35.16	0.00	0.00	0.00	67.18	0.00	762.44	0.00	762.44	0.00	0.00
WISE	95.49	0.11	5.36	0.22	0.00	0.05	100.85	0.38	1,550.97	0.01	1,550.97	0.01	0.39
HOOD	166.87	0.53	10.66	1.11	0.00	0.25	177.53	1.88	2,729.52	0.01	2,729.52	0.01	1.90
HUNT	121.64	0.75	0.00	1.19	0.00	0.44	121.64	2.38	1,938.26	0.01	1,938.26	0.01	2.39
HENDERSON	44.17	0.07	0.00	0.15	0.00	0.03	44.17	0.26	1,059.87	0.00	1,059.87	0.00	0.26
HIDALGO	2,608.63	0.44	2,554.15	0.68	637.88	0.27	5,800.65	1.40	27,659.05	0.13	107,575.50	0.49	1.89
CAMERON	1,005.51	0.53	289.36	0.81	314.71	0.32	1,609.58	1.65	10,680.61	0.05	59,107.15	0.27	1.92
BELL	1,501.94	0.00	909.21	0.00	207.77	0.00	2,618.91	0.00	42,633.35	0.20	51,943.85	0.24	0.24
WEBB	794.87	0.35	1,430.53	0.53	1,095.48	0.21	3,520.89	1.09	9,258.23	0.04	276,774.12	1.27	2.36
BRAZOS	866.23	0.24	739.04	0.47	824.06	0.12	2,420.23	0.83	17,787.14	0.08	319,130.93	1.47	2.30
KENDALL	150.36	0.00	0.00	0.00	131.59	0.00	281.96	0.00	2,335.42	0.01	47,954.49	0.22	0.22
BURNET	314.88	0.00	4.77	0.00	12.37	0.00	332.03	0.00	5,103.08	0.02	12,967.85	0.06	0.06
GRAYSON	383.99	0.00	48.18	0.00	49.98	0.00	502.15	0.00	6,540.11	0.03	8,403.44	0.04	0.04
CORYELL	126.95	0.00	271.25	0.00	180.00	0.00	416.20	0.00	5,555.98	0.03	6,521.12	0.03	0.03
MIDLAND	723.62	0.00	743.20	0.00	350.72	0.00	1,817.53	0.00	24,430.49	0.11	38,328.39	0.18	0.18
LLANO	78.46	0.33	0.00	0.51	22.58	0.20	101.04	1.05	1,261.13	0.01	18,948.23	0.09	1.14
MAVERICK	60.85	0.00	28.05	0.00	9.37	0.00	98.27	0.00	709.69	0.00	2,155.17	0.01	0.01
MCMULLEN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ARANSAS	149.83	0.00	3.51	0.00	0.00	0.00	153.34	0.00	2,187.96	0.01	2,187.96	0.01	0.01
WICHITA	79.85	0.01	0.00	0.02	160.72	0.01	240.57	0.05	1,907.81	0.01	25,057.08	0.12	0.16
TAYLOR	279.66	0.00	645.28	0.00	241.83	0.00	1,166.77	0.00	13,130.83	0.06	94,643.60	0.44	0.44
TOM GREEN	221.19	0.00	0.00	0.00	315.02	0.00	536.21	0.00	4,623.43	0.02	14,090.24	0.06	0.06
MCLENNAN	524.78	0.59	2,298.13	1.23	387.60	0.28	3,210.51	2.10	34,755.60	0.16	80,132.63	0.37	2.47
MCCULLOCH	0.00	0.00	0.00	0.00	3.58	0.00	3.58	0.00	0.00	0.00	191.85	0.00	0.00
JIM HOGG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VAL VERDE	69.77	0.00	0.00	0.00	20.77	0.00	90.54	0.00	972.34	0.00	17,244.47	0.08	0.08
ECTOR	445.01	0.25	405.38	0.41	168.06	0.15	1,018.45	0.81	14,495.20	0.07	29,667.28	0.14	0.95
WHARTON	56.37	0.17	3.21	0.27	36.12	0.11	95.69	0.55	1,112.61	0.01	12,034.90	0.06	0.60
KERR	65.04	0.00	10.32	0.00	10.32	0.00	75.37	0.00	1,045.41	0.00	2,459.38	0.01	0.01
PRESIDIO	6.56	0.00	0.00	0.00	0.00	0.00	6.56	0.00	137.14	0.00	137.14	0.00	0.00
JIM WELLS	10.16	0.00	0.00	0.00	0.00	0.00	10.16	0.00	148.34	0.00	148.34	0.00	0.00
CALHOUN	56.37	0.08	19.23	0.12	0.00	0.05	75.60	0.25	1,117.31	0.01	1,117.31	0.01	0.25
GILLESPIE	42.33	0.00	0.00	0.00	6.32	0.00	48.65	0.00	680.35	0.00	5,632.74	0.03	0.03
MATAGORDA	69.44	0.00	0.00	0.00	32.57	0.00	102.01	0.00	1,369.45	0.01	3,519.28	0.02	0.02
NAVARRO	85.83	0.02	5.02	0.00	25.77	0.00	114.62	0.00	1,969.50	0.01	2,596.13	0.01	0.01
ANGELINA	42.59	0.00	0.00	0.00	67.81	0.00	110.40	0.00	1,192.52	0.01	2,997.92	0.01	0.01
NACOGDOCHES	10.25	0.00	12.06	0.00	52.49	0.00	75.01	0.00	284.70	0.00	1,687.54	0.01	0.01
FANNIN	13.12	0.00	26.77	0.00	4.14	0.00	44.82	0.00	443.08	0.00	3,685.72	0.02	0.02
ATASCOSA	33.85	0.00	0.00	0.00	74.19	0.00	108.04	0.00	537.07	0.00	44,883.28	0.21	0.21
WASHINGTON	39.06	0.00	120.40	0.00	0.00	0.00	159.46	0.00	784.74	0.00	784.74	0.00	0.00
LAMAR	17.36	0.41	53.57	0.87	31.21	0.20	102.14	1.48	932.92	0.00	17,197.76	0.01	1.49
VAN ZANDT	20.29	0.00	0.00	0.00	16.84	0.00	37.13	0.00	319.43	0.00	767.73	0.00	0.00
WILLACY	48.09	0.00	148.39	0.00	6.59	0.00	203.07	0.00	958.81	0.00	3,671.20	0.02	0.02
BROWN	59.00	0.00	150.70	0.00	22.95	0.00	232.65	0.00	2,828.99	0.01	3,852.50	0.02	0.02
ERATH	28.06	0.00	522.90	0.00	0.00	0.00	550.96	0.00	6,016.53	0.03	6,016.53	0.03	0.03
AUSTIN	14.55	0.00	0.00	0.00	9.51	0.00	24.06	0.00	301.24	0.00	554.36	0.00	0.00
COOKE	47.70	0.00	0.00	0.00	40.84	0.00	88.55	0.00	760.10	0.00	21,082.40	0.10	0.10
MEDINA	31.79												



**Annual Elec. Savings w/ 7% T&D Loss  
(Single-Family, Multi-Family and Commercial Buildings)**



**Annual Elec. Savings w/ 7% T&D Loss  
(Single-Family, Multi-Family and Commercial Buildings)**

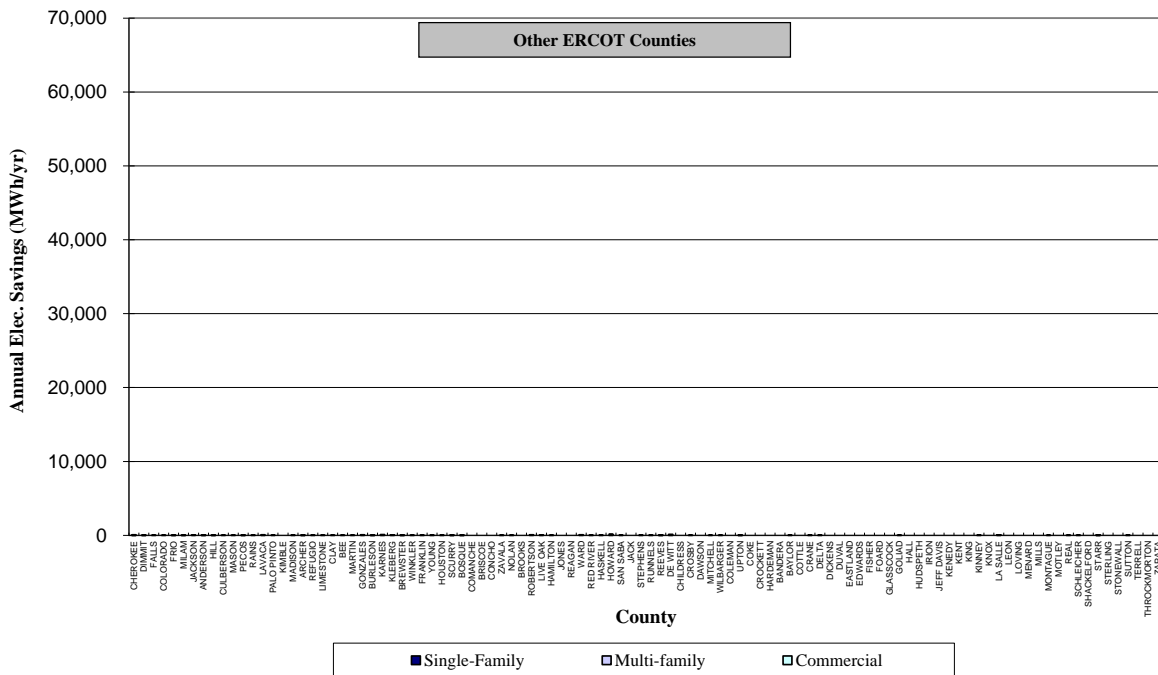


Figure 17: 2015 Annual Electricity Savings by County from New Residential and Commercial Construction



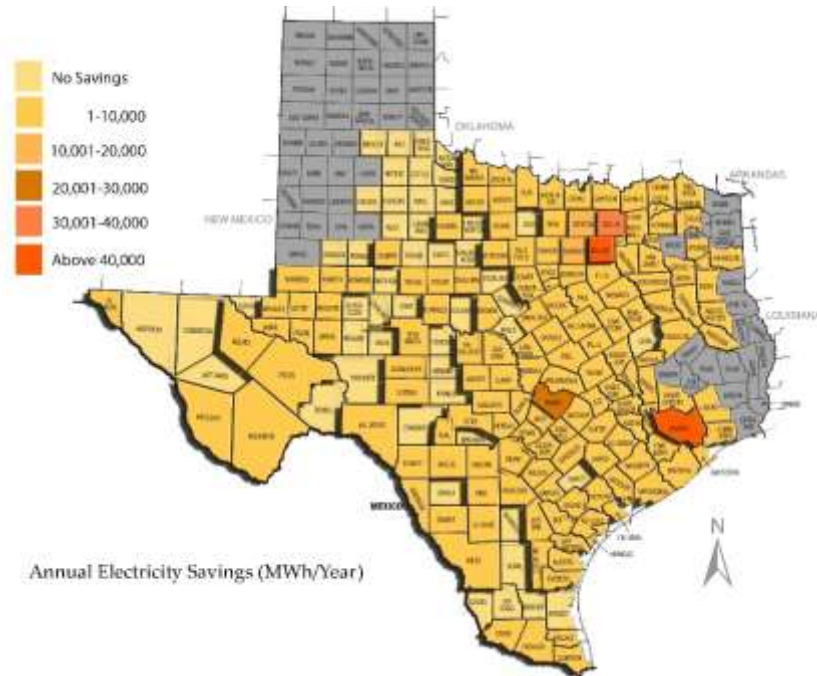
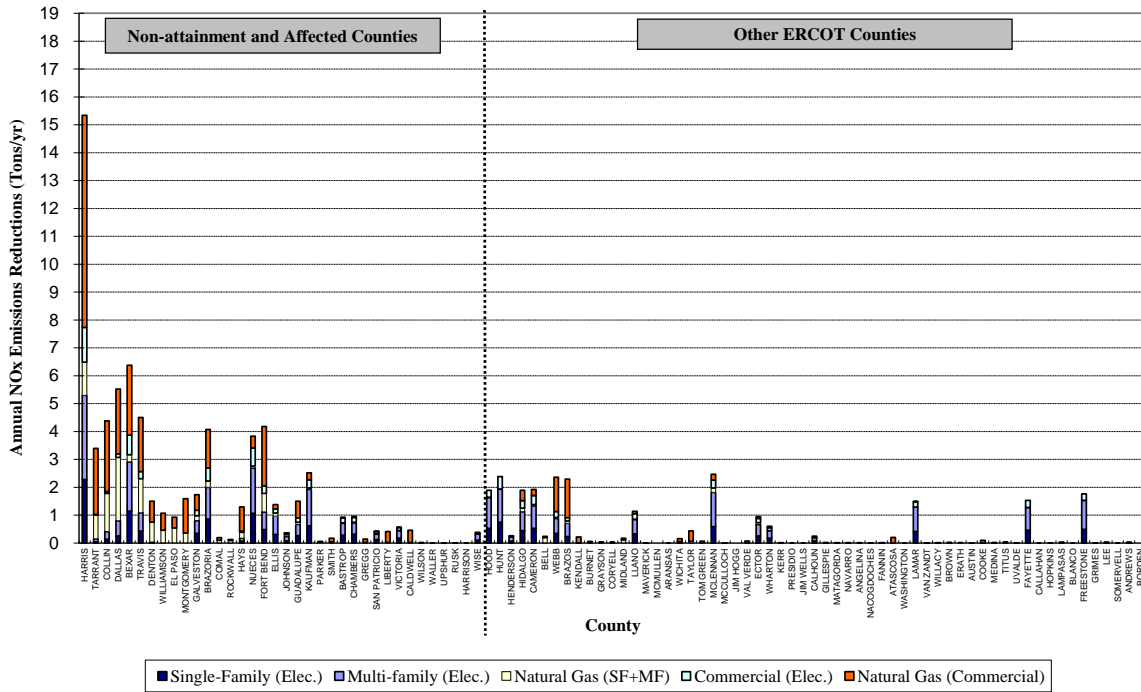


Figure 18: Map of 2015 Annual Electricity Savings by County from New Residential and Commercial Construction

**Total Annual NOx Emissions Reductions  
(Single-Family, Multi-Family and Commercial Buildings)**



**Total Annual NOx Emissions Reductions  
(Single-Family, Multi-Family and Commercial Buildings)**

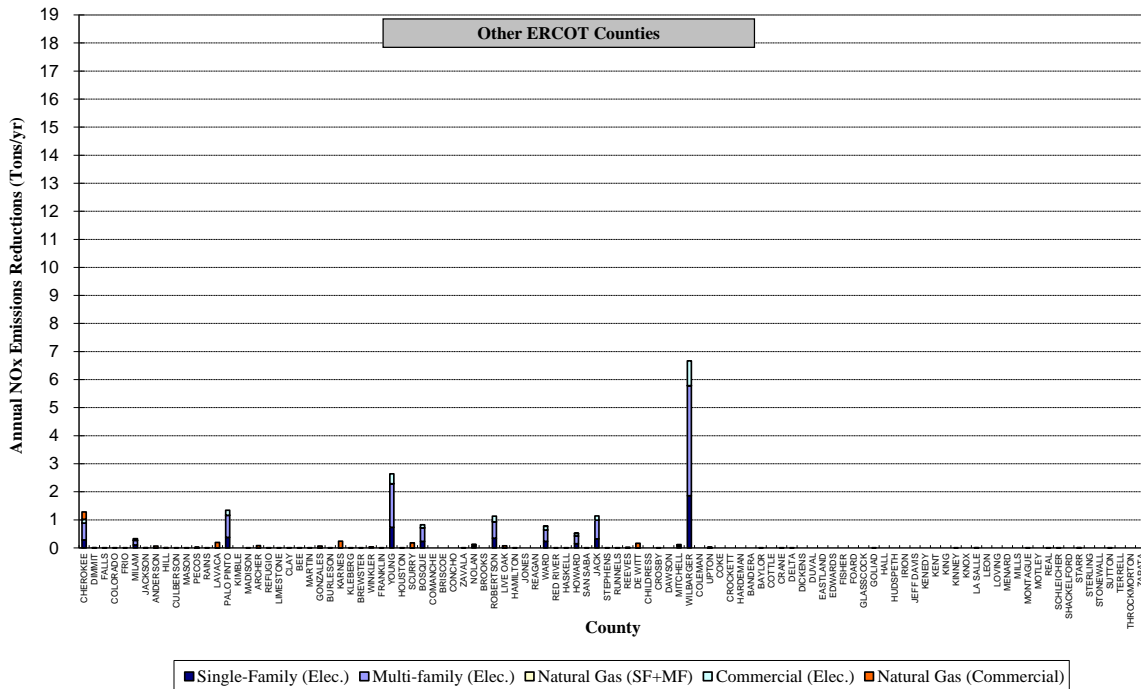


Figure 19: 2015 Annual NOx Reductions by County from New Residential and Commercial Construction



## 5 Calculation of Integrated NO<sub>x</sub> Emissions Reductions from Multiple State Agencies Participating in the Texas Emissions Reduction Plan (TERP)

### 5.1 Background

In January 2005, the Laboratory was asked by the Texas Commission on Environmental Quality (TCEQ) to develop a method by which the NO<sub>x</sub> emissions reductions from the energy-efficiency programs from multiple Texas State Agencies working under Senate Bill 5 and Senate Bill 7 could be reported in a uniform format to allow the TCEQ to consider the combined savings for Texas' State Implementation Plan (SIP) planning purposes. This required that the analysis should include the integrated savings estimation from all projects projected through 2020 for both the annual and Ozone Season Day (OSD) NO<sub>x</sub> reductions. The NO<sub>x</sub> emissions reductions from all these programs were calculated using estimated emissions factors for 2010 from the US Environmental Protection Agency (US EPA) eGRID database, which had been specially prepared for this purpose. The different programs included in this 2015 integrated analysis are:

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

*The Laboratory's single-family and multi-family programs* include the energy savings attained by constructing new residences in Texas. The baseline to estimate energy savings uses the published data on residential construction characteristics by the 2008 National Association of Home Builders (NAHB 2008) based on the IECC 2006 building code (ICC 2006). Annual electricity savings (MWh) are obtained from the Laboratory's Annual Reports to the TCEQ (Haberl et al., 2002 - 2015).

*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 90.1-2007) against pre-code buildings (ASHRAE Standard 90.1-2004) using EUI in the USDOE report and constructed square footage in Dodge data (Dodge 2016).

*The Public Utility Commission of Texas (PUC) Senate Bill 7 program* includes the energy efficiency programs implemented by electric utilities under the Public Utility Regulatory Act §39.905. The PUC regulated energy efficiency program was adopted pursuant to 1999 legislation (SB 7) and subsequent legislation in 2001 (SB 5), 2007 (HB 3693), and 2011 (SB 1125). The energy efficiency measures include high efficiency HVAC equipment, variable speed drives, increased insulation levels, infiltration reduction, duct sealing, Energy Star Homes, etc. Annual electricity savings claimed by the utilities were reported for the different programs completed in the years 2001 through 2015.

*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 2015 reporting year SECO submitted annual energy savings values for projects funded by SECO and by Energy Service projects.

*The Electric Reliability Council of Texas (ERCOT) electricity production from currently installed green power generation (wind)* in Texas is reported. Actual measured electricity productions for 2001 through 2015 were included. For projections to 2020, the annual growth factor was estimated using the last seven years installed wind power capacity.

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

## 5.2 Description of the Analysis Method

Annual and Ozone Season Day (OSD) NO<sub>x</sub> emissions reductions were calculated for 2015 and integrated from 2009 to 2020 using several factors to discount the potential savings. These factors include an annual degradation factor, a transmission and distribution factor, a discount factor, and growth factors as shown in Table 28 and are described as follows:

*Annual degradation factor:* This factor was used to account for an assumed decrease in the performance of the measures installed as the equipment wears down and degrades. With the exception of electricity generated from wind, an annual degradation factor of 2% was used for ESL Single-family, Multi-family, and Commercial programs and an annual degradation factor of 5% was used for all other programs<sup>35</sup>. The value of the 5% degradation factor was taken from a study by Kats et al. (1996).

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

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

*Growth factor:* The growth factors shown in Table 24 were used to account for several different factors. Growth factors for single-family (4.1%), multi-family residential (6.1%), and commercial (5.3%) construction are projections based on the average growth rate for these housing types from recent U.S. Census data for Texas. Growth factor for wind energy (8.5%) is a linear projection based on the installed wind power capacity for 2009 through 2015 from the Public Utility Commission of Texas. No growth was assumed for PUC programs, SECO, and SEER 13 entries.

Figure 21 shows the overall information flow that was used to calculate the NO<sub>x</sub> emissions savings from the annual and OSD electricity savings (MWh) from all programs. For the Laboratory's single-family and multi-family code-implementation programs, the annual and OSD were calculated from DOE-2 hourly simulation models<sup>36</sup>. The base case is taken as the average characteristics of single- and multi-family residences for Texas published by the National Association of Home Builders for 2008 (NAHB 2008). The annual electricity savings from PUC's energy efficiency programs were calculated using PUC approved demand savings calculations or tables or industry accepted measurement and verification methods (PUC 2015). The OSD consumption is the average daily consumption for the period between July 15 and September 15.

The SECO electricity savings were submitted as annual savings by project<sup>37</sup>. A description of the measures completed for the project was also submitted for information purposes. The electricity production from wind farms in Texas was from the actual on-site metered data measured at 15-minute intervals.

<sup>35</sup> A degradation of 5% per year would accumulate as a 5%, 10%, 15%...etc, degradation in performance. Although the assumption of this high level of degradation may not actually occur, it was chosen as a conservative estimate. For wind energy, a degradation factor of 0% was used. The choice of a 0% degradation factor for wind is based on two year's of analysis of measured wind data from all Texas wind farms that shows no degradation, on average, for a two year period after the wind farms became operational.

<sup>36</sup> These values are based on a performance analysis as defined by Chapter 4 of IECC 2006. This analysis is discussed in the Laboratory's annual reports to the TCEQ.

<sup>37</sup> The reporting requirements to the SECO did not require energy savings by project type, although for selected sites, energy savings by project type was available.

Integration of the savings from the different programs into a uniform format allowed for creditable NO<sub>x</sub> emissions to be evaluated using different criteria as shown in Table 28. These include evaluation across programs, evaluation across individual counties by program, evaluation by SIP area, evaluation for all ERCOT counties except Houston/Galveston, and evaluation within a 200 km radius of Dallas/Ft. Worth.

### 5.3 Calculation Procedure

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

*ESL Single-family and Multi-family.* The calculation of the annual electricity savings reported for the years 2002 through 2015 included the savings from code-compliant new housing in all 36 non-attainment and affected counties as reported in the Laboratory's annual report submitted by the Laboratory to the Texas Commission of Environmental Quality (TCEQ). From 2009 to 2015, based on year 2008, the annual electricity savings were calculated for new residential construction in all the counties in ERCOT region, which includes the 36 non-attainment and affected counties. These savings were then tabulated by county and program. Using the calculated values through 2015, savings were then projected to 2020 by incorporating the different adjustment factors mentioned above.

In these calculations, it was assumed that the same amount of electricity savings from the code-complaint construction would be achieved for each year after 2015 through 2020<sup>38</sup>. The projected energy savings through 2020, according to county, were then divided into the CM zones in the 2010 eGRID. To determine which CM zone was to be used, or in counties with multiple CM zone, the allocation to each CM zone by county was obtained from CM zone's listing published in the Laboratory's 2010 annual report<sup>39</sup>.

For the 2015 annual NO<sub>x</sub> emissions calculations, the US EPA's 2010 eGRID were used. An example of the eGRID spreadsheet is given in the Table 29. The total electricity savings for each CM zone were used to calculate the NO<sub>x</sub> emissions reductions for each of the different counties using the emissions factors contained in eGRID. Similar calculations were performed for each year for which the analysis was required.

*ESL-Commercial Buildings.* The annual electricity savings for 2004 through 2015 for commercial buildings were obtained from the annual reports for 2004 through 2015 submitted by the Laboratory to TCEQ<sup>40</sup>. From 2009 to 2015, based on year 2008, the annual electricity savings were also calculated for new commercial construction by county. Using the calculated savings through 2015, savings were then projected to 2020 by incorporating the different adjustment factors mentioned above<sup>41</sup>. In the projected annual electricity savings, it was assumed that the same 2015 amount of electricity savings would be achieved for each year through 2020. Similarly to the single family calculations, the projected energy saving numbers through 2020, by county, were allocated into the appropriate CM zones.

*PUC-Senate Bill 7.* For the PUC Senate Bill 7 program savings, the annual electricity savings for 2001 through 2015 were obtained from the Public Utility Commission of Texas. Using these values savings were projected through 2020 by incorporating the different adjustment factors mentioned above. Similar savings were assumed for each year after 2015 until 2020. The 2010 annual eGRID was also used to calculate the NO<sub>x</sub> emissions savings for the PUC-Senate Bill 7 program. The total electricity savings for each CM zone were used to calculate the NO<sub>x</sub>

<sup>38</sup> This would include the appropriate discount and degradation factors for each year.

<sup>39</sup> Haberl et al., 2010, pp. 265.

<sup>40</sup> These savings include new construction in office, education, retail, food, lodging and warehouse construction as defined by Dodge building type (Dodge 2011), using energy savings from the US DOE's report (USDOE 2011), and data from CBECS (1995 - 2003) and Dodge (2016).

<sup>41</sup> This also includes the appropriate discount and degradation factors for each year.

emissions reductions for each county using the emissions factors contained in the US EPA's eGRID spreadsheet. The integrated NOx emissions reductions for each county were then calculated.

*SECO Savings.* The annual electricity consumption reported by political subdivisions for 47 counties through 2015 were obtained from the State Energy Conservation Office (SECO). Using the reported consumption, the annual and OSD electricity savings resulted from energy conservation projects were then calculated. To achieve this, the annual energy use intensity (EUI) for each county was estimated and the county's energy savings for each year against the baseline year of 2008 were then calculated<sup>42</sup>. In addition, the savings through 2020 were projected using the different adjustment factors mentioned above. In a similar fashion to the previous programs, it was assumed that the same amount of electricity savings will be achieved for each year through 2020. The 2010 annual eGRID was also used to calculate the NOx emissions savings for the SECO program.

*Electricity Generated by Wind Farms.* The measured electricity production from all the wind farms in Texas for 2001 through 2015 was obtained from the Energy Reliability Council of Texas (ERCOT). To obtain the annual production, the 15-minute data were summed for the 12 months. Using the reported numbers for 2015, savings through 2020 were projected incorporating the different adjustment factors mentioned above. The 2010 annual eGRID was then used to calculate the NOx emissions reductions for the electricity generated by Texas' wind farms<sup>43</sup>. The total electricity savings for each CM zone were used to calculate the NOx emissions reductions for each of the different counties.

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

In the 2015 report to the TCEQ, the annual and OSD electricity savings for all the counties in ERCOT region as well as the 36 non-attainment and affected counties were calculated. Using the numbers for 2008, the savings after 2008 until 2020 were projected by incorporating the appropriate adjustment factors<sup>44</sup>. The total electricity savings for each CM zone were used to calculate the NOx emissions reductions for each of the different county using the emissions factors contained in the 2010 eGRID. Integrated NOx emissions reductions for each county by SIP area were also calculated.

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<sup>42</sup> In the 2015 report, EUI values were used to calculate the electricity savings. This calculation method was also applied to savings estimation for the previous years from 2009 to 2015.

<sup>43</sup> This credited the electricity generated by the wind farm to the utility that either owned the wind farm or was associated with the wind farm owner.

<sup>44</sup> Additional details about this calculation are contained in the Laboratory's 2008 Annual Report to the TCEQ, available at the Senate Bill 5 web site "<http://esl.tamu.edu/>".

## 5.4 Results

The total integrated annual and OSD electricity savings for all the different programs in the integrated format were calculated for 2009 through 2020 as shown in Table 30, using the adjustment factors shown in Table 28. Annual and OSD NO<sub>x</sub> emissions reductions from the electricity savings (presented in Table 30) for all the programs in the integrated format were shown in Table 31.

In 2015, the total integrated annual savings from all programs are 29,759,642 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 1,158,444 MWh/year (3.9% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program are 3,100,439 MWh/year (10.4%),
- Savings from SECO's Senate Bill 5 program are 940,372 MWh/year (3.2%),
- Electricity savings from green power purchases (wind) are 24,322,675 MWh/year (81.6%), and
- Savings from residential air conditioner retrofits<sup>45</sup> are 273,712 MWh/year (0.9%).

In 2015, the total integrated OSD savings from all programs are 93,560 MWh/day, which would be a 3,898 MW average hourly load reduction during the OSD period. The integrated OSD electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction are 3,631 MWh/day (3.9%),
- Savings from the PUC's Senate Bill 7 programs are 8,494 MWh/day (9.1%),
- Savings from SECO's Senate Bill 5 program are 2,576 MWh/day (2.8%),
- Electricity savings from green power purchases (wind) are 76,917 MWh/day (82.2%), and
- Savings from residential air conditioner retrofits are 1,941 MWh/day (2.1%).

By 2020, the total integrated annual savings from all programs will be 45,126,247 MWh/year. The integrated annual electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction will be 2,454,765 MWh/year (5.4% of the total electricity savings),
- Savings from the PUC's Senate Bill 7 program will be 4,927,777 MWh/year (10.9%),
- Savings from SECO's Senate Bill 5 program will be 958,959 MWh/year (2.1%),
- Electricity savings from green power purchases (wind) will be 36,572,954 MWh/year (81.0%), and
- Savings from residential air conditioner retrofits will be 211,793 MWh/year (0.5%).

By 2020, the total integrated OSD savings from all programs will be 140,426 MWh/day, which would be a 5,851 MW average hourly load reduction during the OSD period. The integrated OSD electricity savings from all the different programs are:

- Savings from code-compliant residential and commercial construction will be 7,139 MWh/day (5.1%),
- Savings from the PUC's Senate Bill 7 programs will be 13,501 MWh/day (9.6%),
- Savings from SECO's Senate Bill 5 program will be 2,627 MWh/day (1.9%),
- Electricity savings from green power purchases (wind) will be 115,657 MWh/day (82.4%), and
- Savings from residential air conditioner retrofits will be 1,502 MWh/day (1.1%).

In 2015 (Table 31), the total integrated annual NO<sub>x</sub> emissions reductions from all programs are 8,174 tons-NO<sub>x</sub>/year. The integrated annual NO<sub>x</sub> emissions reductions from all the different programs are:

- NO<sub>x</sub> emissions reductions from code-compliant residential and commercial construction are 292 tons-NO<sub>x</sub>/year (3.6% of the total NO<sub>x</sub> savings),
- NO<sub>x</sub> emissions reductions from the PUC's Senate Bill 7 programs are 775 tons-NO<sub>x</sub>/year (9.5%),
- NO<sub>x</sub> emissions reductions from SECO's Senate Bill 5 program are 243 tons-NO<sub>x</sub>/year (3.0%),
- NO<sub>x</sub> emissions reductions from green power purchases (wind) are 6,800 tons-NO<sub>x</sub>/year (83.2%), and
- NO<sub>x</sub> emissions reductions from residential air conditioner retrofits are 64 tons-NO<sub>x</sub>/year (0.8%).

<sup>45</sup> This assumes air conditioners in existing homes are replaced with the more efficient SEER 13 units, versus an average of SEER 11, which is slightly more efficient than the previous minimum standard of SEER 10.



In 2015, the total integrated OSD NOx emissions reductions from all programs are 25.65 tons-NOx/day. The integrated OSD NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction are 0.91 tons-NOx/day (3.6%),
- NOx emissions reductions from the PUC's Senate Bill 7 programs are 2.12 tons-NOx/day (8.3 %),
- NOx emissions reductions from SECO's Senate Bill 5 program are 0.67 tons-NOx/day (2.6%),
- NOx emissions reductions from green power purchases (wind) are 21.50 tons-NOx/day (83.8%), and
- NOx emissions reductions from residential air conditioner retrofits are 0.45 tons-NOx/day (1.8%).

By 2020, the total integrated annual NOx emissions reductions from all programs will be 12,377 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 620 tons-NOx/year (5.0% of the total NOx savings),
- NOx emissions reductions from the PUC's Senate Bill 7 programs will be 1,230 tons-NOx/year (9.9%),
- NOx emissions reductions from SECO's Senate Bill 5 program will be 252 tons-NOx/year (2.0%),
- NOx emissions reductions from green power purchases (wind) will be 10,225 tons-NOx/year (82.6%), and
- NOx emissions reductions from residential air conditioner retrofits will be 50 tons-NOx/year (0.4%).

By 2020, the total integrated OSD NOx emissions reductions from all programs will be 38.54 tons-NOx/day. The integrated OSD NOx emissions reductions from all the different programs are:

- NOx emissions reductions from code-compliant residential and commercial construction will be 1.80 tons-NOx/day (4.7%),
- NOx emissions reductions from the PUC's Senate Bill 7 programs will be 3.37 tons-NOx/day (8.7%),
- NOx emissions reductions from SECO's Senate Bill 5 program will be 0.69 tons-NOx/day (1.8%),
- NOx emissions reductions from green power purchases (wind) will be 32.33 tons-NOx/day (83.9%), and
- NOx emissions reductions from residential air conditioner retrofits will be 0.35 tons-NOx/day (0.9%).

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

	ESL-Single Family <sup>16</sup>	ESL <sup>16</sup> -Multifamily	ESL <sup>16</sup> -Commercial	PUC (SB7) <sup>15</sup>	SECO <sup>15</sup>	Wind-ERCOT <sup>8</sup>	SEER13 Single Family	SEER13 Multi Family
Annual Degradation Factor <sup>11</sup>	2.0%	2.0%	2.0%	5.0%	5.0%	0.0%	5.0%	5.0%
T&D Loss <sup>9</sup>	7.0%	7.0%	7.0%	7.0%	7.0%	0.0%	7.0%	7.0%
Initial Discount Factor <sup>12</sup>	20.0%	20.0%	20.0%	10.0%	60.0%	5.0%	20.0%	20.0%
Growth Factor	4.1%	6.1%	5.3%	0.0%	0.0%	8.5%	N.A.	N.A.
Weather Normalized	Yes	Yes	Yes	No	No	No	Yes	Yes

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

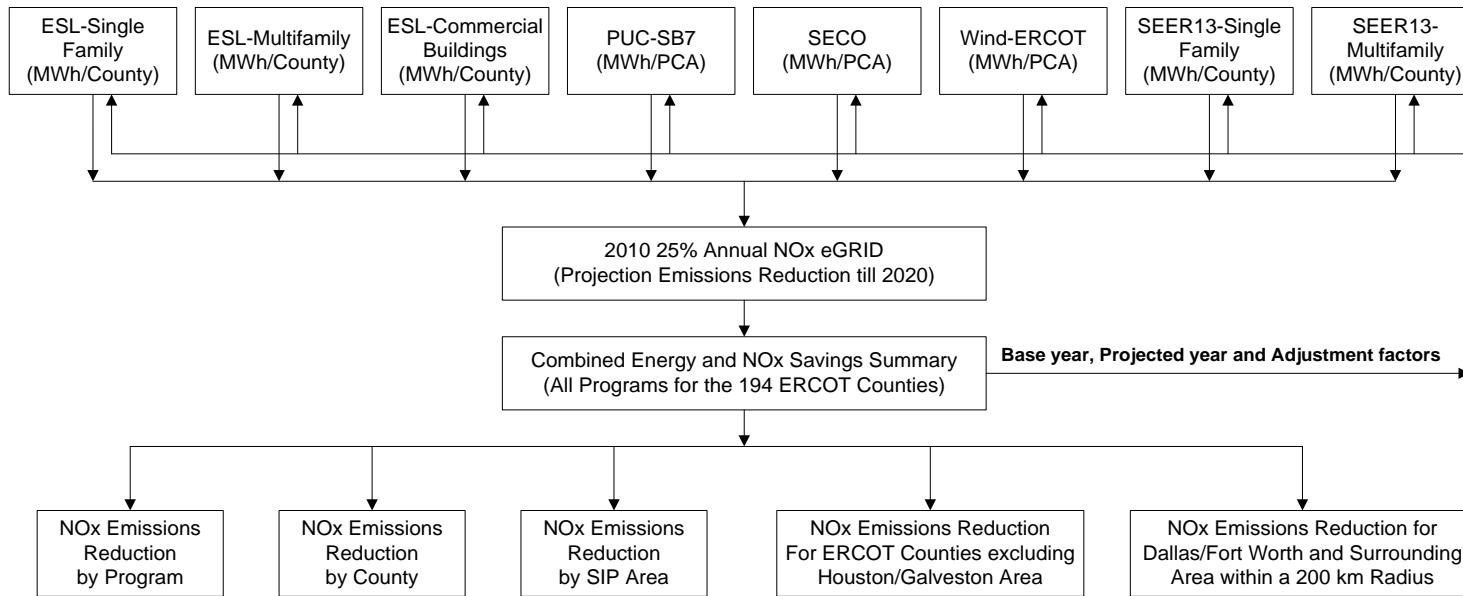


Figure 21: Process Flow Diagram of the NOx Emissions Reduction Calculations

Table 29: Example of NOx Emissions Reduction Calculations using 2010 eGRID

Area	County	CM Zones				Total Nox Reductions (lbs)	Total Nox Reductions (Tons)				
		H	N	W	S						
Houston-Galveston Area	Brazoria	0.0562032	7088.1865	0.0000071	0.8642	0.0000003	0.0019	0.0005265	50.0152	7139.07	3.57
	Chambers	0.0204500	2579.0962	0.0000026	0.3145	0.0000001	0.0007	0.0001916	18.1985	2597.61	1.30
	Fort Bend	0.0313463	3953.3085	0.0000040	0.4820	0.0000002	0.0011	0.0002937	27.8951	3981.69	1.99
	Galveston	0.0228620	2858.0623	0.0000029	0.3485	0.0000001	0.0008	0.0002123	20.1669	2878.58	1.44
	Harris	0.1486911	18752.4990	0.0000189	2.2864	0.0000009	0.0050	0.0013930	132.3203	18887.11	9.44
	Liberty	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
	Montgomery	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
	Waller	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
	Beaumont/Port Arthur Area	Hardin	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000
Jefferson		0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
Orange		0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
Dallas/Fort Worth Area	Calin	0.0012932	163.0907	0.0079329	961.4843	0.0003832	2.1129	0.0000809	7.6878	1134.38	0.57
	Dallas	0.0024826	313.0995	0.0152295	1845.8460	0.0007356	4.0563	0.0001554	14.7590	2177.76	1.09
	Denton	0.0001267	15.9744	0.0007770	94.1757	0.0000375	0.2070	0.0000079	0.7530	111.11	0.06
	Tarrant	0.0004742	59.8026	0.0029089	352.5599	0.0001405	0.7748	0.0000297	2.8190	415.96	0.21
	Ellis	0.0029920	377.3415	0.0183544	2224.5783	0.0008865	4.8886	0.0001873	17.7873	2624.60	1.31
	Johnson	0.0007256	91.5105	0.0044512	539.4906	0.0002150	1.1856	0.0000454	4.3137	636.50	0.32
	Kaufman	0.0005978	753.1524	0.0036343	4440.1333	0.0017695	9.7574	0.0003738	35.5024	5238.55	2.62
	Parker	0.0000012	0.1551	0.0000075	0.9142	0.0000004	0.0020	0.0000001	0.0073	1.08	0.00
	Rockwall	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
	Henderson	0.0006908	87.1187	0.0042376	513.5995	0.0002047	1.1287	0.0000432	4.1066	605.95	0.30
	Hood	0.0050771	640.3088	0.0311454	3774.8750	0.0015044	8.2954	0.0003178	30.1831	4453.66	2.23
	El Paso Area	Hunt	0.0088463	1115.6746	0.0047066	570.4523	0.0002273	1.2536	0.0652823	6201.0426	7888.42
El Paso		0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
San Antonio Area	Bexar	0.0138906	1751.8434	0.0009368	113.5434	0.0000452	0.2495	0.1109355	10537.5587	12403.19	6.20
	Cornell	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
	Guadalupe	0.0032029	403.9392	0.0002160	26.1808	0.0000104	0.0575	0.0257955	2429.7453	2859.92	1.43
	Wilson	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
Austin Area	Bastrop	0.0033782	426.0519	0.0002278	27.6140	0.0000110	0.0607	0.0289798	2562.7561	3016.48	1.51
	Caldwell	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
	Hays	0.0008331	105.0718	0.0000562	6.8101	0.0000027	0.0150	0.0066537	632.0203	743.92	0.37
	Travis	0.0051785	653.1020	0.0003493	42.3299	0.0000169	0.0930	0.0413577	3928.4911	4624.02	2.31
	Williamson	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
North East Texas Area	Gregg	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
	Harrison	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
	Rusk	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
	Smith	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
	Upshur	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
Corpus Christi Area	Nueces	0.0128578	1621.5862	0.0008672	105.1010	0.0000419	0.2310	0.1026870	9754.0457	11480.96	5.74
	San Patricio	0.0015100	190.4310	0.0001018	12.3425	0.0000049	0.0271	0.0120591	1145.4667	1348.27	0.67
Victoria Area	Victoria	0.0021192	267.2619	0.0001429	17.3222	0.0000069	0.0381	0.0169244	1607.6138	1892.24	0.95
Other ERCOT counties	Andrews	0.0000037	0.4722	0.0000230	2.7839	0.0039003	21.5069	0.0000002	0.0223	24.79	0.01
	Angelina	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
	Bosque	0.0022204	280.0335	0.0136212	1650.9091	0.0006579	3.6279	0.0001390	13.2003	1947.77	0.97
	Brazos	0.0024089	303.8007	0.0112305	1361.1576	0.0005425	2.9912	0.0047829	454.3195	2122.27	1.06
	Calhoun	0.0009466	119.3803	0.0000638	7.7375	0.0000031	0.0170	0.0075598	718.0877	845.22	0.42
	Cameron	0.0063536	801.3017	0.0004285	51.9353	0.0000207	0.1141	0.0507425	4819.9308	5673.28	2.84
	Cherokee	0.0027392	345.4544	0.0168033	2036.5913	0.0008116	4.4755	0.0001714	16.2842	2402.81	1.20
	Coke	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
	Coleman	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
	Crockett	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
	Ector	0.0019215	242.3351	0.0006604	80.0361	0.0911346	502.5346	0.0146527	1391.8309	2216.74	1.11
	Fannin	0.0000041	0.5114	0.0000249	3.0149	0.0000012	0.0066	0.0000003	0.0241	3.56	0.00
	Fayette	0.0051867	654.1320	0.0103217	1251.0047	0.0004986	2.7491	0.0283993	2697.5967	4605.46	2.30
	Freestone	0.0047643	600.8648	0.0292268	3542.3370	0.0014117	7.7844	0.0002982	28.3238	4179.31	2.09
	Frio	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
	Grimes	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
	Hardeman	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
	Haskell	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
	Hidalgo	0.0053716	677.4477	0.0003623	43.9079	0.0000175	0.0965	0.0428994	4074.9335	4796.39	2.40
	Howard	0.0002411	30.4091	0.0000741	92.6066	0.1283942	707.9910	0.0009490	90.1429	921.15	0.46
	Jack	0.0030783	388.2281	0.0188839	2288.7590	0.0009121	5.0296	0.0001927	18.3005	2700.32	1.35
	Jones	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
	Lamar	0.0040001	504.4864	0.0245388	2974.1483	0.0011853	6.5358	0.0002504	23.7807	3508.95	1.75
	Limestone	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
	Llano	0.0040314	508.4346	0.0002719	32.9535	0.0000131	0.0724	0.0321966	3058.2983	3599.76	1.80
	McLennan	0.0056576	713.5231	0.0347066	4206.5028	0.0016764	9.2439	0.0003541	33.6343	4962.90	2.48
	Miami	0.0012686	159.9930	0.0000856	10.3697	0.0000041	0.0228	0.0101316	962.3780	1132.76	0.57
	Michell	0.0000311	3.9259	0.0001910	23.1446	0.0324260	178.8033	0.0000019	0.1851	206.06	0.10
	Nolan	0.0000293	3.6896	0.0001795	21.7517	0.0304745	168.0434	0.0000019	0.1739	193.66	0.10
	Palo Pinto	0.0036129	455.6535	0.0221635	2686.2585	0.0010705	5.9032	0.0002261	21.4788	3169.29	1.58
	Pecos	0.0000020	0.2484	0.0000121	1.4647	0.0020520	11.3153	0.0000001	0.0117	13.04	0.01
	Presidio	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00
Red River	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00	
Robertson	0.0039506	498.2351	0.0055755	675.7568	0.0002693	1.4850	0.0246170	2338.3186	3513.80	1.76	
Taylor	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00	
Texas	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00	
Tom Green	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000000	0.0000	0.0000	0.00	
Upton	0.0000025	0.3208	0.0000156	1.8911	0.0026494	14.6095	0.0000002	0.0151	16.84	0.01	
Ward	0.0001995	25.1628	0.0012239	148.3446	0.2078335	1146.0356	0.0000125	1.1861	1320.73	0.66	
Webb	0.0042017	529.9097	0.0002834	34.3454	0.0000137	0.0755	0.0335565	3187.4734	3751.80		

Table 30: Annual and OSD Electricity Savings for the Different Programs (Base Year 2008)

PROGRAM	ANNUAL (MWh)												
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ESL-Single Family	0	21,748	55,268	93,760	153,171	220,975	293,313	367,771	444,033	522,198	602,369	684,651	769,156
ESL-Multifamily	0	50,218	94,867	167,566	262,939	357,717	463,922	579,667	700,724	827,451	960,229	1,099,461	1,245,572
ESL-Commercial	0	0	25,750	54,550	87,230	126,228	170,173	211,006	253,367	297,350	343,053	390,579	440,036
PUC (SB7)	0	538,841	976,984	1,437,883	1,831,318	2,267,414	2,675,295	3,100,439	3,504,325	3,888,018	4,252,526	4,598,808	4,927,777
SECO	0	71,910	154,786	347,175	508,375	705,060	936,047	940,372	944,480	948,383	952,090	955,613	958,959
Wind-ERCOT	0	3,454,992	8,587,397	11,606,284	13,774,557	16,597,064	19,905,202	24,322,675	26,390,103	28,633,262	31,067,089	33,707,791	36,572,954
SEER13-Single Family	0	343,330	326,163	309,855	294,362	279,644	265,662	252,379	239,760	227,772	216,383	205,564	195,286
SEER13-Multi Family	0	29,021	27,569	26,191	24,881	23,637	22,456	21,333	20,266	19,253	18,290	17,376	16,507
<b>Total Annual (MWh)</b>	<b>0</b>	<b>4,510,059</b>	<b>10,248,785</b>	<b>14,043,263</b>	<b>16,936,834</b>	<b>20,577,739</b>	<b>24,732,069</b>	<b>29,795,642</b>	<b>32,497,059</b>	<b>35,363,686</b>	<b>38,412,029</b>	<b>41,659,843</b>	<b>45,126,247</b>

PROGRAM	OZONE SEASON DAY - OSD (MWh/day)												
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ESL-Single Family	0	124	283	468	626	808	1,002	1,202	1,407	1,617	1,833	2,055	2,283
ESL-Multifamily	0	233	460	744	999	1,253	1,539	1,851	2,177	2,519	2,878	3,254	3,650
ESL-Commercial	0	0	71	149	239	346	466	578	694	815	940	1,070	1,206
PUC (SB7)	0	1,476	2,677	3,939	5,017	6,212	7,330	8,494	9,601	10,652	11,651	12,599	13,501
SECO	0	197	424	951	1,393	1,932	2,576	2,588	2,598	2,608	2,618	2,627	
Wind-ERCOT	0	15,037	24,335	29,191	35,122	34,369	45,184	76,917	83,455	90,549	98,246	106,597	115,657
SEER13-Single Family	0	2,445	2,323	2,207	2,097	1,992	1,892	1,798	1,708	1,622	1,541	1,464	1,391
SEER13-Multi Family	0	195	186	176	167	159	151	144	136	130	123	117	111
<b>Total OSD (MWh)</b>	<b>0</b>	<b>19,709</b>	<b>30,758</b>	<b>37,826</b>	<b>45,661</b>	<b>47,071</b>	<b>60,129</b>	<b>93,560</b>	<b>101,766</b>	<b>110,503</b>	<b>119,820</b>	<b>129,775</b>	<b>140,426</b>

Table 31: Annual and OSD NOx Emissions Reduction Values for the Different Programs (Base Year 2008)

PROGRAM	ANNUAL (in tons NOx)												
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ESL-Single Family	0	5	14	23	38	54	72	91	110	129	149	170	191
ESL-Multifamily	0	13	24	43	67	91	118	148	179	211	245	280	317
ESL-Commercial	0	0	6	14	22	32	43	53	64	75	87	99	111
PUC (SB7)	0	135	246	362	460	567	669	775	876	971	1,062	1,148	1,230
SECO	0	19	43	92	133	183	241	243	245	247	249	251	252
Wind-ERCOT	0	945	2,388	3,222	3,851	4,643	5,577	6,800	7,378	8,005	8,685	9,424	10,225
SEER13-Single Family	0	81	77	73	69	66	62	59	56	53	51	48	46
SEER13-Multi Family	0	7	6	6	6	6	5	5	5	5	4	4	4
<b>Total Annual (Tons NOx)</b>	<b>0</b>	<b>1,204</b>	<b>2,803</b>	<b>3,834</b>	<b>4,646</b>	<b>5,642</b>	<b>6,788</b>	<b>8,174</b>	<b>8,912</b>	<b>9,697</b>	<b>10,532</b>	<b>11,424</b>	<b>12,377</b>

PROGRAM	OZONE SEASON DAY - OSD (in tons NOx/day)												
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
ESL-Single Family	0.00	0.03	0.07	0.11	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.51	0.57
ESL-Multifamily	0.00	0.06	0.12	0.19	0.26	0.32	0.39	0.47	0.55	0.64	0.73	0.83	0.93
ESL-Commercial	0.00	0.00	0.02	0.04	0.06	0.09	0.12	0.15	0.17	0.21	0.24	0.27	0.30
PUC (SB7)	0.00	0.37	0.67	0.99	1.26	1.55	1.83	2.12	2.40	2.66	2.91	3.15	3.37
SECO	0.00	0.05	0.12	0.25	0.37	0.50	0.66	0.67	0.67	0.68	0.68	0.69	0.69
Wind-ERCOT	0.00	4.15	6.75	8.04	9.79	9.56	12.64	21.50	23.33	25.31	27.46	29.80	32.33
SEER13-Single Family	0.00	0.57	0.54	0.51	0.49	0.46	0.44	0.42	0.40	0.38	0.36	0.34	0.32
SEER13-Multi Family	0.00	0.05	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03
<b>Total OSD (Tons NOx)</b>	<b>0.00</b>	<b>5.27</b>	<b>8.33</b>	<b>10.18</b>	<b>12.41</b>	<b>12.72</b>	<b>16.36</b>	<b>25.65</b>	<b>27.90</b>	<b>30.30</b>	<b>32.86</b>	<b>35.60</b>	<b>38.54</b>

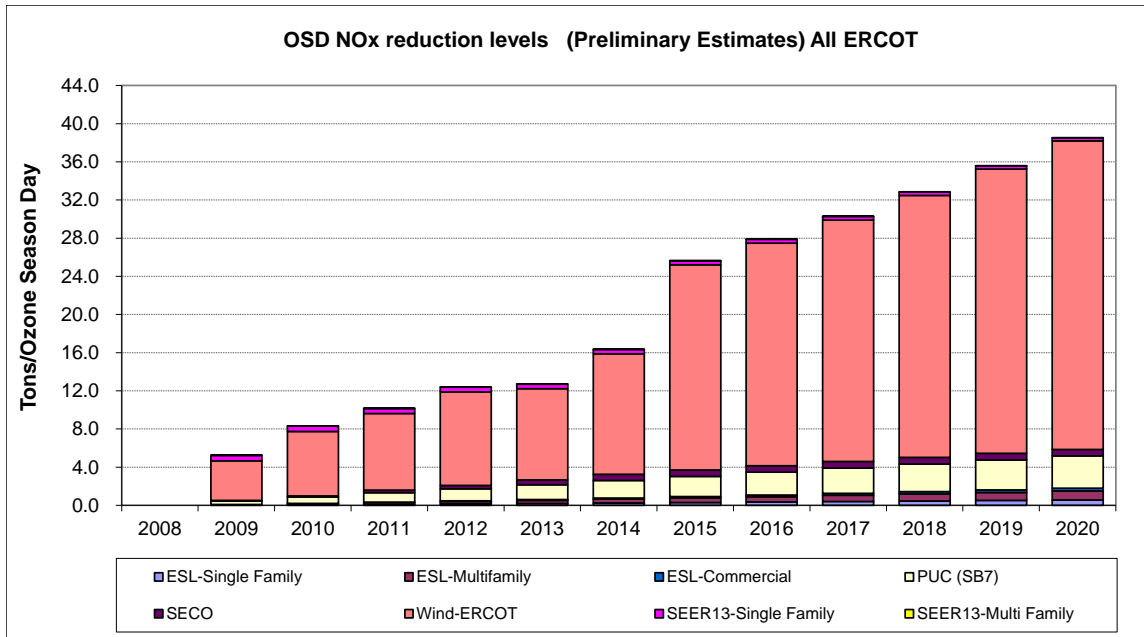


Figure 22: Integrated OSD NOx Emissions Reduction Projections through 2020 (Base Year 2008)

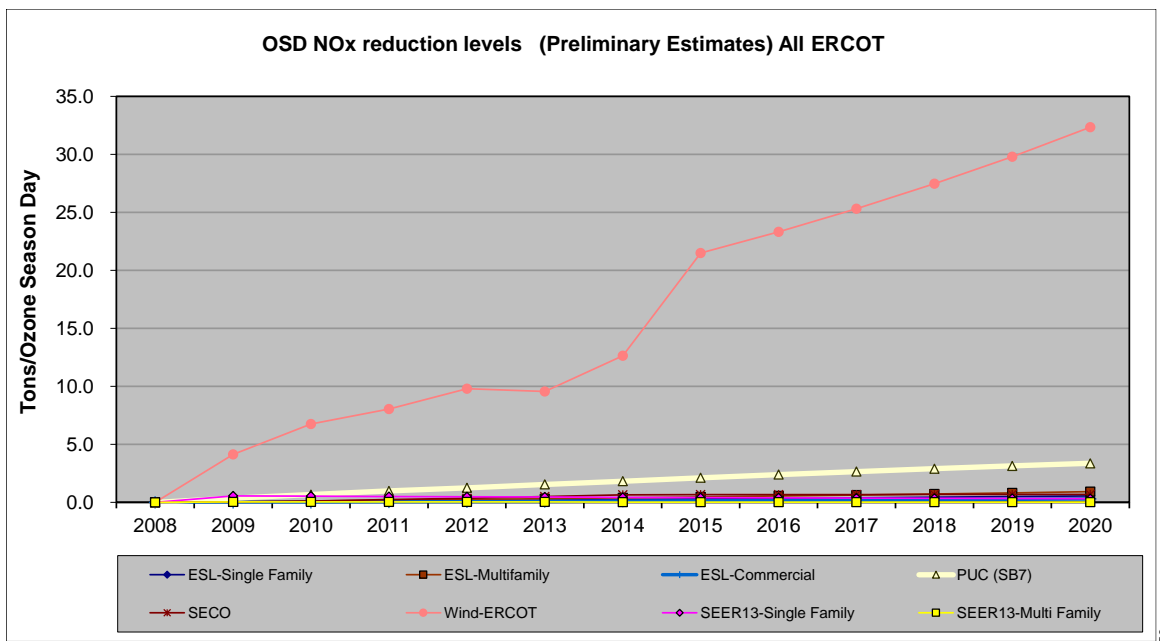


Figure 23: Integrated OSD Individual Programs NOx Emissions Reduction Projections through 2020 (Base Year 2008)

## 6 2015 Year Activities of Energy Systems Laboratory for Texas Emissions Reduction Plan

### 6.1 IC3 Texas Building Registry (TBR)

#### 6.1.1 Background

In 2008, the 81<sup>st</sup> Texas Legislature amended the Texas Administrative Code (TAC .§388.008, 2009) to develop a Registry of Above-Code homes. The Laboratory built the first version of the Registry in 2009. This preliminary version allowed The Laboratory to provide basic metrics on usage of the Laboratory's above code calculators, *IC3*<sup>46</sup> and *TCV*<sup>47</sup>. By running reports against the calculator's databases, The Laboratory 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 so the Laboratory could improve the calculators. In 2015, the reports continued and numbers were gathered.

Figure 24 shows the Projects and Certificates issued each month from January 2015 to December 2015. A Project is a house plan, while Certificates are printed reports given to the building official - assuming that the house is at or above code. In 2015, some users entered a basic floor plan and re-cycled it to generate more certificates.

Figure 25 shows the cumulative Users and Certificates for 2015. The divergence between the two lines emphasizes the difference between the projects completed and certificates issued, showing that more projects were entered (and presumably did not pass) than certificates created.

Figure 26 shows that the largest adopter of the *IC3* software was the North Central Texas Council of Governments (NCTCOG) area, specifically, users building in Dallas, Collin, Denton, and Tarrant Counties.

Figure 27 shows the certifications issued by city.

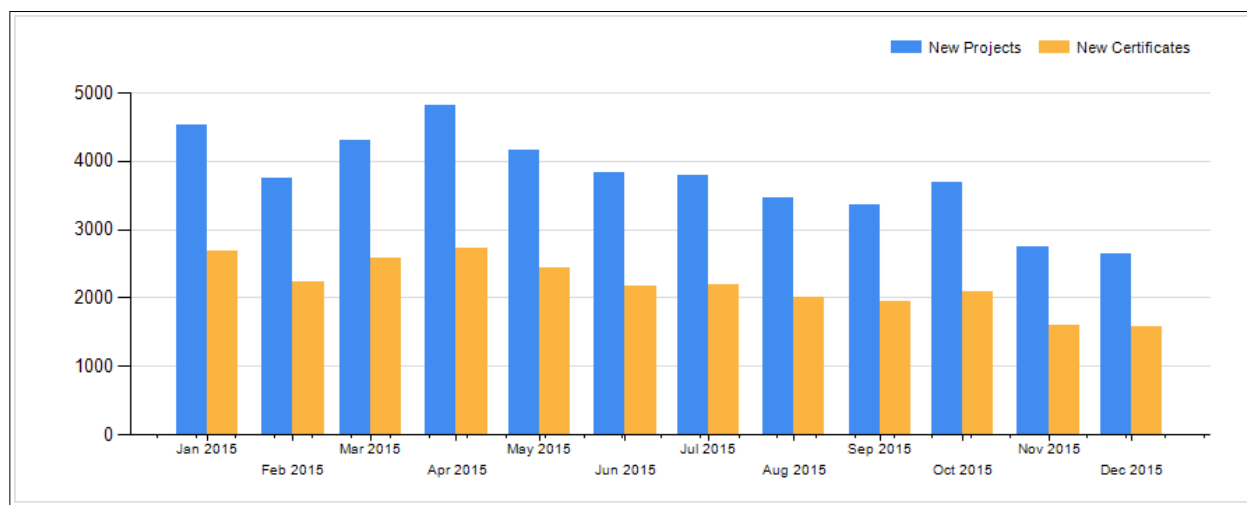


Figure 24: *IC3* 2015 Certificates and Projects

<sup>46</sup> International Code Compliance Calculator, a web based, above code calculator for single family, detached, new construction in Texas.

<sup>47</sup> Texas Climate Vision, a web based, above code calculator for single family, detached, new construction in Austin Energy's service area.

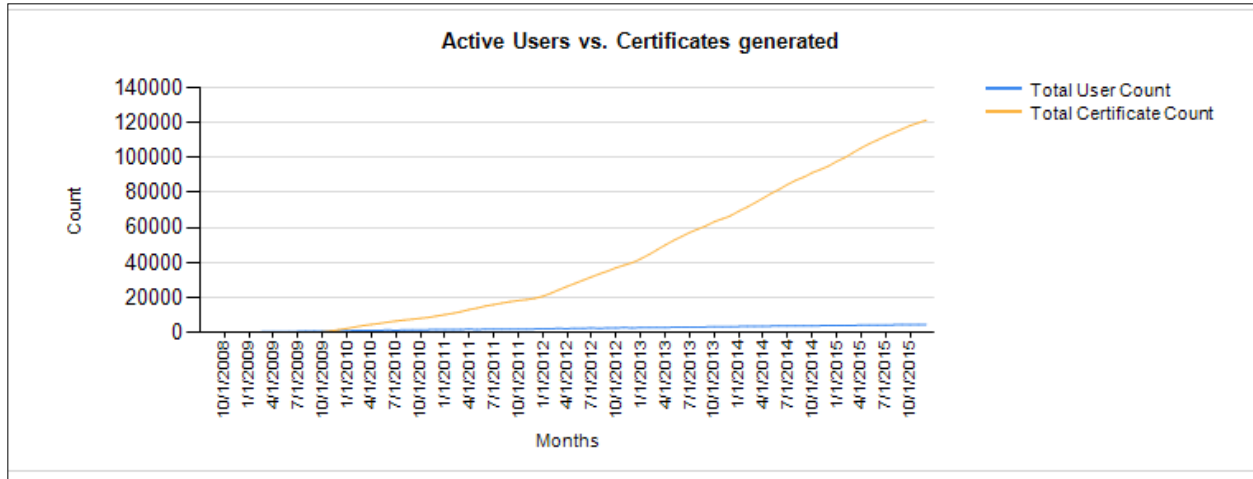


Figure 25: IC3 2015 Active Users and Certificates

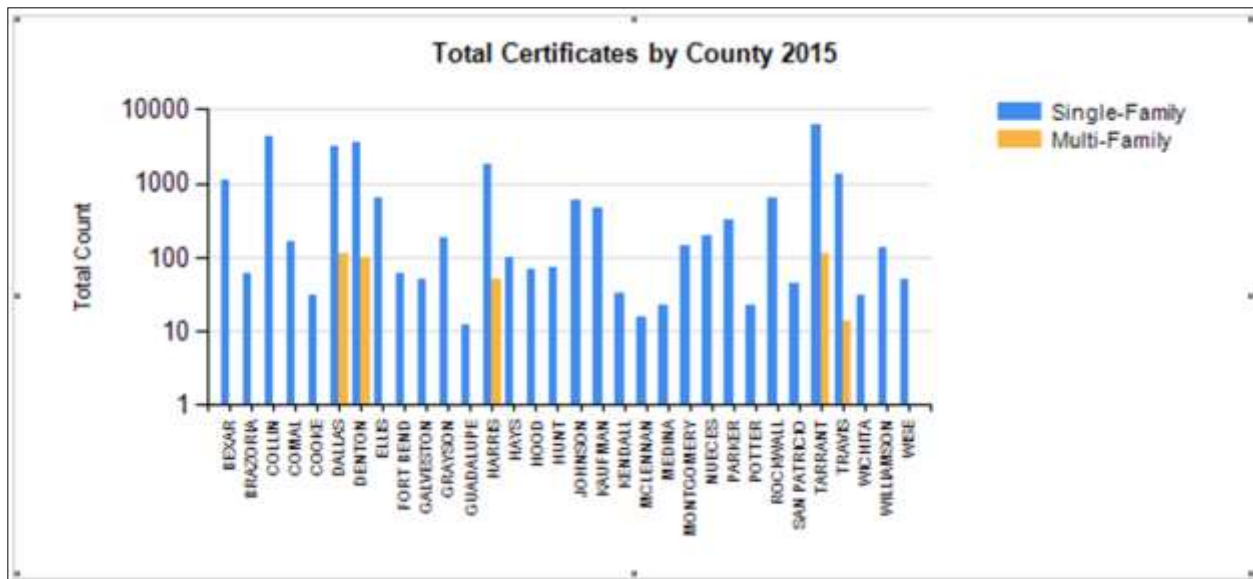


Figure 26: IC3 2015 Certificates – Counties with at least 10 Certificates

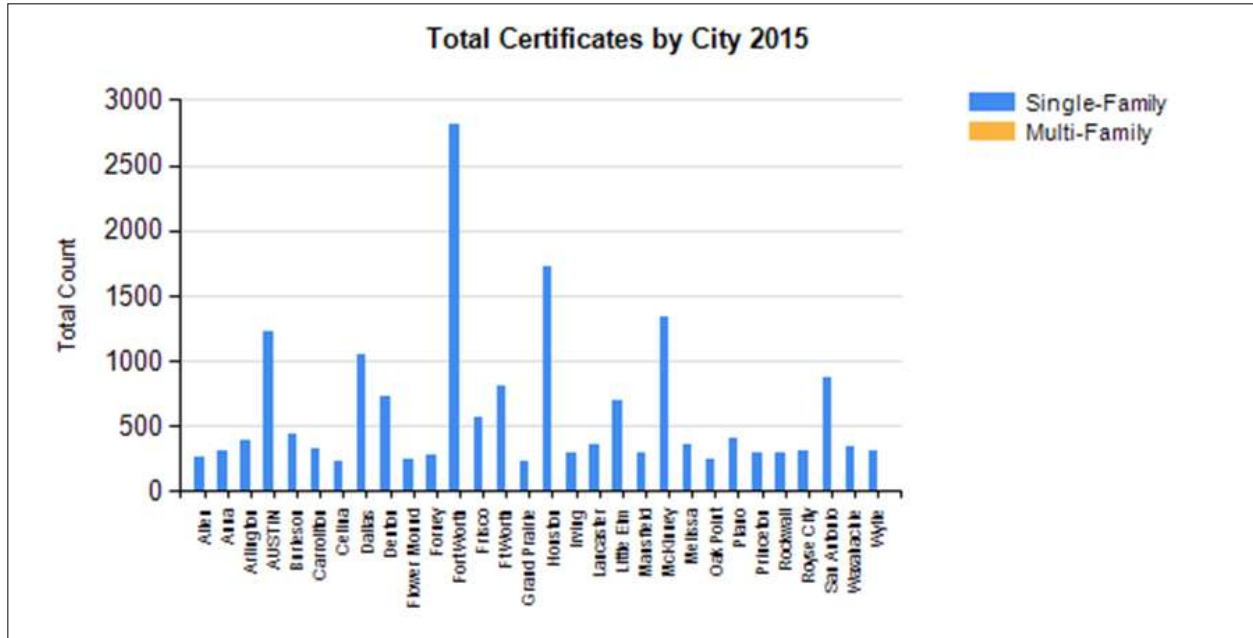


Figure 27: IC3 2015 Certificates – Cities with at least 200 Certificates

#### 6.1.2 Texas Building Registry Current Version

As illustrated below and a “*Report on the Development of the Format for a Texas Residential Registry* (Gilman, et al., 2008), the underlying database was optimized for supporting the IC3 and TCV calculators and therefore needed a transformation to allow for seamless reporting. Consequently, The Laboratory 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 2008*. This product offers reporting capabilities through various tools.

Figure 28 shows the “layout” of the IC3 (v3.x) and TCV<sup>48</sup> (v1.1) databases. It gives a rough overview of the different tables (called “entities”) found in the IC3 database. The center entity is the Project, which is the center of the IC3 software’s abstraction of a house. The other tables include floors, walls, electrical, and systems.

<sup>48</sup> The TCV v1.1 database has different fields due to the built-in inspection module and the fact it was completed two years earlier than the described IC3 v3.6.



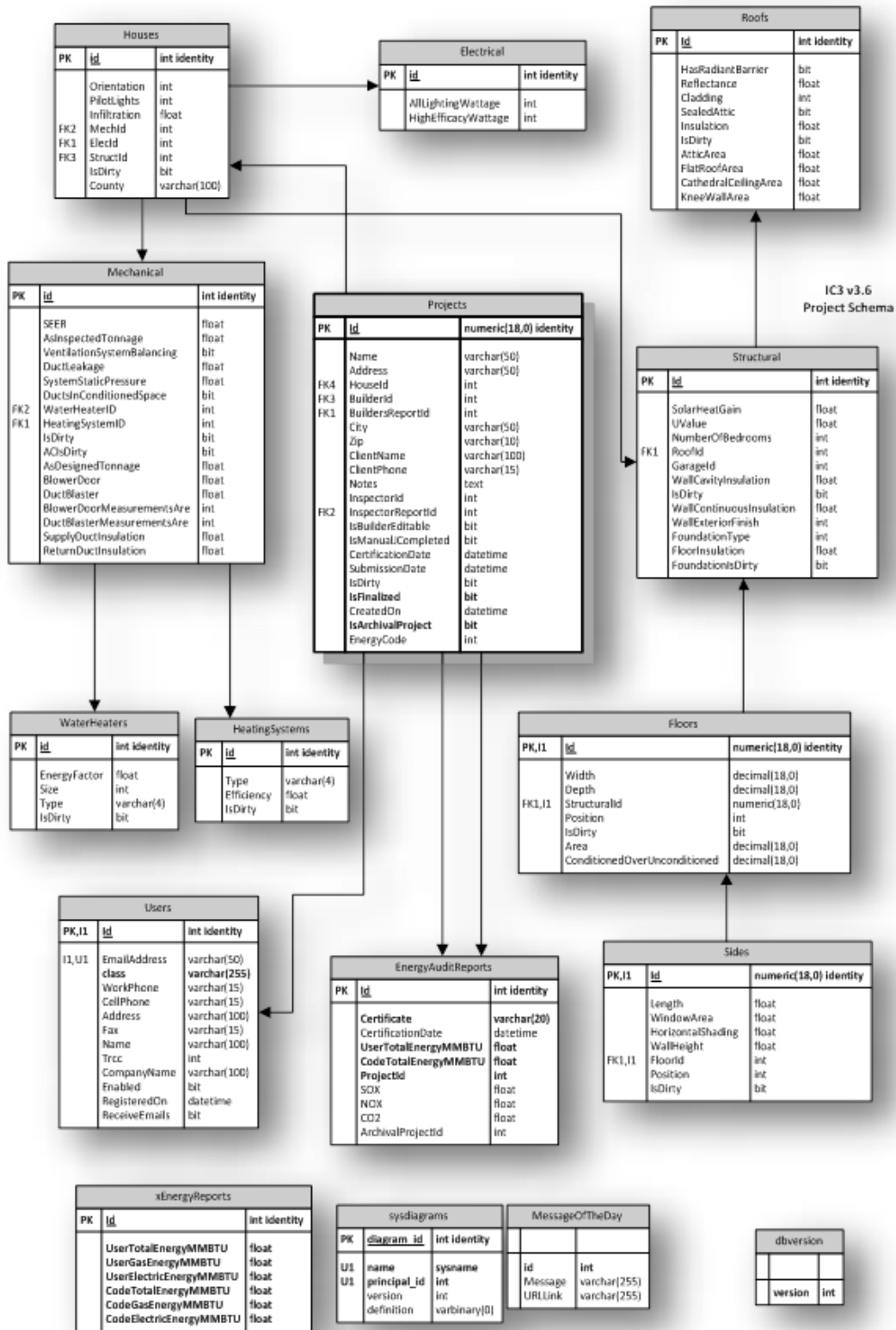


Figure 28: Database Schema

### 6.1.3 Usage Reports

Figure 29 shows a steady growth from the start of record keeping (July 2009) until the end of 2015. During this year, ESL conducted several workshops and was able to detect a correlation between workshops and IC3 usage.

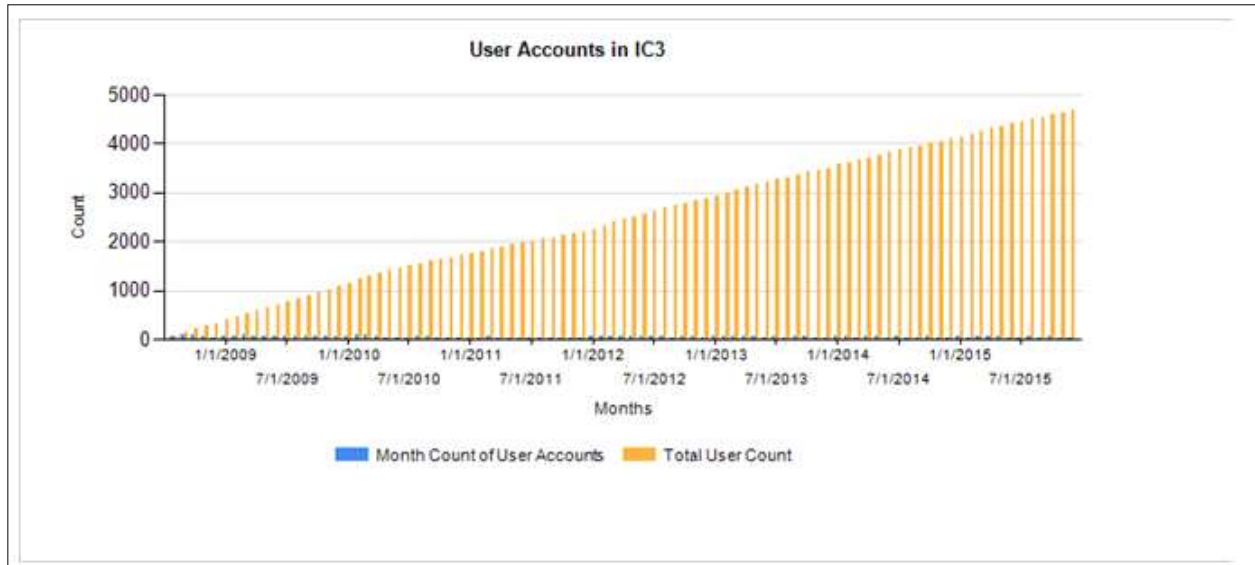


Figure 29: IC3 Usage Growth in 2015

Figure 30 shows the correlation between users and their successful projects (i.e. those that generate certificates). The graph shows that users were generating more certificates, and were doing so at a much faster rate than the rate of adding new users.

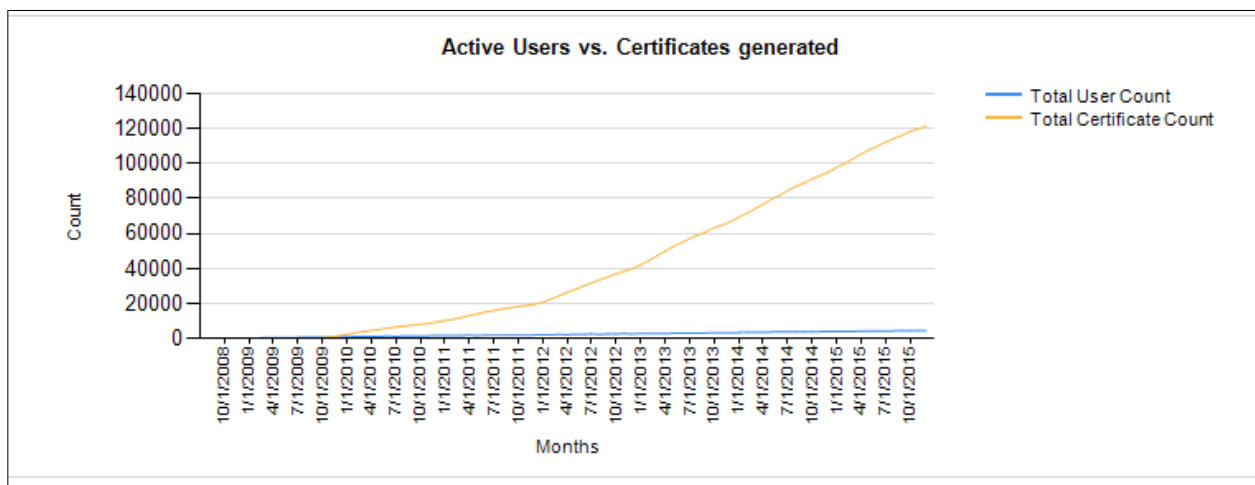


Figure 30: Users and Certificates 2015

Figure 31 through Figure 35 show where the usage was using Counties and Cities as the grouping entity. The North Central Texas Council of Governments (NCTCOG) led the way in usage during 2015. In the figures, the colors change to show the lowest counts in the dark green all the way to the highest counts in red.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
ANDERSON	0	0	0	0	0	0	1	0	0	0	0	0	1
BEXAR	126	99	132	122	114	123	132	80	34	41	31	54	1088
BRAZORIA	1	17	4	7	5	13	7	3	0	3	0	0	60
BRAZOS	0	0	0	0	0	8	0	0	0	0	1	0	9
BURNET	0	0	0	0	0	0	0	0	1	0	0	0	1
CAMERON	0	0	0	0	0	0	0	0	0	0	6	0	6
CHAMBERS	0	0	0	0	0	0	0	0	0	1	0	0	1
CLAY	0	0	0	0	0	0	0	1	0	2	0	0	3
COLLIN	501	339	343	448	374	278	370	442	391	478	192	241	4397
COMAL	20	9	8	24	9	16	18	33	13	4	5	5	164
COOKE	0	3	17	0	6	0	0	2	0	1	0	2	31
DALLAS	320	237	237	286	395	253	234	248	226	268	204	195	3103
DENTON	354	378	500	349	343	328	194	229	214	283	281	150	3603
EASTLAND	4	0	0	0	0	0	0	0	0	0	0	0	4
ELLIS	35	42	41	74	58	69	68	36	61	102	18	29	633
FANNIN	0	0	0	0	3	0	0	0	0	0	0	0	3
FORT BEND	13	4	17	4	9	4	5	4	0	0	0	0	60
GALVESTON	3	15	4	1	12	1	1	8	2	3	0	1	51
GRAY	0	0	0	2	0	0	0	0	0	0	0	0	2
GRAYSON	24	4	7	15	36	11	28	6	32	7	8	2	180
GUADALUPE	3	4	4	0	0	1	0	0	0	0	0	0	12
HARDIN	0	0	0	0	0	0	0	1	0	0	0	0	1
HARRIS	121	157	225	215	73	106	214	162	154	135	131	117	1810
HAYS	8	0	9	10	6	7	11	9	13	12	13	0	98
HENDERSON	1	0	4	0	0	4	0	0	1	0	0	0	10
HIDALGO	1	0	0	0	0	0	0	0	0	0	0	0	1

Figure 31: Counties Generating Single-Family HomesIC3 Certificates in 2015

HOOD	0	0	10	5	5	1	13	6	3	10	10	6	69
HOPKINS	0	0	0	0	0	1	0	0	0	0	0	0	1
HOUSTON	0	1	6	1	0	0	0	0	1	0	0	0	9
HUNT	4	7	7	16	7	12	1	0	0	1	0	17	72
JOHNSON	60	57	42	55	42	51	75	45	62	39	30	34	592
KAUFMAN	72	60	41	55	30	47	34	33	26	31	29	8	466
KENDALL	2	3	0	2	0	5	5	5	1	2	2	5	32
LLANO	0	0	0	0	0	0	2	0	0	0	0	1	3
MCLENNAN	0	0	11	0	0	2	0	2	0	0	0	0	15
MEDINA	0	2	1	0	1	5	1	3	2	2	0	5	22
MIDLAND	0	0	0	0	1	0	0	0	0	0	0	0	1
MILAM	1	0	0	0	0	0	0	0	0	0	0	0	1
MONTGOMERY	4	6	11	22	30	40	0	5	7	4	10	1	140
NUECES	18	16	15	19	15	19	14	13	13	15	15	17	189
PALO PINTO	0	1	0	0	0	0	1	0	0	0	1	0	3
PARKER	29	19	31	28	16	35	38	19	23	33	25	25	321
POTTER	0	0	0	0	0	0	0	0	0	0	14	9	23
ROCKWALL	51	65	50	82	40	55	33	45	54	64	65	33	637
SAN PATRICIO	6	4	4	5	3	3	3	3	2	3	2	5	43
SMITH	0	2	0	3	0	0	0	0	0	3	0	0	8
SOMERVELL	0	0	0	0	0	0	0	0	2	0	0	0	2
TARRANT	743	478	572	662	544	514	476	429	430	362	387	423	6020
TERRELL	2	0	0	0	0	0	0	0	0	0	0	0	2
TRAVIS	106	114	126	147	155	81	162	80	150	104	73	58	1356
VAL VERDE	3	0	0	0	1	0	0	5	0	0	0	0	9
WICHITA	2	0	5	1	0	2	1	5	3	1	7	4	31
WILLIAMSON	11	26	32	8	7	21	13	0	5	2	3	10	138
WILSON	3	0	0	0	0	0	0	0	0	0	0	0	3
WISE	5	3	7	6	6	3	3	2	1	2	9	4	51
WOOD	0	0	0	2	2	0	0	0	0	0	0	0	4
YOUNG	0	0	0	0	2	0	0	0	0	0	0	0	2

Figure 31: Continued

													Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
COLLIN	0	0	0	3	0	2	0	0	0	0	1	0	6
DALLAS	8	0	5	2	12	12	0	33	0	37	0	1	110
DENTON	0	0	1	0	0	0	0	0	0	0	0	99	100
GRAYSON	0	0	0	0	0	0	0	0	0	0	0	2	2
HARRIS	0	0	2	12	0	4	0	0	14	3	4	11	50
TARRANT	0	6	7	6	34	23	6	14	3	1	14	1	115
TRAVIS	1	0	2	2	3	2	4	0	0	0	0	0	14

Figure 32: Counties Generating Multi-Family Homes IC3 Certificates in 2015

													Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Mansfield	0	2	0	0	0	0	0	0	0	0	0	0	2
Seguin	1	0	0	0	0	0	0	0	0	0	0	0	1
111	0	0	0	0	0	0	0	0	0	0	4	0	4
Addison	0	0	0	0	0	0	0	2	0	0	0	0	2
Agryle	0	0	0	1	2	0	0	0	0	0	0	0	3
Alba	0	0	0	0	2	0	0	0	0	0	0	0	2
Aledo	16	2	3	5	4	22	13	4	10	7	7	13	106
Allen	15	9	22	0	8	22	38	36	19	18	9	3	199
Allen	0	0	0	53	0	0	0	0	0	0	0	0	53
Alvin	1	18	7	7	5	12	7	3	0	1	0	0	61
amarillo	0	0	0	0	0	0	0	0	0	0	8	0	8
Anahuac	0	0	0	0	0	0	0	0	0	1	0	0	1
Anna	63	22	9	16	25	35	34	18	24	43	23	0	312
Annetta South	0	0	0	0	0	0	0	0	0	0	1	0	1
Argyle	4	7	6	6	2	3	5	13	3	11	2	4	66
Arlington	19	27	40	22	24	42	38	43	15	24	27	64	385
Arlington	0	0	0	0	0	0	0	0	5	0	0	0	5
Arygle	0	0	0	0	13	0	0	0	1	0	0	0	14
Aubrey	0	0	0	6	4	0	0	0	0	0	6	1	17
Aurora	0	0	0	0	2	0	0	0	0	0	0	0	2
Aurora	0	0	0	0	0	0	0	0	0	1	0	0	1
Aurora Vista	0	0	0	1	0	0	0	0	0	0	0	0	1
Austin	95	124	117	146	135	68	134	65	136	93	60	47	1220
Azle	48	8	8	40	17	7	2	12	12	15	10	7	186
Bartonville	0	0	0	0	1	3	2	1	0	0	0	0	7
Baytown	0	0	0	0	0	1	0	0	0	0	0	0	1
Bedford	0	18	14	0	0	1	0	3	0	2	0	2	40

Figure 33: Cities Generating Single-Family Homes IC3 Certificates in 2015

Bellair	0	0	0	0	0	0	1	0	0	0	0	0	1
Bellaire	1	0	0	0	0	0	0	0	0	0	0	0	1
Belverde	0	1	0	0	0	1	0	0	0	0	0	0	2
Benbrook	25	9	19	6	3	12	11	11	10	38	17	0	161
Benbrook	0	0	0	0	0	0	0	0	0	0	0	9	9
Benbrook, Texas	0	0	0	0	0	0	0	0	1	0	0	0	1
Bilverde	0	0	0	0	0	0	1	0	0	0	0	0	1
Blue Ridge	0	0	0	2	4	0	3	3	2	1	3	1	19
Boerne	5	3	1	2	0	7	10	0	3	2	2	0	35
Boerne	0	0	0	0	0	0	0	10	0	0	0	5	15
Bonham	0	0	0	0	3	0	0	0	0	0	0	0	3
Bridgeport	0	0	0	3	0	0	0	0	0	0	0	0	3
bryan	0	0	0	0	0	0	0	0	0	0	6	9	15
Buda	0	0	0	0	0	0	0	0	1	0	0	0	1
Bulverde	0	0	0	2	0	0	0	0	1	0	0	0	3
Bulverde	21	8	0	9	9	8	9	15	0	0	4	0	83
Bulverde	0	0	8	0	0	0	0	0	12	5	0	5	30
Burleson	49	37	31	0	31	38	53	47	19	40	21	24	390
Burleson	0	0	0	52	0	0	0	0	0	0	0	0	52
Canyon Lake	1	0	0	0	0	0	0	0	0	0	0	0	1
Carrollton	44	31	31	37	65	30	22	18	9	7	11	18	323
Carrollton	1	5	16	8	0	2	0	2	0	0	0	0	34
Carrollton	0	0	0	0	12	0	0	0	0	0	0	0	12
Caruth Lakes	0	0	0	1	0	0	0	0	0	2	0	1	4
Castroville	0	0	3	0	2	6	1	3	2	2	2	0	21
Castroville	0	4	0	0	0	0	0	0	0	0	0	5	9
Cedar Hill	16	13	5	13	9	14	21	8	6	17	6	9	137
Cedar Hill, TX	0	3	0	0	0	0	0	0	0	0	0	0	3
Cedar Park	6	11	2	0	0	0	1	0	0	0	0	0	20
Celina	21	5	30	24	33	22	17	21	26	6	5	23	233
Chapel Hill	0	1	0	0	2	0	0	0	0	0	0	0	3
Cisco	4	0	0	0	0	0	0	0	0	0	0	0	4
Clear Lake Shores	0	0	0	1	0	0	0	0	0	0	0	0	1

Figure 33: Continued

Cleburn	0	0	0	0	0	0	1	0	0	0	0	0	1
Clebume	4	6	4	1	0	2	6	1	29	0	1	2	56
cll	0	0	0	0	0	8	0	0	0	0	0	0	8
COCKRELL HILL	0	0	0	0	0	0	0	0	0	0	0	1	1
College Station	0	0	0	0	0	0	4	0	0	0	1	0	5
Colleyville	9	12	15	20	7	11	0	9	15	3	11	3	115
Colleyville	0	0	0	0	0	0	9	0	0	0	0	0	9
Colleyville	0	0	0	0	1	0	0	0	0	0	0	0	1
Combine	1	0	0	0	1	0	1	1	2	1	1	0	8
Conroe	4	6	10	21	31	36	0	5	1	0	10	1	125
Converse	1	0	0	0	0	0	0	0	0	0	0	0	1
Copeville	0	0	0	0	0	0	0	0	0	0	0	1	1
Copeville/Nevada	0	0	0	0	0	0	0	0	0	0	1	0	1
Coppell	9	11	5	6	8	16	7	9	2	0	3	4	80
Copper Canyon	0	1	0	2	0	0	1	0	0	0	0	0	4
Corinth	0	0	3	0	0	0	3	0	5	0	2	1	14
Cornith	0	0	2	0	0	0	0	0	0	0	0	0	2
Corpus Christi	18	16	15	19	15	19	14	12	13	15	15	17	188
Crandall	3	22	4	5	1	5	1	0	0	0	0	0	41
Crosby	0	0	0	0	0	0	0	0	0	0	0	1	1
Cross Roads	2	0	0	0	1	0	0	0	0	0	3	0	6
Crossroads	0	0	0	1	3	0	0	4	1	0	20	0	29
Crowely	0	0	1	0	0	0	0	0	0	0	0	0	1
Crowley	0	0	2	0	1	0	0	1	0	1	0	12	17
Crowley	0	0	0	43	0	0	0	0	0	0	0	0	43
Dalals	1	0	0	0	0	0	0	0	0	0	0	0	1
Dallas	104	76	79	122	95	103	83	76	103	62	79	70	1052
Dallas, TX 75214	0	0	0	0	0	0	0	0	0	0	0	1	1
Dalls	0	5	0	0	0	0	0	0	0	0	0	0	5
dd	0	0	16	0	0	3	0	0	0	1	0	0	20
decatur	3	2	2	0	0	1	1	0	0	0	0	0	9
Del Rio	3	0	0	0	1	0	0	5	0	0	0	0	9
Denison	0	0	0	0	0	3	0	2	0	1	0	0	6
Dennison	0	0	0	0	0	0	0	0	0	0	0	2	2

Figure 33: Continued



Denton	109	112	66	66	68	49	26	34	22	60	78	0	690
Denton	0	0	0	0	0	0	0	0	0	0	0	28	28
Denton County	17	22	10	17	25	11	15	16	15	17	14	19	198
Desoto	38	30	10	21	20	12	5	3	7	5	2	20	173
Dish	0	7	0	0	0	5	6	1	0	0	0	2	21
Double Oak	2	0	0	0	0	0	0	0	0	0	0	0	2
Duncanville	0	0	0	0	2	0	0	0	2	0	2	0	6
Ennis	0	1	0	0	0	0	0	0	0	5	1	0	7
Euless	8	0	1	2	9	10	8	5	5	5	4	0	57
Everman	0	0	0	0	1	1	0	0	0	0	0	0	2
Fair Oaks	0	0	3	0	0	0	0	0	0	0	0	0	3
Fair Oaks Ranch	2	0	8	3	0	9	0	6	0	0	3	0	31
Fair Oaks Ranch	0	8	0	0	3	0	0	0	1	9	0	4	25
Fair Oaks Ranch	0	0	0	0	0	0	8	0	0	0	0	0	8
Fairs Oaks Ranch	0	1	0	0	0	0	0	0	0	0	0	0	1
Fairview	0	2	0	1	0	2	0	0	0	0	0	1	6
Farmers Branch	1	0	0	0	2	2	2	4	0	1	1	2	15
Farmersville	0	1	0	0	0	0	0	0	0	0	0	0	1
Fate	0	6	3	9	5	9	1	1	0	0	3	0	37
Fate	7	0	0	0	0	0	0	0	0	0	0	0	7
Ferris	0	0	0	0	0	0	0	5	2	3	0	0	10
floresville	3	0	0	0	0	0	0	0	0	0	0	0	3
Flower Mound	31	37	21	29	22	24	10	11	25	14	10	9	243
Flowermound	0	0	2	0	0	0	0	0	0	0	0	0	2
flower-mound	1	2	0	0	0	0	0	0	0	0	0	0	3
Foert Worth	0	0	0	0	0	2	0	0	0	0	0	0	2
Forest Hill	0	4	4	2	9	5	12	3	3	2	9	2	55
Forney	21	26	28	37	23	35	20	28	16	20	22	6	282
Forsest Hill	0	0	0	0	0	1	3	0	0	0	1	2	7
Fort Wort	1	0	0	0	0	0	0	0	0	0	0	0	1
Fort Worth	287	202	282	330	293	274	240	212	160	149	197	181	2807
Fort Worth TX.	0	0	0	0	0	0	0	0	0	0	0	1	1
Fort Worth, Texas	0	0	0	0	0	0	0	0	0	0	0	8	8

Figure 33: Continued

Forth Worth	0	0	3	0	0	1	0	4	0	2	0	0	10
Fortworth	107	1	10	3	33	0	0	0	10	0	0	0	164
Forworth	0	0	0	0	0	0	0	0	0	4	10	11	25
Frisco	66	50	54	40	54	58	62	48	22	53	17	34	558
Frot Worth	0	0	0	0	0	0	1	0	2	1	0	0	4
Ft Worth	125	73	64	0	42	57	63	46	81	43	53	81	728
Ft Worth	0	0	0	72	0	0	0	0	0	0	0	0	72
FT WORTH, TX	0	0	0	0	0	0	0	0	1	0	0	0	1
Ft. Worth	2	7	2	14	0	2	1	0	3	0	0	0	31
Ft. Worth Ave	0	0	0	0	0	2	0	0	0	0	0	0	2
Fulshear	0	2	0	0	0	0	0	0	0	0	0	0	2
Gainesville	0	2	17	0	6	0	0	0	0	0	0	0	25
Gaineville	0	0	0	0	0	0	0	0	0	0	0	2	2
Gainsville	1	0	1	0	0	0	0	1	0	0	0	0	3
Galveston	1	0	1	0	0	0	0	1	0	0	0	1	4
Garland	21	1	22	13	35	10	18	20	6	19	19	13	197
Glenn Heights	5	0	3	7	9	4	5	0	9	2	0	3	47
Glenn Heights	0	10	0	0	0	0	0	0	0	0	0	0	10
Godley	0	0	0	3	0	0	0	0	0	0	0	0	3
Gordon	0	1	0	0	0	0	1	0	0	0	1	0	3
Gordonville	0	0	0	3	0	0	0	0	1	0	0	0	4
Graham	0	0	0	0	2	0	0	0	0	0	0	0	2
Granbury	0	0	10	5	5	0	13	6	3	10	10	6	68
Grand Prairie	14	15	22	23	17	28	29	17	14	11	9	35	234
Grand Prarie	0	4	0	0	0	0	0	0	0	0	0	0	4
Grand Prririe	0	0	0	0	0	0	8	0	0	2	0	0	10
Grandbury	0	0	0	0	0	0	0	0	0	1	0	0	1
Grandview	2	0	0	0	2	0	0	0	0	0	0	0	4
Grandview	0	0	0	0	0	0	0	0	0	0	1	0	1
Grapevine	3	5	7	9	16	4	1	5	4	9	5	2	70
Grapevine`	0	0	0	0	0	0	0	0	2	0	0	0	2
Greenville	3	1	3	15	5	1	0	0	0	0	0	0	28
Grepevine	0	0	0	0	0	0	0	0	1	0	0	0	1
Gun Barrel City	1	0	4	0	0	4	0	0	1	0	0	0	10

Figure 33: Continued

Gunter	0	0	0	2	1	1	1	0	0	0	0	0	5
Hackberry	10	0	0	1	2	0	0	0	2	0	0	0	15
Haltom City	0	1	0	2	3	0	0	0	0	2	0	0	8
Haslet	1	4	1	0	3	0	0	0	0	1	1	0	11
Heartland	4	0	2	6	2	4	10	3	7	7	1	2	48
Heath	6	5	4	7	9	8	4	4	21	22	16	10	116
Helotes	10	2	4	3	0	15	12	6	1	0	2	0	55
Helotes	0	0	0	0	6	0	0	0	0	0	0	1	7
Henrietta	0	0	0	0	0	0	0	1	0	0	0	0	1
Hertland	0	0	0	0	0	1	0	0	0	0	0	0	1
Hickory Creek	5	5	1	2	5	4	2	1	10	5	1	1	42
Highland Park	1	5	2	2	8	4	4	3	10	0	4	2	45
Highland Park	0	0	0	0	0	1	0	0	0	0	0	0	1
Highland Village	0	0	3	3	0	0	2	2	0	0	0	0	10
Horseshoe Bay	0	0	0	0	0	0	2	3	0	0	2	1	8
Houston	122	145	215	197	60	95	208	158	145	135	128	114	1722
Houston Tx.	0	0	1	0	0	0	0	0	0	0	0	0	1
Hudson Oak	0	0	0	0	0	0	0	0	0	0	3	0	3
Hudson Oaks	0	0	2	4	2	1	1	1	0	2	4	0	17
Huffman	2	0	1	2	0	0	0	1	3	0	0	0	9
Huffman	0	0	0	0	0	0	0	0	0	0	1	0	1
Humble	0	3	0	3	1	2	0	0	1	0	3	1	14
Hurst	0	0	1	0	0	0	4	0	2	3	0	5	15
Irving	46	26	0	28	24	28	14	0	8	32	25	17	248
Irving	0	0	26	0	0	0	0	12	0	0	0	0	38
Jarrell	0	0	0	0	0	13	0	0	0	0	0	0	13
Jersey Village	0	0	0	0	0	0	0	1	1	0	0	0	2
Josephine	1	0	2	0	5	0	0	0	36	5	0	2	51
Joshua	0	12	0	1	0	5	1	0	0	1	0	0	20
Justin	3	0	0	12	8	0	3	7	0	2	9	1	45
Justin	0	0	2	0	0	6	0	0	0	0	0	0	8
Katy	2	7	10	13	8	2	0	0	0	0	0	0	42
Kaufman	15	0	0	4	0	0	2	0	2	4	0	0	27
Keene	1	0	0	2	0	0	0	0	0	0	0	0	3

Figure 33: Continued

Keller	9	0	17	0	1	2	5	1	6	1	2	4	48
Kemah	2	0	0	0	0	0	0	1	0	0	0	0	3
Kennedale	0	0	0	1	0	0	0	0	3	3	0	0	7
Kentsdale Farms, Desoto	0	0	1	0	0	0	0	0	0	0	0	0	1
Krugerville	2	0	0	0	0	0	0	0	0	2	0	0	4
Krum	0	3	0	0	1	0	0	0	2	0	0	0	6
Kruger	0	0	0	0	0	0	3	0	0	0	0	0	3
Kyle	8	0	9	10	6	7	11	9	12	12	12	0	96
La Porte	0	1	0	0	0	0	0	0	0	0	0	0	1
Lake Dallas	0	0	0	0	0	0	0	0	0	5	0	2	7
Lake Kiowa	0	1	0	0	0	0	0	2	0	0	0	0	3
Lake Worth	2	2	2	1	1	0	1	10	2	2	1	0	24
Lakeside City	0	0	0	0	0	0	1	0	0	0	0	0	1
Lancaster	16	22	7	18	99	14	24	9	21	84	25	19	358
LaPorte	0	0	0	0	0	0	0	1	0	0	0	0	1
Las Colinas	0	0	8	0	0	0	0	0	0	0	0	0	8
Lavon	9	7	5	13	9	13	6	6	3	7	3	6	87
League City	0	15	3	0	12	1	1	6	2	3	0	0	43
Leander	7	5	0	3	2	4	2	0	3	0	0	0	26
Lewisville	10	23	52	22	13	7	5	6	14	28	0	6	186
Lewisville	0	0	0	0	0	0	0	0	0	0	8	0	8
Lewville	0	0	0	0	0	0	0	0	0	0	1	0	1
Lewisville	0	0	0	0	0	1	1	0	0	0	0	0	2
Lipan	0	0	0	0	0	1	0	0	0	0	0	0	1
Little Elm	0	60	176	40	41	68	20	54	56	49	57	25	646
Little Elm	52	0	0	0	0	0	0	0	0	0	0	0	52
Lively Lane	0	1	0	0	0	0	0	0	0	0	0	0	1
Lucas	2	5	13	5	1	1	2	7	4	28	4	3	75
Lumberton	0	0	0	0	0	0	0	1	0	0	0	0	1
Magnolia	0	0	1	1	0	0	0	0	0	0	0	0	2
Manor	9	0	7	6	18	13	33	10	16	12	9	0	133
Mansfield	0	0	0	0	0	0	0	0	0	3	0	0	3
Mansfield	35	32	40	23	24	39	20	19	20	8	13	13	286

Figure 33: Continued

Marble Falls	0	0	0	0	0	0	0	0	1	0	0	0	1
Masfield	1	0	0	0	0	0	0	0	0	0	2	0	3
MASTER	0	0	2	1	0	0	0	0	0	0	0	0	3
Maypearl	0	0	0	0	0	0	0	0	1	1	0	0	2
Mc Kinney	0	1	6	9	0	0	0	0	0	0	0	0	16
McAllen	1	0	0	0	0	0	0	0	0	0	0	0	1
McClendon Chisholm	0	0	0	0	0	0	0	0	0	0	3	0	3
McKinney	202	96	84	97	60	55	135	76	143	218	66	104	1336
McLendon Chisholm	2	10	7	14	2	2	2	0	0	0	0	1	40
McLendon Chisolm	2	0	0	0	0	0	0	0	0	0	0	0	2
McLendon- Chisholm	0	0	0	0	0	0	0	0	0	1	0	0	1
Melissa	27	25	31	24	53	16	17	48	29	17	19	46	352
Mellisa	0	1	0	0	0	0	0	0	0	0	0	0	1
Mesquite	0	0	4	0	9	3	0	9	4	3	7	1	40
Midland	0	0	0	0	1	0	0	0	0	0	0	0	1
Midlothian	7	14	8	9	11	6	8	2	15	9	9	9	107
Missouri City	4	0	2	1	2	3	2	0	0	0	0	0	14
Montgomery	0	0	0	0	0	0	0	0	0	1	0	0	1
Murphy	0	4	0	1	1	2	0	1	0	0	1	0	10
N. Richland Hills	0	0	0	0	0	0	0	0	2	0	0	0	2
Nemo	0	0	0	0	0	0	0	0	2	0	0	0	2
New Braunfels	0	0	0	13	0	6	7	18	0	0	0	1	45
New Fairview	0	0	0	0	2	0	1	0	0	0	0	0	3
Neward	0	0	0	0	0	0	0	0	0	0	2	0	2
Newark	0	0	0	0	0	0	0	0	0	0	7	4	11
Newark	0	0	0	0	0	1	0	0	0	0	0	0	1
North Lake	0	2	0	1	0	0	0	0	0	0	0	0	3
North Richland Hills	10	32	10	12	12	2	0	5	16	13	2	1	115
North Richland Hills	0	0	0	0	0	0	19	0	0	0	0	0	19
Northlake	1	3	1	0	1	3	1	0	0	3	0	0	13
Oak Leaf	1	6	0	0	0	0	0	0	0	0	0	0	7

Figure 33: Continued

Oak Point	19	26	24	12	20	30	17	19	13	19	37	5	241
Oak Pointe	0	0	1	0	0	0	1	0	0	0	0	0	2
Ovilla	2	3	2	4	0	0	0	1	0	0	0	2	14
Palmer	0	1	0	0	0	0	0	0	0	0	0	0	1
Pampa	0	0	0	2	0	0	0	0	0	0	0	0	2
Pantego	0	0	1	0	0	0	0	0	1	0	0	0	2
Pearland	0	0	0	0	0	0	0	0	0	2	0	0	2
Pelican Bay	0	0	0	1	0	0	0	0	0	0	0	0	1
Peraland	0	0	0	0	1	0	0	0	0	0	0	0	1
Pilot Point	0	0	0	6	0	3	0	0	0	0	0	0	9
Pilot Pointt	0	0	0	0	0	0	0	0	1	0	0	0	1
Piney Point	0	0	0	0	0	0	0	0	1	0	0	0	1
Piney Point Village	1	0	0	0	0	0	0	0	2	0	0	1	4
Plan	0	0	0	0	0	0	0	0	0	1	0	0	1
Plan0	0	0	0	0	0	0	0	0	3	0	0	0	3
Plano	66	35	32	38	40	31	32	21	27	43	33	13	411
Poetry	0	0	0	0	0	2	0	0	0	0	0	0	2
Portland	6	4	4	5	3	3	3	4	2	3	2	5	44
Post Oak Bend	0	1	6	0	0	0	0	0	0	0	0	0	7
Post Oak Bend City	17	1	0	0	0	0	0	0	0	0	0	0	18
Princeton	4	40	1	47	6	19	3	112	31	25	5	7	300
Prinston	0	0	0	1	0	0	0	0	0	0	0	0	1
Prosper	7	2	0	6	1	1	5	6	2	0	0	3	33
Providence	9	6	16	28	7	17	12	10	5	9	8	2	129
Red Oak	7	0	8	9	9	17	4	3	2	21	0	0	80
Reno	0	0	2	0	0	0	0	0	1	0	0	0	3
Reno	0	0	0	0	0	0	2	0	0	0	0	0	2
Rhome	2	1	1	0	0	0	0	2	0	0	0	0	6
Richardson	10	4	5	2	6	0	3	8	2	14	1	3	58
Roan0ke	0	0	0	0	0	0	0	0	0	1	0	0	1
Roanoke	14	6	17	18	16	10	12	11	4	2	0	0	110
Rockwall	17	37	30	42	17	29	15	25	29	19	18	20	298
Rockwall Tx.	0	1	0	0	0	1	0	0	0	0	0	0	2

Figure 33: Continued

Roman Forest	0	0	0	0	0	0	0	0	6	1	0	0	7
Rosenberg	0	0	0	0	1	1	0	3	0	0	0	0	5
Round Rock	0	0	26	0	0	0	0	0	0	0	0	0	26
Rowlett	2	5	7	2	2	2	4	3	3	0	0	3	33
Royce City	0	0	0	0	0	0	0	0	2	0	0	0	2
Royse City	0	22	39	19	39	22	23	26	7	35	25	24	281
Royse City	25	0	0	0	0	0	0	0	0	0	0	0	25
Run Away Bay	0	0	2	0	0	0	0	0	0	0	0	0	2
Runaway Bay	0	0	4	2	2	2	1	0	1	1	0	0	13
sa	0	0	0	0	0	1	0	0	1	0	0	0	2
Sache	2	0	0	1	0	0	0	0	0	0	0	0	3
Sachse	9	3	5	2	0	0	3	0	1	0	3	0	26
Saginaw	10	16	4	3	18	10	4	5	14	12	3	2	101
Saiginaw	0	0	0	0	0	0	5	0	0	0	0	0	5
San Antonio	3	0	0	0	0	2	0	0	0	2	1	0	8
San Antonio	0	1	3	0	3	0	2	0	1	0	0	0	10
San Antoni	0	0	0	0	0	1	0	0	0	0	0	0	1
San Antonio	99	79	109	111	97	83	105	61	26	28	22	0	820
San Antonio	0	0	0	0	0	0	0	0	0	0	0	45	45
Sanger	5	3	14	2	11	10	25	10	14	9	4	2	109
Savannah	2	6	18	25	17	16	2	7	4	2	1	1	101
Schertz	5	3	0	5	4	8	2	0	1	1	0	0	29
Schertz	0	0	0	0	0	0	0	2	0	0	2	3	7
Scurry	0	0	0	0	0	1	0	0	0	0	0	0	1
Seabrook	0	0	2	0	0	0	0	0	0	0	0	0	2
Seagoville	3	0	5	23	34	4	1	53	23	9	10	0	165
Seguin	0	0	2	0	0	1	0	0	0	0	0	0	3
Seguin	0	3	0	0	0	0	0	0	0	0	0	0	3
Selma	3	0	1	0	0	2	0	0	1	0	0	0	7
Sequin	0	2	2	0	0	0	0	0	0	0	0	0	4
Shady Shores	0	0	0	0	0	0	0	0	0	8	0	0	8
ShadyShores	0	0	2	0	0	0	0	0	0	0	0	0	2
Shamrock Gardens, DeSoto	0	3	6	0	0	0	0	0	0	0	0	0	9

Figure 33: Continued

Shdy Shores	0	0	1	0	0	0	0	0	0	0	0	0	1
Sherman	4	4	6	12	12	4	10	2	7	6	5	0	72
Shore Acres	0	0	0	0	0	1	0	0	0	0	0	0	1
South Lake	0	2	0	0	0	0	0	0	0	2	1	1	6
South Padre Island	0	0	0	0	0	0	0	0	0	0	6	0	6
SOuth Side Place	0	0	1	0	0	0	0	0	0	0	0	0	1
Southlake	26	19	21	23	7	10	7	16	9	14	7	9	168
Southlake, TX	0	0	0	0	0	0	0	0	0	1	1	0	2
Spicewood	0	0	3	0	0	0	0	1	0	0	1	0	5
Spring	0	0	0	0	0	4	0	0	0	0	0	0	4
Spring Valley	0	0	0	0	3	0	0	0	0	0	0	0	3
St Paul	0	0	0	0	0	0	0	0	1	0	0	0	1
Sugar Land	2	2	11	3	6	1	3	2	1	0	0	0	31
Sugarland	0	0	4	0	0	0	1	1	0	0	0	0	6
Sulphur Springs	0	0	0	0	0	1	0	0	0	0	0	0	1
Sunnyvale	0	1	1	1	2	1	3	4	0	2	0	0	15
Taylor	0	0	0	0	0	0	0	0	0	0	0	8	8
Terrell	13	10	1	3	3	1	0	1	1	0	5	0	38
Terrell Hills	0	0	1	0	0	0	0	0	0	0	0	0	1
Texas Town	0	0	0	0	0	0	0	0	0	0	0	4	4
The Colony	1	2	2	4	0	4	1	1	0	12	1	3	31
Tomball	0	0	0	0	0	1	0	0	0	0	0	0	1
Trophy Club	11	6	15	7	3	2	3	7	1	4	0	8	67
Tyler	0	2	0	3	0	0	0	0	0	3	0	0	8
Union Valley	0	0	0	0	0	0	0	0	0	0	1	0	1
Univeristy Park	0	0	0	0	4	2	0	0	0	0	0	0	6
Univeristy Park	0	1	0	0	0	0	0	0	0	0	0	0	1
Universal City	0	2	0	0	0	0	0	0	0	0	0	0	2
University Park	11	6	2	15	5	9	12	8	19	6	13	4	110
VALLEY VIEW	0	0	0	0	0	0	0	0	0	1	0	0	1
Van Alstyne	20	0	1	0	23	2	20	2	24	0	3	0	95
Venus	0	0	0	0	14	14	14	6	14	0	9	4	75
Waco	0	0	11	0	0	0	0	0	0	0	0	0	11

Figure 33: Continued



Watauga	0	0	0	0	1	0	0	1	0	0	0	0	2
Waxahachie	14	9	17	42	30	42	41	22	33	61	8	15	334
Weaaherford	0	0	0	0	0	0	0	1	0	0	0	0	1
Weatherfor	2	1	0	0	1	0	0	0	0	0	0	0	4
Weatherford	0	15	22	17	7	9	22	9	12	15	10	11	149
Weatherford	19	0	0	0	0	0	0	0	0	0	0	0	19
west	0	0	0	0	0	2	0	2	0	0	0	0	4
West Columbia	0	0	0	0	0	0	3	0	0	0	0	0	3
West Lake	0	0	0	0	0	0	0	0	0	0	0	4	4
West University	0	0	0	0	0	0	0	0	1	0	0	0	1
West University Place	0	1	1	1	0	5	0	0	0	0	0	0	8
Westlake	1	2	2	9	3	0	0	1	3	0	0	2	23
Westover Hills	0	0	0	0	0	1	0	0	0	0	0	0	1
Westworth Village	0	0	0	0	0	0	0	2	0	0	0	0	2
White Settlement	1	0	1	1	4	5	4	3	10	1	4	0	34
Whitesboro	0	0	0	0	0	1	0	0	0	0	0	0	1
Wichita Falls	2	0	5	1	0	2	0	3	3	3	7	4	30
Wichita Falls TX	0	0	0	0	0	0	0	2	0	0	0	0	2
Willis	0	0	0	0	0	0	0	0	0	3	0	0	3
Willow Park	0	0	1	0	4	0	0	1	2	0	1	0	9
Willow Park	0	0	0	0	0	5	5	0	0	0	0	0	10
Woodway	0	0	1	1	0	0	1	0	0	0	0	0	3
Wylie	34	29	27	69	45	16	13	30	23	16	8	2	312
Yantis	0	0	0	2	0	0	0	0	0	0	0	0	2

Figure 33: Continued

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Addison	0	0	0	0	0	0	0	2	0	0	0	0	2
Austin	1	0	2	0	3	0	0	0	0	0	0	0	6
Austin	0	0	0	2	0	2	4	0	0	0	0	0	8
Benbrook	0	0	0	0	0	0	0	6	2	0	0	0	8
Coppell	0	0	0	1	0	0	0	0	0	0	0	0	1
Dallas	8	0	5	1	12	3	0	31	0	37	0	0	97
Denton	0	0	1	0	0	0	0	0	0	0	0	99	100
Fort Worth	0	6	7	2	34	23	3	8	1	1	4	0	89
Ft Worth	0	0	0	0	0	0	0	0	0	0	10	1	11
Ft. Worth	0	0	0	0	0	0	3	0	0	0	0	0	3
Houston	0	0	0	12	0	4	0	0	0	3	4	11	34
Houston	0	0	2	0	0	0	0	0	14	0	0	0	16
Irving	0	0	0	0	0	9	0	0	0	0	0	1	10
McKinney	0	0	0	3	0	2	0	0	0	0	1	0	6
Southlake	0	0	0	4	0	0	0	0	0	0	0	0	4
Van Alstyne	0	0	0	0	0	0	0	0	0	0	0	2	2

Figure 34: Cities Generating Multi-Family Homes IC3 Certificates in 2015

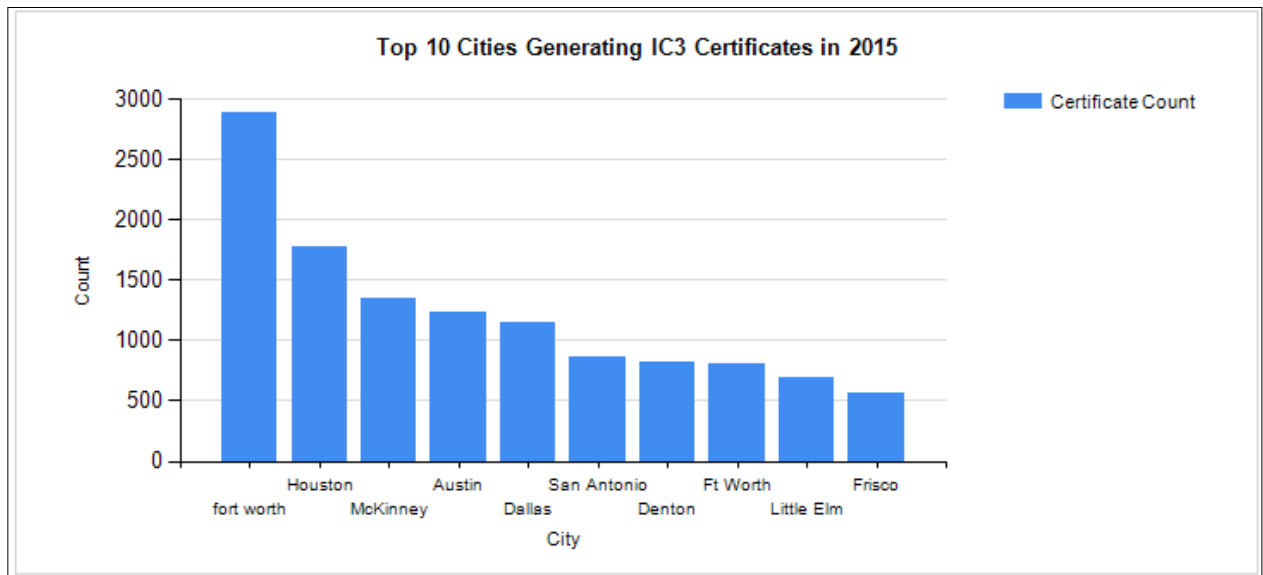


Figure 35: Top 10 Cities Generating Certificates in 2015

6.1.4 Parameter Reports

A unique and valuable use of the Registry is to look at building trends across the state. This report shows the yearly average wall cavity insulation distribution in Texas for 2015. In Figure 36 we see ranges, for Single-Familyhomes, of 13 to 16.91 with an average of 13.88. Last year’s average was 13.99. The total count of Single-Family Homes is 17821, which is 833 less than last year. In Figure 37 we see ranges, for Multi-Family Homes , of 13.74 to 19 with an average of 15.8. Last years average was 17.07. The total count Multi-Family Homes is 317, which is 4 more than last year.

## Yearly Average Wall Cavity Insulation Distribution for 2015

Overall Data Statistics derived from a subset of Counties having house count > 10

	Total Count	Average Wall Cavity Insulation	Standard Deviation
Single Family	17821	13.88	2.02
Multi Family	317	15.80	3.49

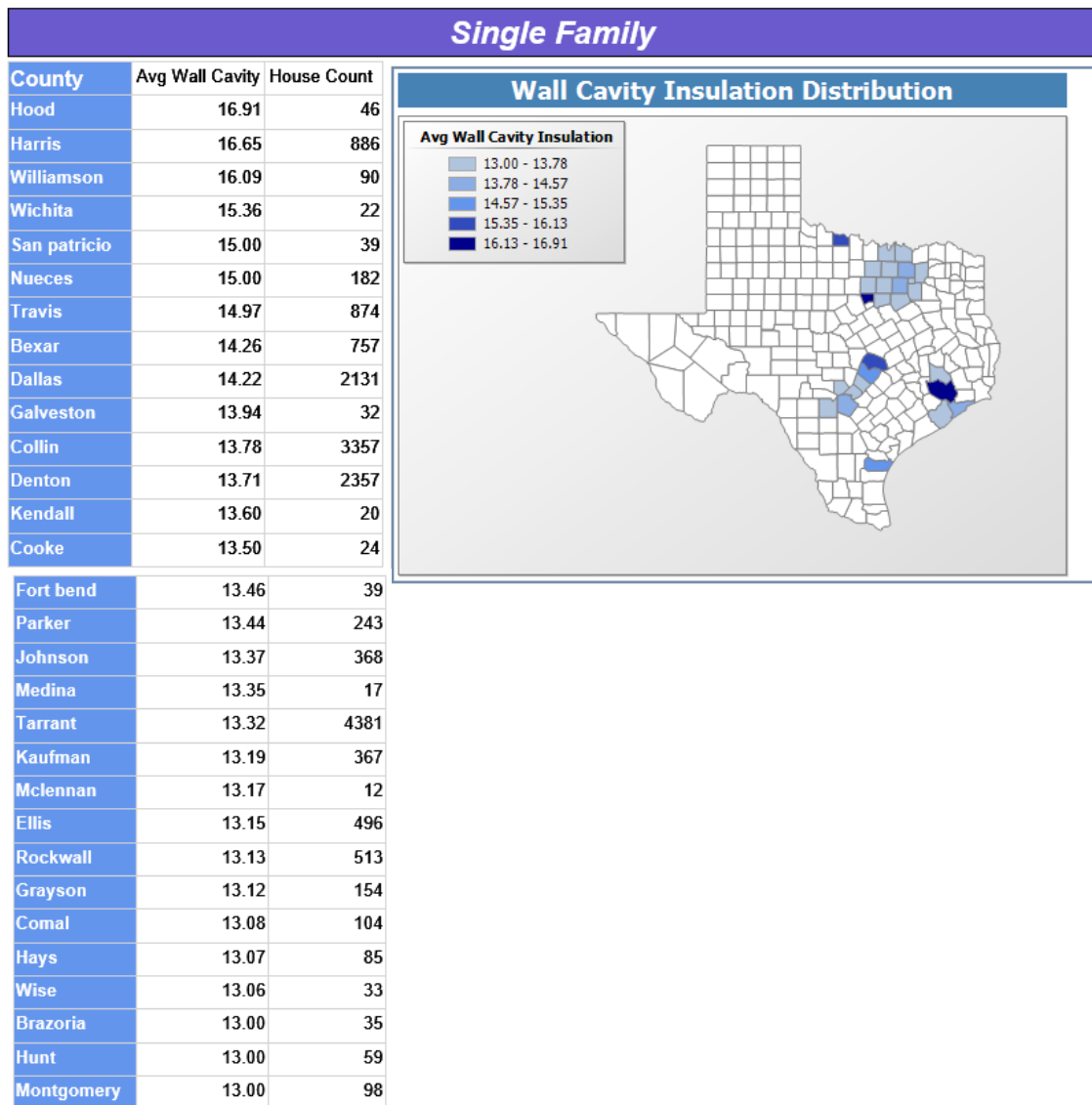


Figure 36: Yearly Average Wall Cavity Insulation Distribution by County for Single-Family Homes in 2015

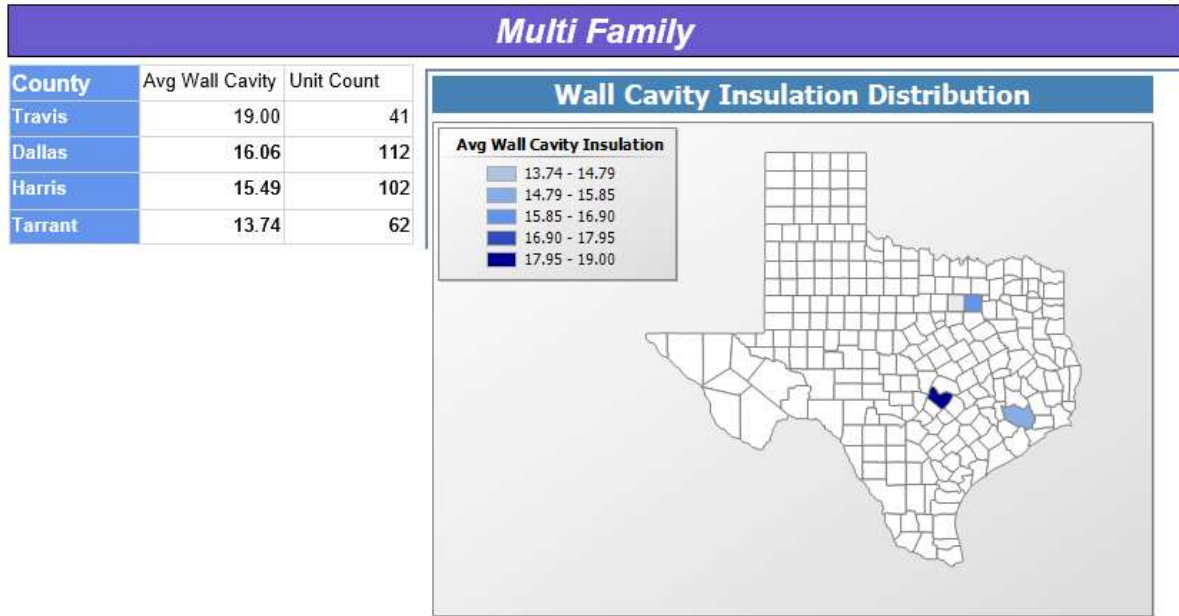


Figure 37: Yearly Average Wall Cavity Insulation Distribution by County for Multi-Family Homes in 2015

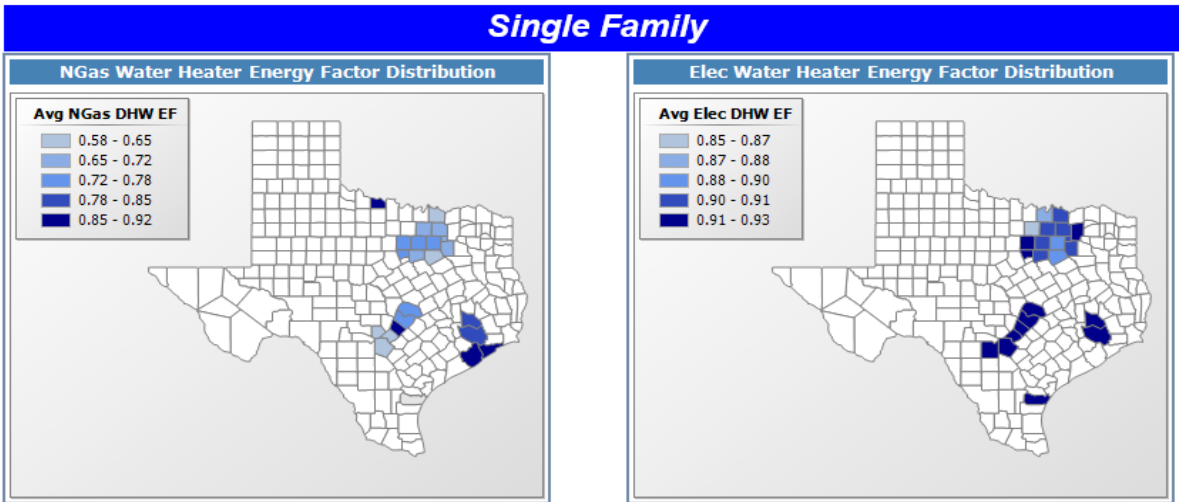
This report shows both natural gas and electric water heater efficiencies across Texas in 2015. In **Error! Reference source not found.** the ranges, for Single-Familyhomes, for natural gas are 0.58 to 0.92 with an average of 0.91. The ranges for electric are 0.85 to 0.93 with an average of 0.70. Last year's average for natural gas was 0.90 and electric was 0.70. In Figure 39, the ranges, for Multi-Family, for natural gas are 0.58 to 0.93 with an average of 0.76. The ranges for electric are 0.81 to 0.99 with an average of 0.91. Last year's average for natural gas was 0.75 and electric was 0.86.

### Yearly Average Water Heater Energy Factor Distribution for 2015

Overall Data Statistics derived from a subset of Counties having house count > 10

	Total Count	Average NGas EF	Standard Deviation
Single Family	7123	0.91	0.05
Multi Family	199	0.76	0.17

	Total Count	Average Elec EF	Standard Deviation
Single Family	10682	0.70	0.13
Multi Family	76	0.91	0.08



County	Avg. NGas WH EF	House Count
Hays	0.92	37
Wichita	0.88	14
Galveston	0.86	32
Brazoria	0.86	35
Harris	0.85	859
Fort bend	0.84	39
Montgomery	0.81	38
Parker	0.76	15
Travis	0.76	659
Hood	0.74	13
Dallas	0.73	1354
Tarrant	0.72	1771
Williamson	0.72	70
Johnson	0.70	64
Kaufman	0.69	155
Denton	0.67	1545
Rockwall	0.66	455
Collin	0.65	2453
Ellis	0.65	157
Kendall	0.63	20
Bexar	0.63	592
Comal	0.62	59
Grayson	0.60	97
Nuecas	0.58	132

County	Avg. Elec WH EF	House Count
Travis	0.93	204
San patricio	0.93	38
Nuecas	0.93	50
Comal	0.93	45
Hood	0.93	33
Williamson	0.93	20
Montgomery	0.92	60
Medina	0.92	17
Hays	0.92	47
Harris	0.92	27
Bexar	0.92	164
Parker	0.92	228
Hunt	0.92	53
Kaufman	0.91	212
Collin	0.91	904
McLennan	0.91	11
Denton	0.91	810
Johnson	0.91	304
Grayson	0.90	57
Tarrant	0.90	2602
Rockwall	0.90	56
Ellis	0.89	338
Dallas	0.89	773
Cooke	0.87	21
Wise	0.85	32

Figure 38: Yearly Average Water Heater Energy Factor Distribution for Single-Family Homes in 2015

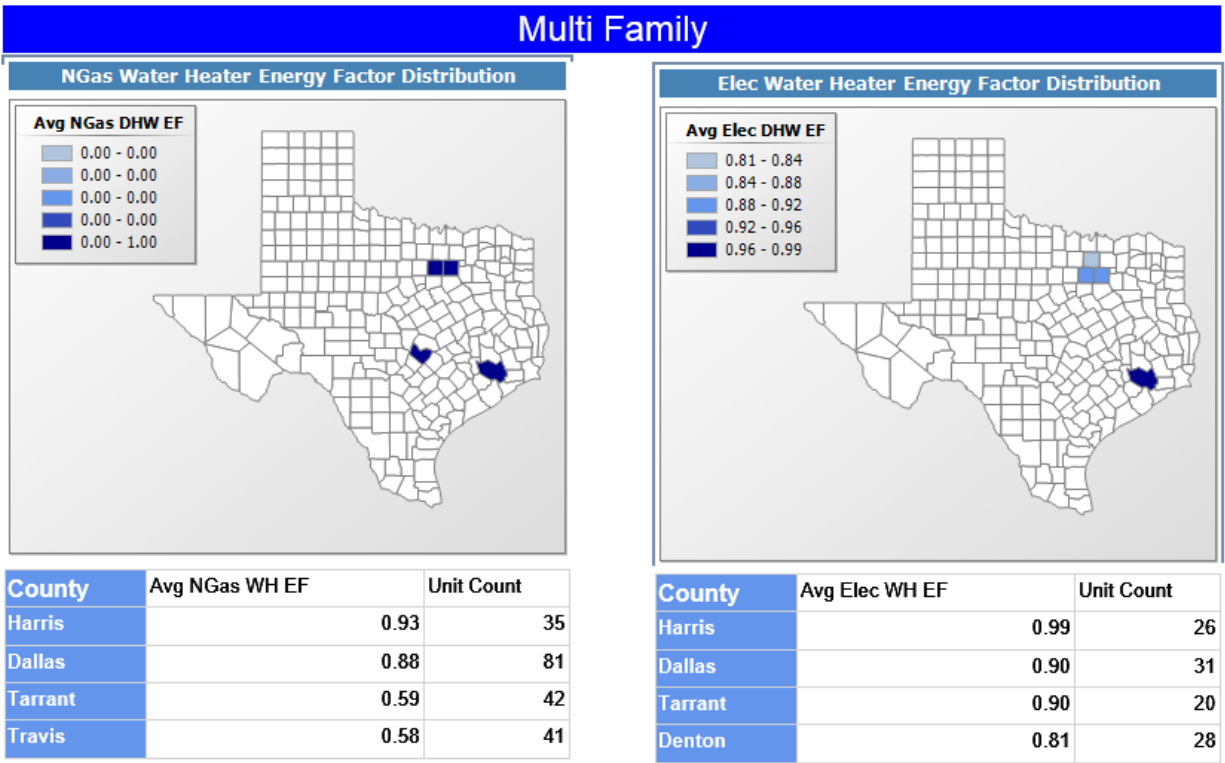


Figure 39: Yearly Average Water Heater Energy Factor Distribution for Multi-Family Homes in 2015

This report shows the average window to wall ratio across Texas in 2015. The formula used is:  $100 * \frac{\text{total window area sq. ft.}}{\text{total wall area sq. ft.}}$   
 In Figure 40 we see ranges, for Single-Familyhomes, from 7.59 to 15.89 with an average of 11.94. Last year's average was 11.89. In Figure 41 we see ranges, for Multi-Family Homes , from 12.77 to 30.67 with an average of 19.67. Last year's average was 21.76.

### Average Window to Wall Area Ratio across Counties for 2015

Overall data Statistics derived from a subset of Counties having house count > 10

	Average	Standard Deviation
Single Family	11.94	3.58
Multi Family	19.67	10.38

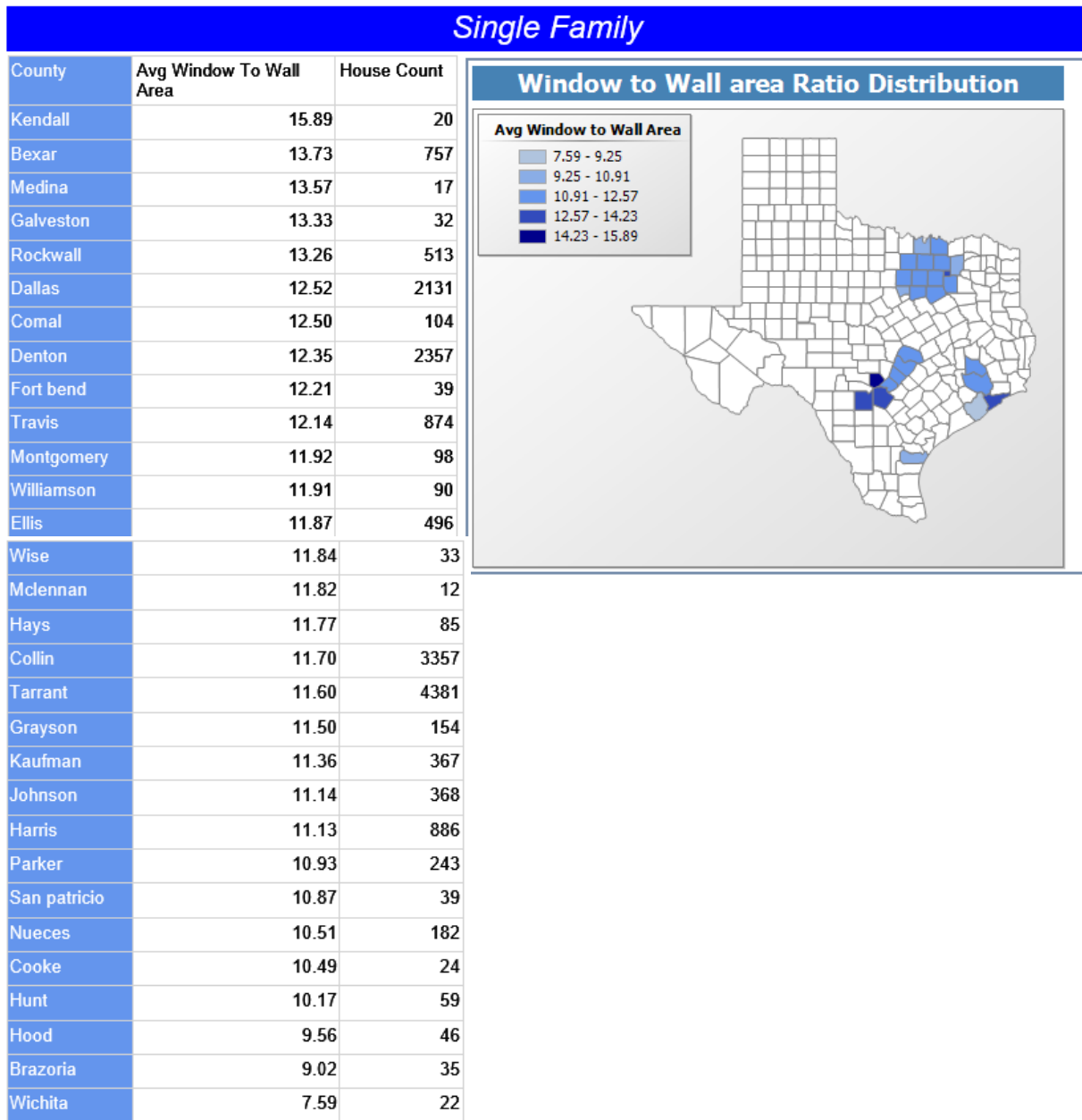


Figure 40: Average Window to Wall Ratio across Counties for Single-Family Homes in 2015

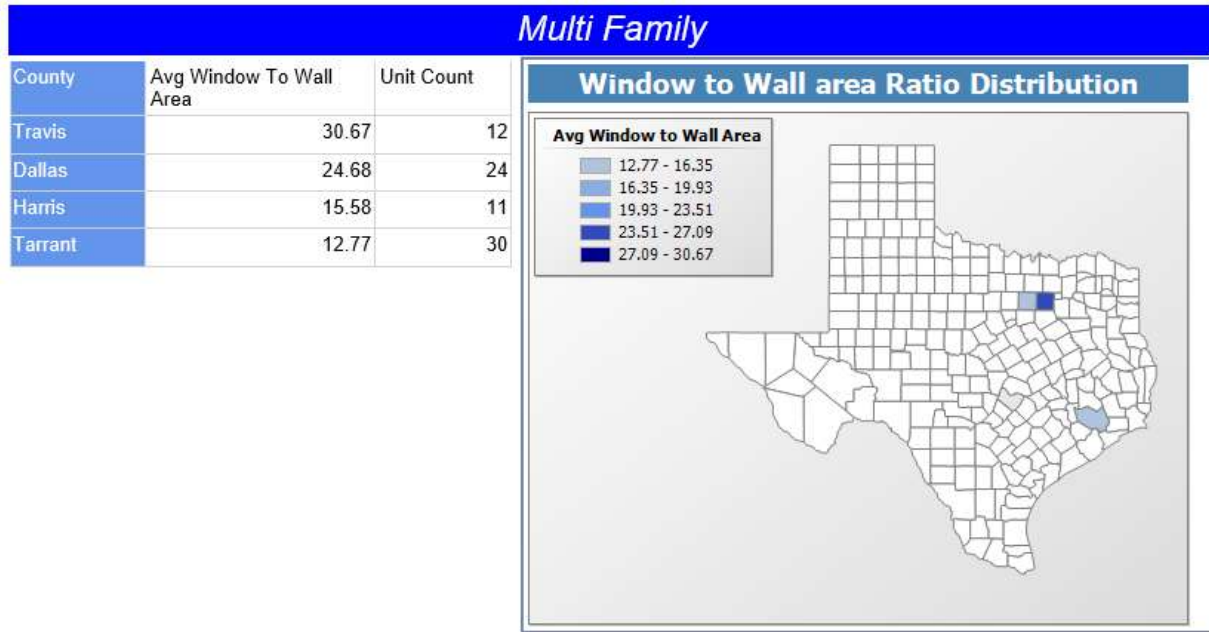


Figure 41: Average Window to Wall Ratio across Counties for Multi-Family Homes in 2015



This report shows the average A/C SEER across Texas in 2015. The efficiency (and sizing) of air conditioning is a vital component of energy efficiency in Texas. In **Error! Reference source not found.** we see ranges, for Single-Familyhomes, from 13.14 to 15.91 with and average of 14.69. Last year’s average was 14.70. In Figure 43 we see ranges, for Multi-Family Homes , from 14.05 to 16.00 with an average of 15.05. Last year’s average was 14.42.

### Average A/C SEER across Counties for 2015

Overall data Statistics derived from a subset of Counties having house count > 10

	Average	Standard Deviation
Single Family	14.69	1.08
Multi Family	15.05	1.17

#### Single Family

County	Avg SEER Value	House Count
Brazoria	15.91	35
Kendall	15.80	20
Fort bend	15.77	39
Galveston	15.56	32
Williamson	15.52	90
Wichita	15.45	22
San patricio	15.41	39
Harris	15.37	886
Travis	15.35	874
Bexar	15.35	757
Nueces	15.34	182
Medina	15.00	17
Johnson	14.89	368
Comal	14.84	104
Denton	14.83	2357
Dallas	14.80	2131
Ellis	14.63	496
Collin	14.55	3357
Hood	14.53	46
Parker	14.49	243
Tarrant	14.36	4381
Hunt	14.31	59
Cooke	14.29	24
Wise	14.26	33
Kaufman	14.17	367
Rockwall	14.16	513
Montgomery	14.14	98
Grayson	14.05	154
Mclennan	14.00	12
Hays	13.14	85

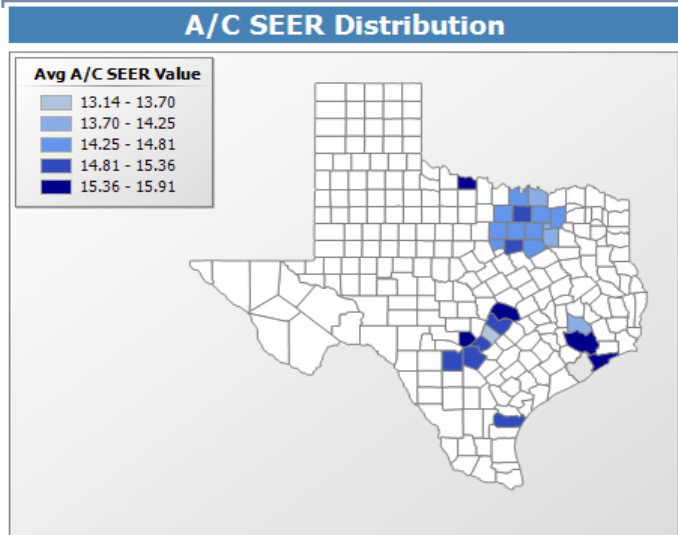


Figure 42: Average A/C SEER across Counties for Single-Family Homes in 2015

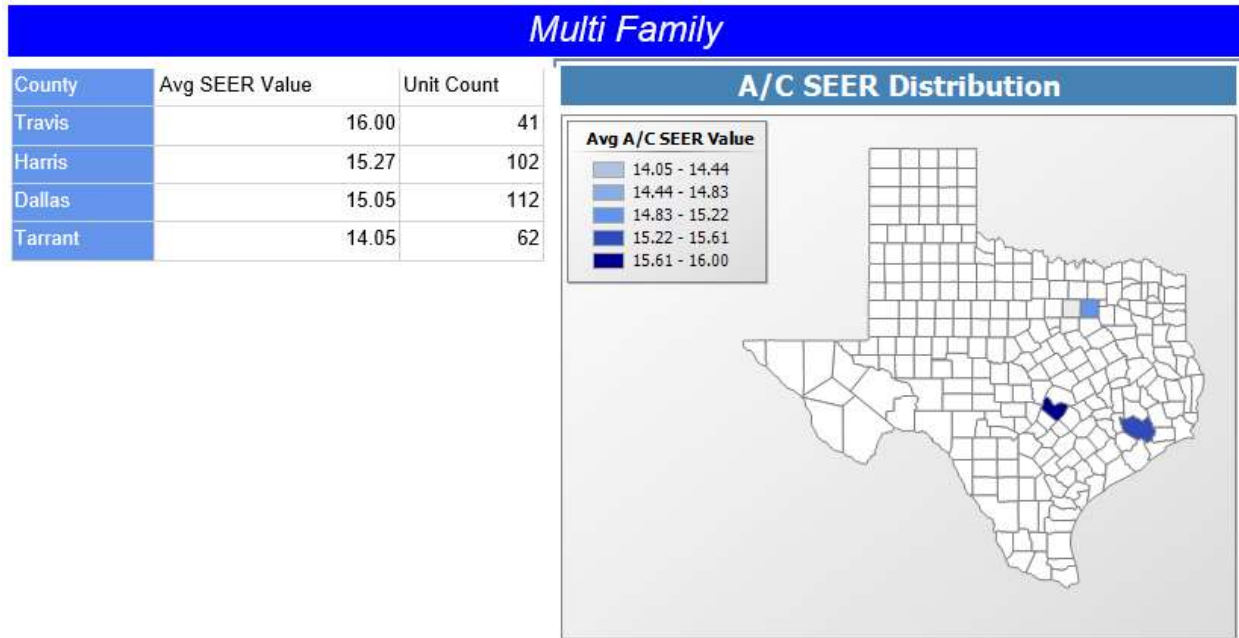


Figure 43 Average A/C SEER across Counties for Multi-Family Homes in 2015.

This report shows the average ceiling insulation across Texas in 2015. In Figure 44 we see ranges, for Single-Family Homes, from 29.50 to 38.75 with an average of 34.06. Last year's average was 34.26. In Figure 45 we see ranges, for Multi-Family Homes, from 28.91 to 35.96 with an average of 33.19. Last year's average was 35.30.

Bexar	34.75	757
Fort bend	34.62	39
Comal	34.54	104
Wise	34.39	33
Parker	34.09	243
Dallas	33.93	2131
Kaufman	33.77	367
Tarrant	32.07	4381
Montgomery	30.97	98
Galveston	30.75	32
Harris	30.65	886
Hays	30.51	85
Brazoria	30.00	35
Medina	30.00	17
Nueces	30.00	182
San patricio	30.00	39
Hood	29.50	46

## Average Ceiling Insulation across Counties for 2015

Overall data Statistics derived from a subset of Counties having house count > 10

	Average	Standard Deviation
Single Family	34.06	5.05
Multi Family	33.19	5.32

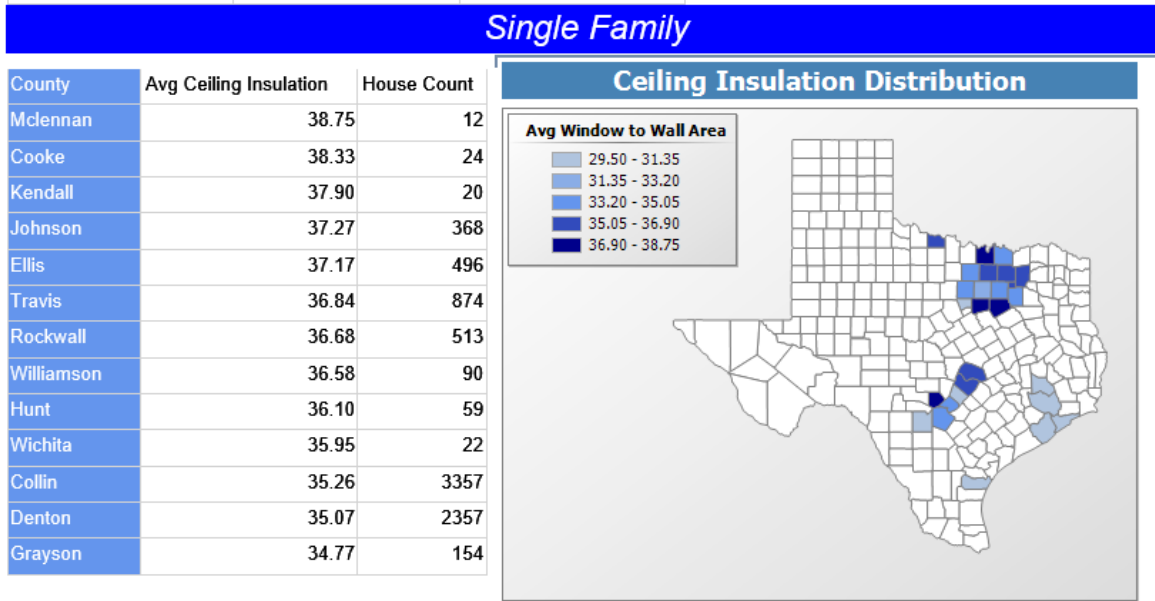


Figure 44: Average Ceiling Insulation across Counties for Single-Family Homes in 2015

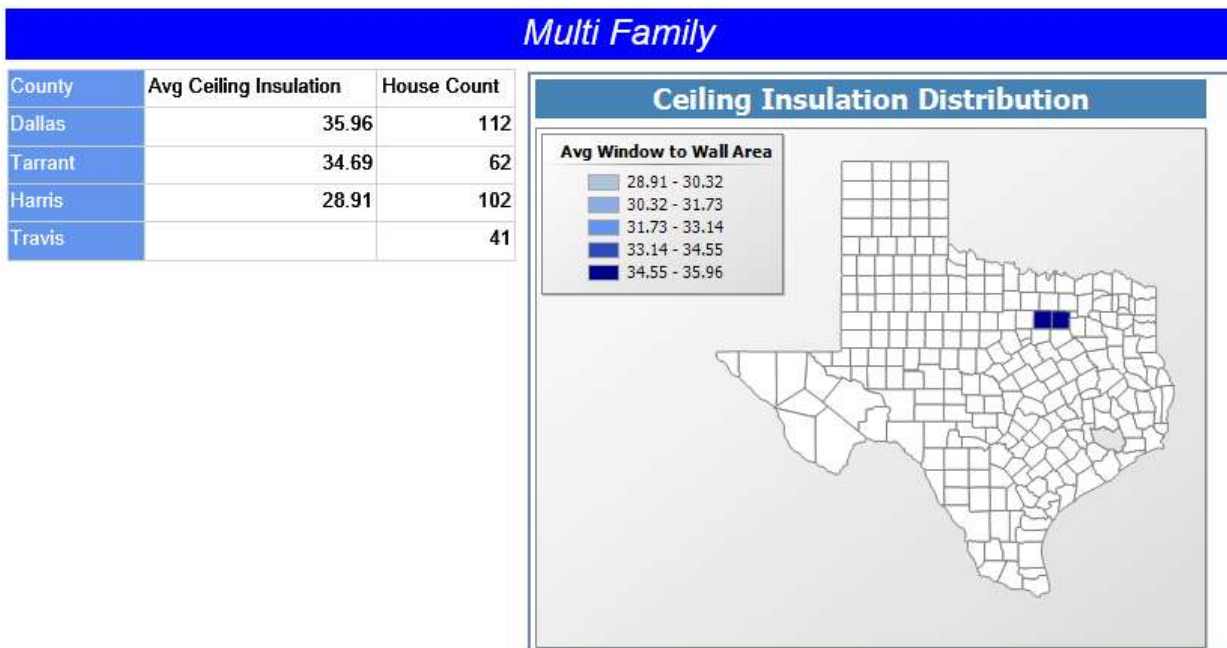


Figure 45: Average Ceiling Insulation across Counties for Multi-Family Homes in 2015

This report shows the average heating efficiency across Texas in 2015. Here we examine space heating efficiency in 2015 using both natural gas and heat pump heating. In Figure 46 we see ranges, for Single-Family Homes, for natural gas are from 0.80 to 0.92 with an average of 0.81. The ranges for heat pump are 8.00 to 10.41 with an average of 8.38. Last year's average for natural gas was 0.81 and heat pump was 8.34. In Figure 47 we see ranges, for Multi-Family Homes, for natural gas from 0.80 to 0.85 with an average of 0.81. The ranges for heat pump are 8.23 to 10.55 with an average of 9.51. Last year's average for electric was 0.83 and heat pump was 9.05.

### Average Heating Efficiency across Counties for 2015

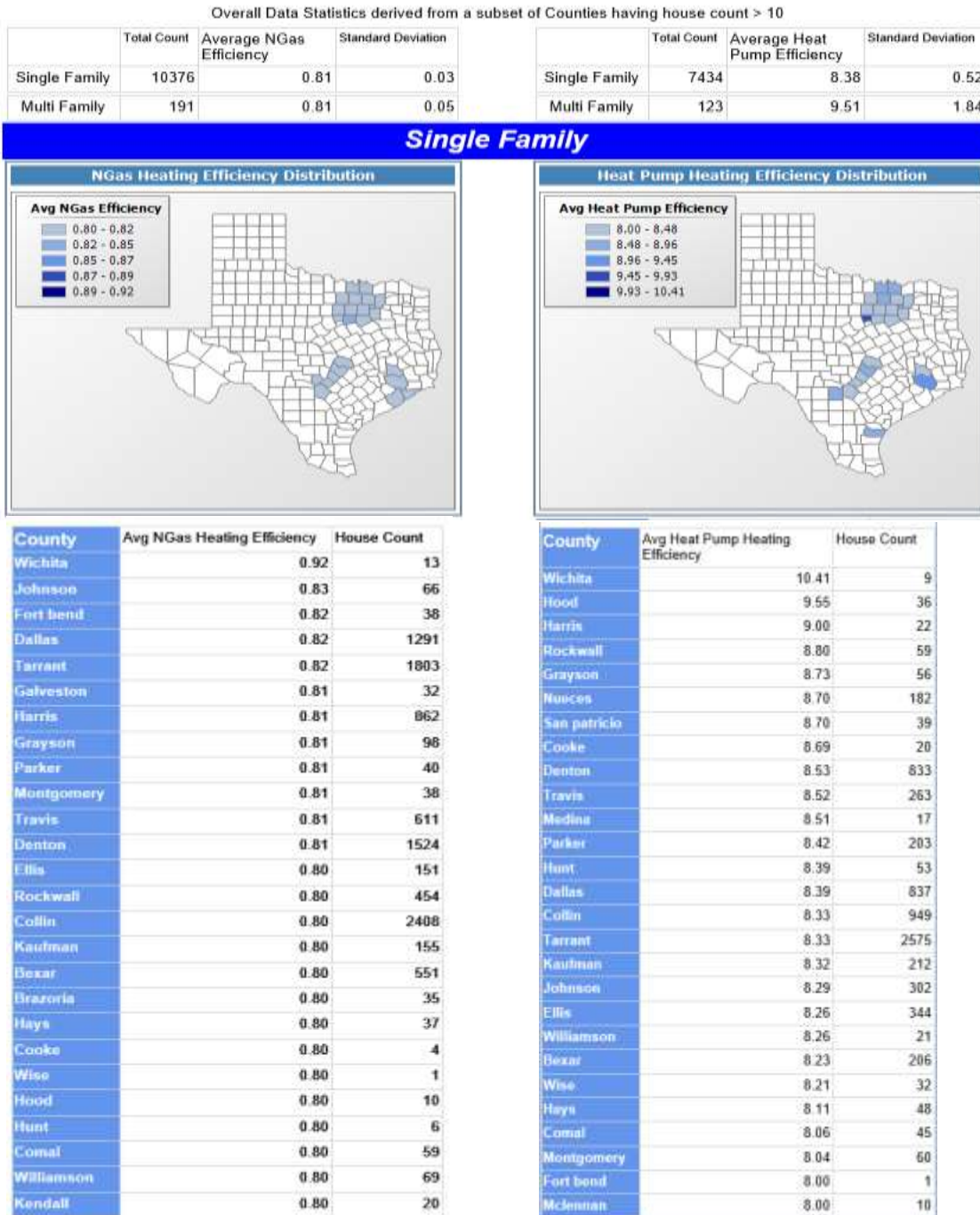


Figure 46: Average Heating Efficiency across Counties for Single-Family Homes in 2015

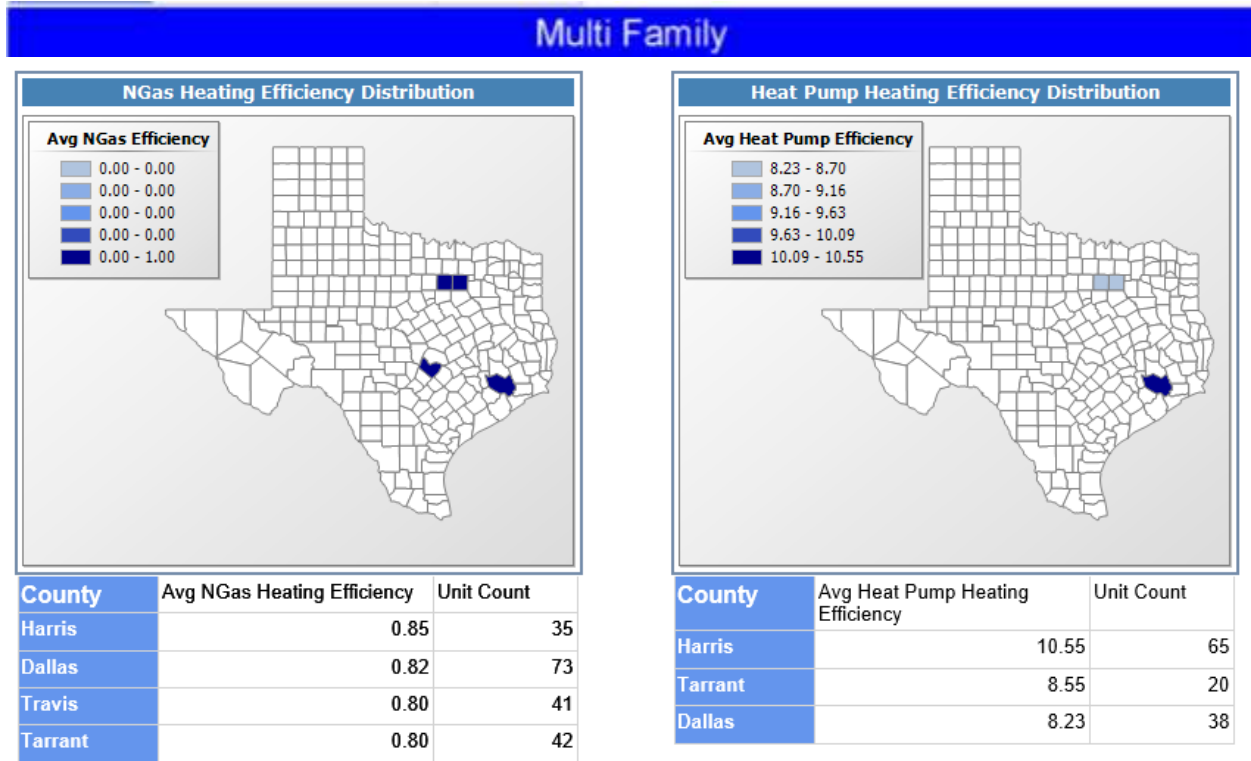


Figure 47: Average Heating Efficiency across Counties for Multi-Family Homes in 2015

This report shows the average SHGC across Texas in 2015. In Figure 48 we see ranges, for Single-Familyhomes, from 0.23 to 0.29 with an average of 0.25. Last year's average was 0.26. In Figure 49 we see ranges, for Multi-Family Homes , from 0.22 to 0.27 ewith an average of 0.25. Last year's average was 0.25.

### Average SHGC across Counties for 2015

Overall data Statistics derived from a subset of Counties having house count > 10

	Average	Standard Deviation
Single Family	0.25	0.03
Multi Family	0.25	0.04

#### Single Family

County	Avg SHGC Value	House Count
Harris	0.29	886
Cooke	0.28	24
Wichita	0.28	22
Hood	0.27	46
Parker	0.27	243
Wise	0.27	33
Tarrant	0.26	4381
Rockwall	0.26	513
Mclennan	0.26	12
Medina	0.26	17
Galveston	0.26	32
Dallas	0.26	2131
Brazoria	0.25	35
Montgomery	0.25	98
Williamson	0.25	90
Hays	0.25	85
Denton	0.25	2357
Kaufman	0.25	367
Hunt	0.24	59
Comal	0.24	104
Collin	0.24	3357
Travis	0.24	874
Grayson	0.24	154
Ellis	0.24	496
Johnson	0.24	368
Kendall	0.24	20
Bexar	0.24	757
Fort bend	0.23	39
San patricio	0.23	39
Nueces	0.23	182

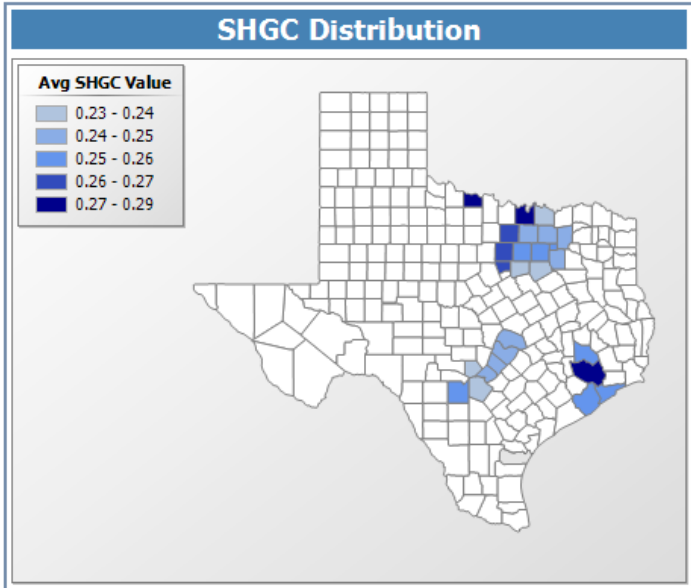


Figure 48: Average SHGC across Counties for Single-Family Homes in 2015

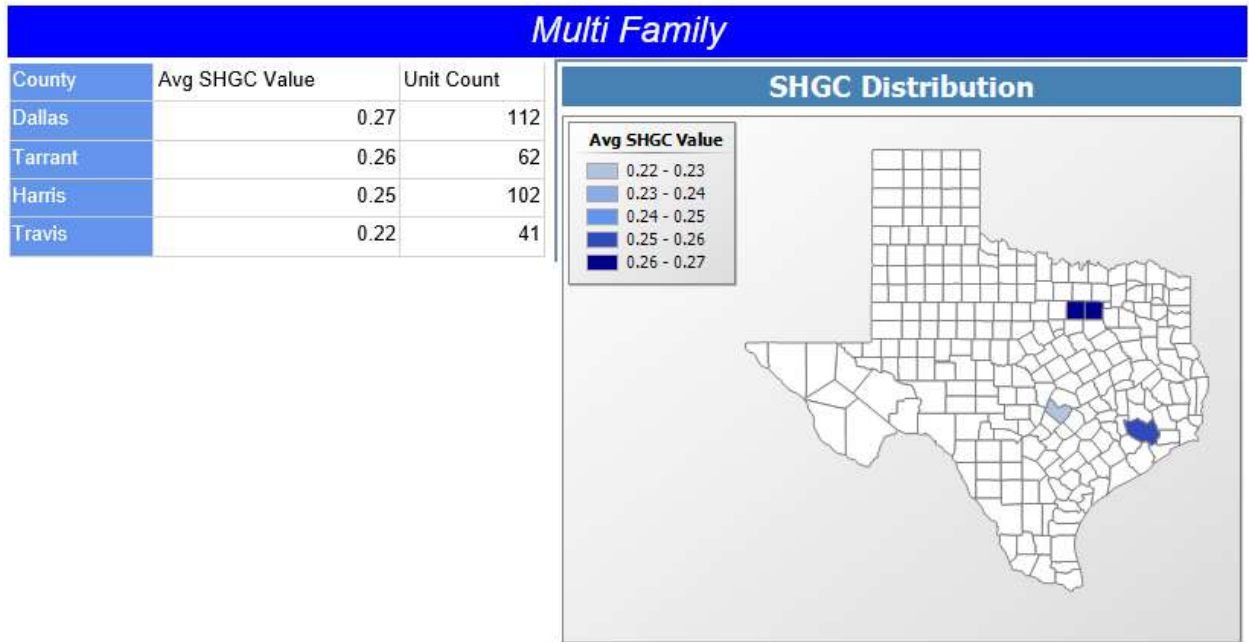


Figure 49: Average SHGC across Counties for Multi-Family Homes in 2015



Another way to evaluate high performing houses is how much air conditioning they have per sq. ft. of house. In Figure 50 we see ranges, for Single-Family homes, of 457 to 778 sq. ft. per ton with an average of 579.6 sq. ft. per ton. Last year's average was 571 sq. ft. per ton. In Figure 51 we see ranges, for Multi-Family Homes, of 709 to 1242 sq. ft. per ton with an average of 979.7 sq. ft. per ton. Last year's average was 1096 sq. ft. per ton.

### Average HVAC across Counties for 2015

Overall data Statistics derived from a subset of Counties having house count > 10

	Average	Standard Deviation
Single Family	579.61	140.44
Multi Family	979.71	450.51

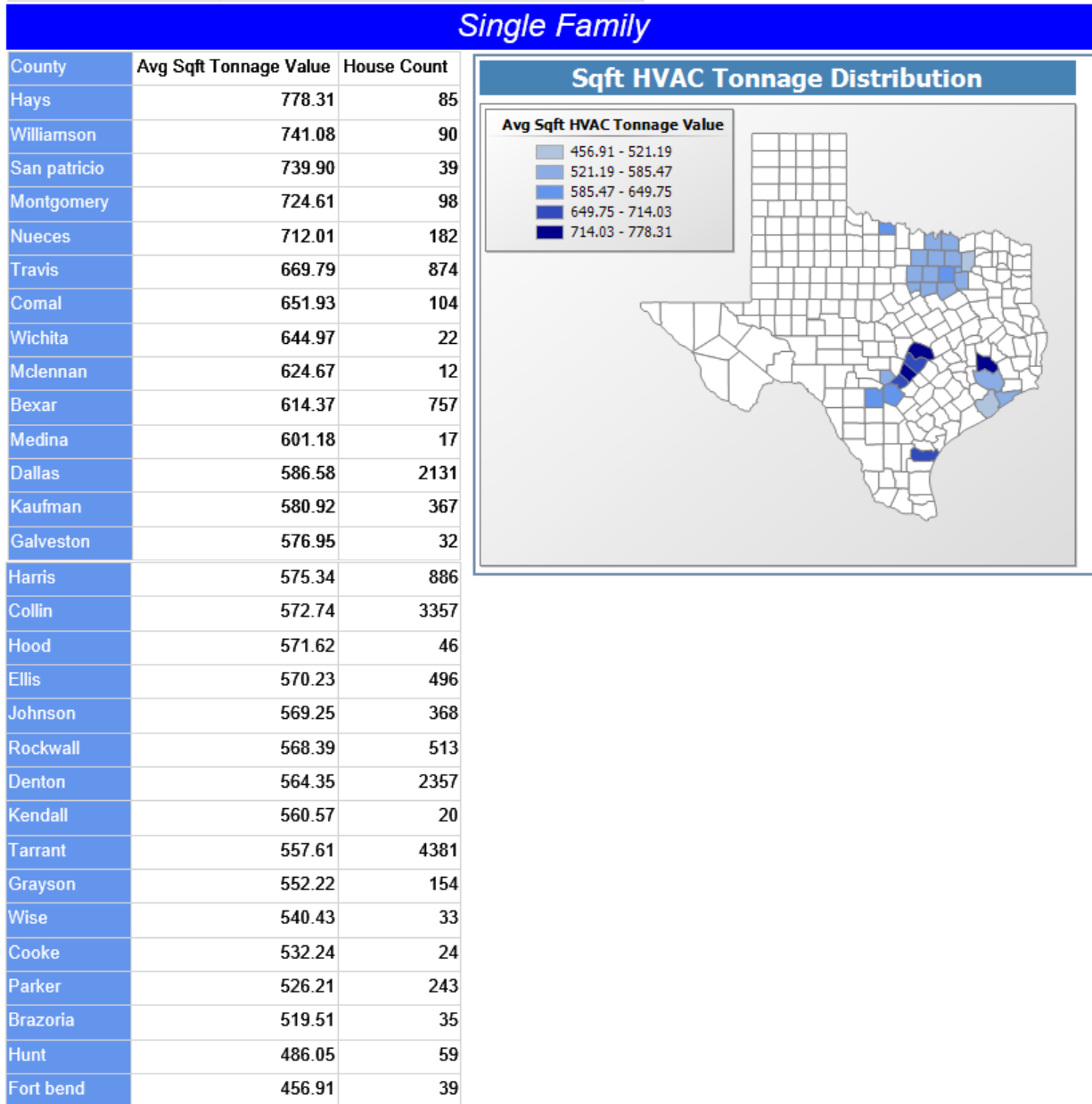


Figure 50: Average HVAC Tonnage to Sq Ft across Counties for Single-Family Homes in 2015

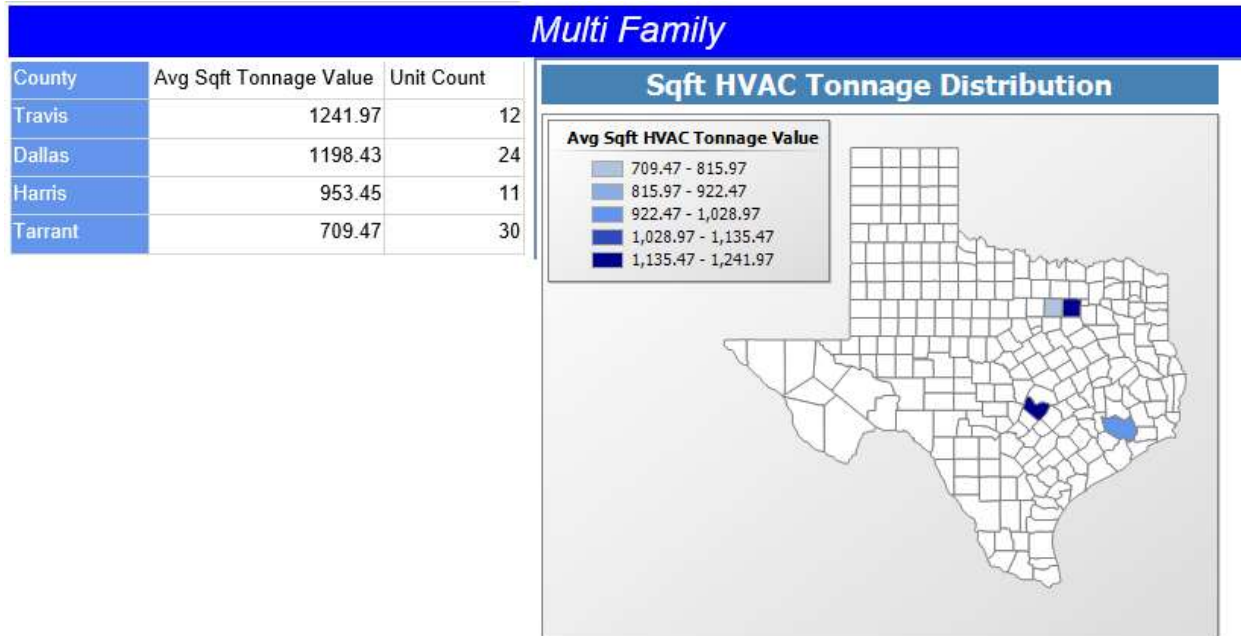


Figure 51: Average HVAC Tonnage to Sq Ft across Counties for Multi-Family Homes in 2015

This report shows the average U Factor across Texas in 2015. The U Factor applies to the heat transfer of a window caused by temperature, no direct solar radiation. In Figure 52 we see ranges, for Single-Family homes, from 0.31 to 0.53 with an average of 0.35. Last year's average was 0.35. In Figure 53 we see ranges, for Multi-Family Homes, from 0.32 to 0.34 with an average of 0.33. Last year's average was 0.33.

### Average U Factor across Counties for 2015

Overall data Statistics derived from a subset of Counties having house count > 10

	Average	Standard Deviation
Single Family	0.35	0.05
Multi Family	0.33	0.05

#### Single Family

County	Avg U Factor	House Count
Hays	0.53	85
Cooke	0.48	24
Montgomery	0.45	98
Comal	0.42	104
Wise	0.42	33
Bexar	0.37	757
Kaufman	0.37	367
Tarrant	0.36	4381
Williamson	0.35	90
Johnson	0.35	368
Ellis	0.35	496
Rockwall	0.35	513
McLennan	0.35	12
Kendall	0.35	20
Medina	0.35	17
Wichita	0.35	22
Hood	0.34	46
Collin	0.34	3357
Dallas	0.34	2131
Denton	0.34	2357
Parker	0.34	243
Hunt	0.34	59
Grayson	0.33	154
Travis	0.33	874
Brazoria	0.33	35
Harris	0.33	886
Nueces	0.32	182
San patricio	0.32	39
Galveston	0.32	32
Fort bend	0.31	39

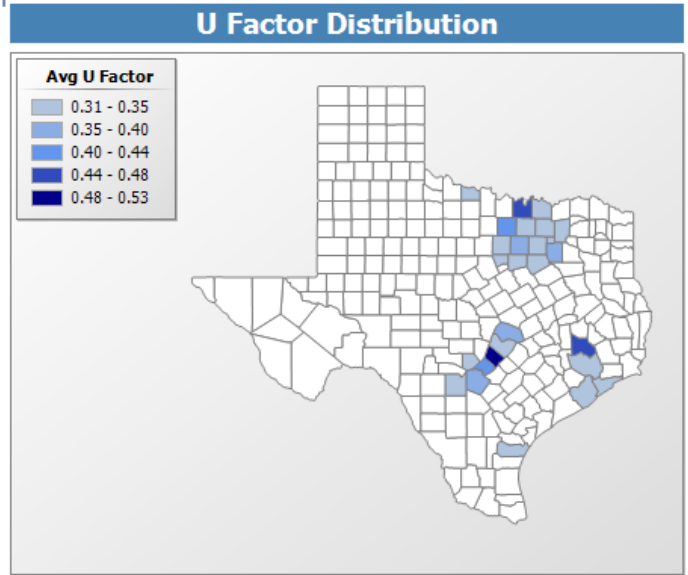


Figure 52: Average U Factor across Counties for Single-Family Homes in 2015

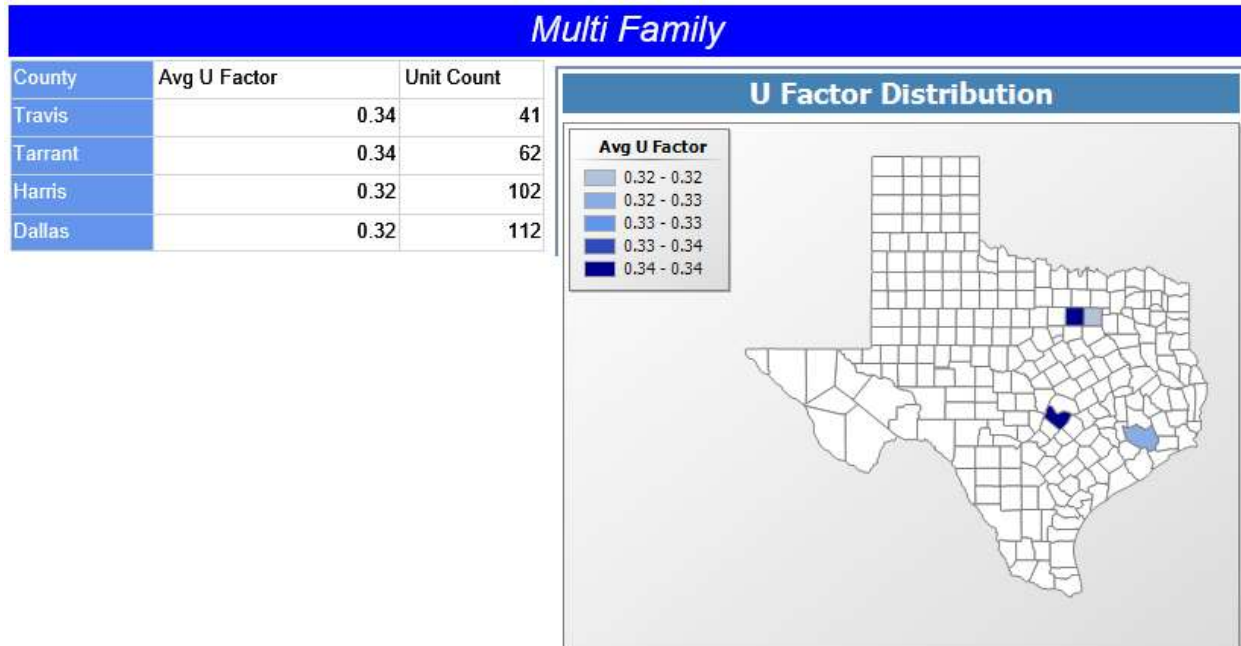


Figure 53: Average U Factor across Counties for Multi-Family Homes in 2015

## 6.2 IC3 Enhancements

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

### 6.2.1 History of IC3 Enhancements

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

In Version 3.5.2 (November 2009)

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

In Version 3.6.1 (December 2009)

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

In Version 3.6.2 (April 2010)

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

In Version 3.7.x (June 2010)

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

In Version 3.8.x (September 2010)

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

In Version 3.9.x (October 2010)

- Added slab insulation
- Updated the manual

In Version 3.10 (September 2011)

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

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

In Version 3.11 (December 2011)

- Added support for IECC 2009 Austin Amendments

In version 3.12.x (January 2012)

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

In version 3.13.x (August 2013)

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

In version 3.14.x (March 2015)

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

## 6.2.2 History of IC3 version 4 Enhancements

Version 4.0 (June 2015)

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

Version 4.0.1 (July 2015)

- The original version (4.0) printed the logged in user's name, phone number, and email address in the builder's fields on the certificate and energy report. These can now be overridden on a project-by-project basis. The new input fields on the left side of the screen are now the values that will be printed on the certificate and energy reports.
- The project notes will now appear on the Energy Report. Due to spacing issues, only the first 60 characters will be printed. If the project notes are longer, they will be truncated in the energy report.
- On a user's main user screen (the one immediately after login that lists all of your projects), a button has been added to the top: 'Edit User Information'. This button allows you to edit the logged in user's contact information that you entered when registering on the site.
- On a user's main user screen (the one immediately after login that lists all of your projects), a button has been added to the top: 'Import Project from IC3 version 3.x '. Several users have requested the ability to 'import' projects from the old version of IC3. This is now possible.
  - o Users will be prompted to enter their IC3 version 3.x credentials and the select a project to import. Only single-family project import is available at this time.
  - o 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).
  - o 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.

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

Table 32: Changes in Single-Family Input file

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

#### Added sensible and latent components for equipment heat gain

In order to incorporate the HERS Index calculations in IC3, it became necessary to elaborate the input for lighting, equipment and occupants<sup>49</sup>. Equipment loads were now divided into sensible and latent components. Two new parameters were added in Version 4.01.09 to incorporate the sensible and latent components of the equipment load.

#### 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

<sup>49</sup> It should be noted that loads from occupants were included in the loads for equipment.

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

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

The heat rate values of 7,700 Btu/hr are adopted from EnergyGauge regardless of the size of the tank<sup>50</sup>.

In addition, the curves used for energy input ratio as a function of part load ratio are the same curves that are used for heat pump space heating obtained from Henderson et al. (2000)<sup>51</sup>.

Corrected layers for cathedral ceiling

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

Added option to include attic volume in conditioned space in case of sealed attic

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

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<sup>50</sup> Email correspondence with Jeff Myron, EnergyGauge Technical Support (10/18/2013).

<sup>51</sup> Henderson, H., D. Parker, Huang, Y. (2000). Improving DOE-2's RESYS Routine: User Defined Functions to Provide More Accurate Part Load Energy Use and Humidity Predictions. Presented at the 2000 ACEEE Summer Study on Energy Efficiency in Buildings, Pacific Grove, CA.



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

Since the fall of 2001, the Laboratory has maintained a TERP webpage, where information is provided to builders, code officials, the design community and homeowners about TERP. In 2010, the Laboratory redesigned its website to make navigation easier. On the navigation bar is a tab that links to the TERP homepage (Figure 54). The homepage contains the following items:

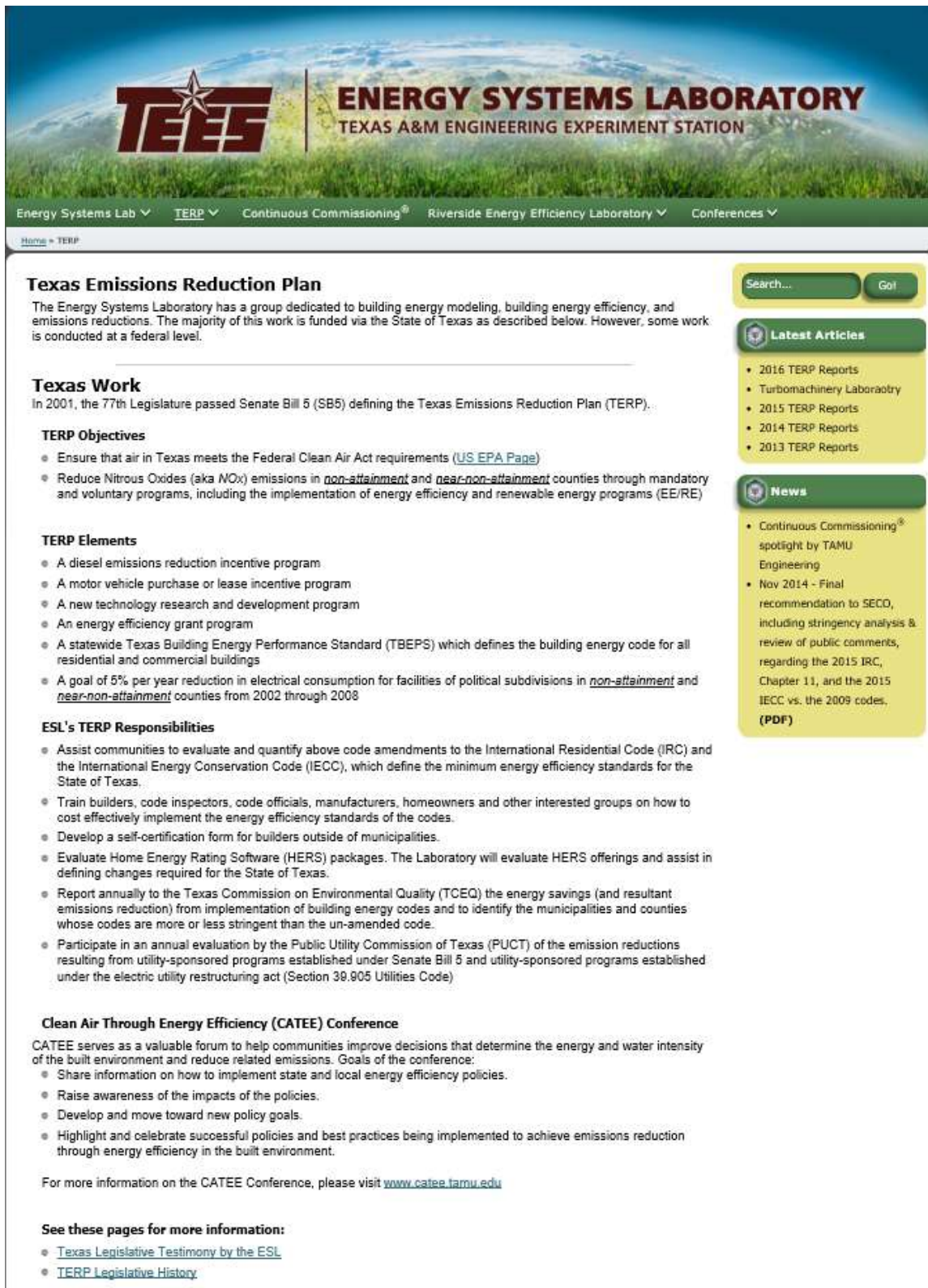
- Definition of the Texas Emissions Reduction Plan
- Texas Work
  - TERP Objectives
  - TERP Elements
  - ESL's TERP Responsibilities
  - The CATEE Conference
  - Links to
    - Texas Legislative Testimony by the ESL
    - TERP Legislative History
- National Work
  - National Center of Excellence on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

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

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

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

- IBPSA
- ICEBO
- IETC
- Workshops
  - IC3
  - IECC Residential
  - IECC Commercial
  - ASHRAE



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## Texas Emissions Reduction Plan

The Energy Systems Laboratory has a group dedicated to building energy modeling, building energy efficiency, and emissions reductions. The majority of this work is funded via the State of Texas as described below. However, some work is conducted at a federal level.

---

### Texas Work

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

#### TERP Objectives

- Ensure that air in Texas meets the Federal Clean Air Act requirements ([US EPA Page](#))
- Reduce Nitrous Oxides (aka NO<sub>x</sub>) emissions in *non-attainment* and *near-non-attainment* counties through mandatory and voluntary programs, including the implementation of energy efficiency and renewable energy programs (EE/RE)

#### TERP Elements

- A diesel emissions reduction incentive program
- A motor vehicle purchase or lease incentive program
- A new technology research and development program
- An energy efficiency grant program
- A statewide Texas Building Energy Performance Standard (TBEPS) which defines the building energy code for all residential and commercial buildings
- A goal of 5% per year reduction in electrical consumption for facilities of political subdivisions in *non-attainment* and *near-non-attainment* counties from 2002 through 2008

#### ESL's TERP Responsibilities

- Assist communities to evaluate and quantify above code amendments to the International Residential Code (IRC) and the International Energy Conservation Code (IECC), which define the minimum energy efficiency standards for the State of Texas.
- Train builders, code inspectors, code officials, manufacturers, homeowners and other interested groups on how to cost effectively implement the energy efficiency standards of the codes.
- Develop a self-certification form for builders outside of municipalities.
- Evaluate Home Energy Rating Software (HERS) packages. The Laboratory will evaluate HERS offerings and assist in defining changes required for the State of Texas.
- Report annually to the Texas Commission on Environmental Quality (TCEQ) the energy savings (and resultant emissions reduction) from implementation of building energy codes and to identify the municipalities and counties whose codes are more or less stringent than the un-amended code.
- Participate in an annual evaluation by the Public Utility Commission of Texas (PUCT) of the emission reductions resulting 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)

#### Clean Air Through Energy Efficiency (CATEE) Conference

CATEE serves as a valuable forum to help communities improve decisions that determine the energy and water intensity of the built environment and reduce related emissions. Goals of the conference:

- Share information on how to implement state and local energy efficiency policies.
- Raise awareness of the impacts of the policies.
- Develop and move toward new policy goals.
- Highlight and celebrate successful policies and best practices being implemented to achieve emissions reduction through energy efficiency in the built environment.

For more information on the CATEE Conference, please visit [www.catee.tamu.edu](http://www.catee.tamu.edu)

#### See these pages for more information:

- [Texas Legislative Testimony by the ESL](#)
- [TERP Legislative History](#)

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- Turbomachinery Laboratory
- 2015 TERP Reports
- 2014 TERP Reports
- 2013 TERP Reports

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- Continuous Commissioning® spotlight by TAMU Engineering
- Nov 2014 - Final recommendation to SECO, including stringency analysis & review of public comments, regarding the 2015 IRC, Chapter 11, and the 2015 IECC vs. the 2009 codes. [\(PDF\)](#)

Figure 54. TERP Home Page

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

Energy Systems Lab ▾ TERP ▾ Continuous Commissioning® Riverside Energy Efficiency Laboratory ▾ Conferences ▾

Home ▸ TERP ▸ Letters and Reports ▸ Legislative Documents

### Legislative Documents

**Documents prepared by the Energy Systems Laboratory to fulfill TERP Legislative Objectives**

**Energy Systems Laboratory stringency review of the latest published editions of building energy codes in comparison to the Texas Building Energy Performance Standards (TBEPS), for consideration for adoption by the State Energy Conservation Office (SECO)**

- Nov 2014 - Final recommendation to SECO, including stringency analysis & review of public comments, regarding the 2015 IRC, Chapter 11, and the 2015 IECC vs. the 2009 codes. [Recommendation \(PDF\)](#)
- Aug 2014 - Letter to SECO regarding the stringency of the 2015 IRC, Chapter 11, and the 2015 IECC vs. the 2009 codes. [letter \(PDF\)](#)
- Aug 2012 - Final recommendation to SECO, including stringency analysis & review of public comments, regarding the 2012 IRC, Chapter 11, and the 2012 IECC vs. the 2009 codes. [recommendation \(PDF\)](#)
- 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. [report \(PDF\)](#)
- Dec 2011 - A comparison of building energy code stringency: 2009 IECC vs. 2012 IECC for commercial construction in Texas. [report \(PDF\)](#) Revised July 2012
- Dec 2011 - A comparison of building energy code stringency: 2009 IRC vs. 2012 IRC for single family residences in Texas. [report \(PDF\)](#) Revised August 2012
- Dec 2011 - Letter to SECO regarding the stringency of the 2012 IRC, Chapter 11, and the 2012 IECC vs. the 2009 codes. [letter \(PDF\)](#)
- Oct 2011 - Letter to DOE in response to Building Energy Codes Cost Analysis notice in Federal Register. [letter \(PDF\)](#)
- May 2011 - General memo and information on 15% above-code energy efficiency measures for residential buildings in Texas, relevant to the 2009 codes. [Memo \(PDF\)](#)
- Sep 2009 - Final recommendation to SECO, including stringency analysis & review of public comments, regarding the 2009 IRC, Chapter 11, and the 2009 IECC vs. the 2000 codes + 2001 supplement. [recommendation \(PDF\)](#)
- Feb 2009 - Letter to SECO regarding the stringency & review of public comments of ASHRAE Standard 90.1-2007 vs. the 2000 IECC + 2001 supplement. [letter \(PDF\)](#) to SECO.
- Feb 2009 - Letter to SECO regarding the stringency of REScheck Code Compliance Software (v4.2.0) vs. the 2000 codes + 2001 supplement. [letter \(PDF\)](#) to SECO.
- Feb 2008 - Final recommendation to SECO, including stringency analysis & review of public comments, regarding the 2008 IRC, Chapter 11, and the 2008 IECC vs. the 2000 IECC + 2001 supplement. [recommendation \(PDF\)](#) to SECO.
- Aug 2007 - General memo and information on 15% above-code energy efficiency measures for residential buildings in Texas, relevant to the 2000 codes + 2001 supplement. [memo \(PDF\)](#)
- Aug 2007 - - General memo and information on 15% above-code energy efficiency measures for commercial buildings in Texas relevant to the ASHRAE Standard 90.1-1999. [memo \(PDF\)](#)

**Energy Systems Laboratory stringency review of proposed local building energy code amendments**

- Dec 2011 - Letter to the City of Houston regarding the 2009 Houston Residential Amendments. [letter \(PDF\)](#)

**Other related documents**

- Aug 2002 - Interim Report, by the Texas Senate Committee on Environmental Quality, on Texas Compliance with the Federal Clean Air Act and Establishment of Texas Emissions Reduction Plan Advisory Committee. [Report \(PDF\)](#) for the Texas Senate Committee on Environmental Quality

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- 2013 TERP Reports

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- Continuous Commissioning® spotlight by TAMU Engineering
- Nov 2014 - Final recommendation to SECO, including stringency analysis & review of public comments, regarding the 2015 IRC, Chapter 11, and the 2015 IECC vs. the 2009 codes. [\(PDF\)](#)

Figure 55: TERP –Letters and Reports



The screenshot shows the website for the Energy Systems Laboratory, Texas A&M Engineering Experiment Station. The header features the TEES logo and the text "ENERGY SYSTEMS LABORATORY TEXAS A&M ENGINEERING EXPERIMENT STATION". Below the header is a navigation bar with links for "Energy Systems Lab", "TERP", "Continuous Commissioning", "Riverside Energy Efficiency Laboratory", and "Conferences". The main content area is titled "TERP Links" and includes a search bar, a "Latest Articles" section with links to 2016, 2015, 2014, and 2013 TERP Reports, and a "News" section with a link to a spotlight on Continuous Commissioning. The "TERP Links" section contains a list of external links to various agencies and organizations.

**TERP Links**

The Energy Systems Laboratory is honored to work with the following agencies, organizations and offices at the local, state, and national level. When you click on a link, a new window will open allowing you easy return to this site.

- [eCalc Emissions & Energy Calculator](#)
- [International Code Compliance Calculator \(ICCC\)](#)
- [Public Utility Commission of Texas \(PUC\)](#)
- [U.S. Department of Energy \(DOE\)](#)
- [Texas State Energy Conservation Office \(SECO\)](#)
- [U.S. Environmental Protection Agency \(EPA\)](#)
- [International Code Council \(ICC\)](#)
- [American Society of Heating, Refrigeration and Air-Conditioning, Engineers \(ASHRAE\)](#)
- [North Central Texas Council of Governments \(NCTCOG\)](#)
- [Alamo Area Council of Governments \(AACOG\)](#)
- [Circle of Ten](#)
- [Texas Home Energy Rating Organization \(HERO\)](#)

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- Continuous Commissioning<sup>®</sup> spotlight by TAMU Engineering
- Nov 2014 - Final recommendation to SECO, including stringency analysis & review of public comments, regarding the 2015 IRC, Chapter 11, and the 2015 IECC vs. the 2009 codes. **(PDF)**

Figure 56: TERP Links

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

<b>CATEE 2015 Program</b>	
<b>Tuesday, Dec. 1 – Pre-Conference Workshops</b>	
9:00am – 12:00pm	<b>Putting PACE Into Action (.275 CEU/2.75 PDH)</b> <ul style="list-style-type: none"> <li>• <u>Moderator: Gavin Dillingham, Ph.D., Research Scientist, City of Houston and Houston Advanced Research Center</u></li> <li>• <u>Jonathon Blackburn, Managing Director, Texas PACE Authority</u></li> <li>• <u>Stephen Block, Attorney, Thompson &amp; Knight, LLP</u></li> <li>• <u>Charlene Heydinger, Executive Director, Texas PACE Authority, Keeping PACE in Texas</u></li> <li>• <u>Heather Lepeska, Program Manager, City of Dallas</u></li> <li>• <u>Craig Smith, Assistant Travis County Attorney, Travis County Attorney's Office</u></li> <li>• <u>David Robins, Partner, Jackson Walker LLP</u></li> </ul>
9:00am – 12:00pm	<b>Continuous Commissioning® (.275 CEU/2.75 PDH)</b> <ul style="list-style-type: none"> <li>• <u>Joseph Martinez, PCC, Associate Director, Energy Systems Laboratory</u></li> <li>• <u>Carlos Yagua, P.E., Assistant Research Engineer, Energy Systems Laboratory</u></li> </ul>
1:30pm – 5:30pm	<b>School Facilities EE/RE Strategies (Sponsored by McKinstry) (.35 CEU/3.5 PDH)</b> <ul style="list-style-type: none"> <li>• <u>Moderator: Michael Grabham, Regional Director – South, McKinstry</u></li> <li>• <u>Bobbie Reilly, Sales Engineer, LG Electronics (VRF Technology)</u></li> <li>• <u>Eric Cotney, Vice President of Sales and Marketing, Axium Solar</u></li> <li>• <u>Jim Watt, P.E., Principal Engineer, Green Star Engineering</u></li> <li>• <u>Thursten Simonsen, P.E., Account Executive, McKinstry</u></li> <li>• <u>Eddy Trevino, P.E., CEM, Program Manager, State Energy Conservation Office</u></li> </ul>
<b>Wednesday, Dec. 2 – Day One of Conference</b> (.575 CEU/5.75PDH)	
7:30am – 5:00pm	Registration & Information Desk Open
8:00am – 8:00pm	<b>Expo Arena Open</b>
9:00am – 10:30am	<b>Opening Plenary:</b> <ul style="list-style-type: none"> <li>• Conference Opening &amp; Introductions, <u>Betin Santos, CATEE Conference Executive Director</u></li> <li>• <u>Welcome, James V. A. Abbey, Ph.D., Director for Global and Corporate Partnerships, The Texas A&amp;M University System</u></li> <li>• Keynote Speaker: Community at its Core – Climate, Energy and the EPA's Clean Power Plan, <u>Matthew Tejada, Ph.D., Director, Office of Environmental Justice, Environmental Protection Agency</u></li> </ul>
10:30am – 11:00am	<b>Refreshment Break in Expo Arena</b>
11:00am – 12:30pm	<b>Concurrent Breakout Sessions:</b> <ul style="list-style-type: none"> <li>• Collaborative Efforts to Support Adoption of New Building Energy Codes, <u>Moderator: Fred Yebra, P.E., State Energy Conservation Office</u> <ul style="list-style-type: none"> <li>• <u>Chris Herbert, Managing Director, SPEER</u></li> <li>• <u>Shirley Ellis, Energy Codes Specialist, Energy</u></li> </ul> </li> </ul>

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Figure 57: CATEE Conference

## 6.4 Activities of Technical Transfer

### 6.4.1 Technical Assistance to the TCEQ

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

The Laboratory provides technical assistance to the TCEQ, the PUC, SECO and ERCOT, as well as Stakeholders participating in a number of conferences and presentations. In 2011, the Laboratory continued to work closely with the TCEQ to develop an integrated emissions calculation, which provided the TCEQ with a creditable NO<sub>x</sub> emissions reduction from energy efficiency and renewable energy (EE/RE) programs reported to the TCEQ in 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014 and 2015 by the Laboratory, PUC, SECO, and Wind-ERCOT.

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

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

### 6.4.2 Code Training

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



6.4.3 ASHRAE Winter Conference Standards Committee Activities in Chicago, Illinois, January 24-26, 2015

The following sections are the minutes and transactions of Standards Committee activities at the ASHRAE Winter Conference in Chicago, Illinois, January 24-26, 2015.

6.4.3.1 ASHRAE SSPC 90.1



ASHRAE SSPC 90.1 MEETING AGENDA  
 Winter Meeting, ASHRAE, Chicago, ILL  
 January 24-26 2015  
 Agenda 01/13/15, subject to change

**Full Committee meetings are in the Palmer House– Wabash (3)**

**Notes:**

- Full Committee meetings will start promptly at times noted.
- Subcommittee meeting rooms are at end of agenda
- All sessions are open to the public.
- The agenda order shown may not be followed
- Material for Project Committee members is posted on the Committee Only FTP site (**2015 meetings\2015\_01\_CHICAGO\_SSPC**)

**Full Committee Saturday, January 24, 2015 ..... 8:00 am to 12 NOON**

**1) Introductions**

- a) Sign-in and Quorum Determination (Ferguson)
- b) Introductions of members and guests (Erbe)
- c) ASHRAE Code of Ethics

**ASHRAE Code Of Ethics**

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

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

- A. Efforts of the Society, its members, and its bodies shall be directed at all times to enhancing the public health, safety and welfare.
- B. Members and organized bodies of the Society shall be good stewards of the world's resources including energy, natural, human and financial resources.
- C. Our products and services shall be offered only in areas where our competence and expertise can satisfy the public need.
- D. We shall act with care and competence in all activities, using and developing up-to-date knowledge and skills.
- E. We shall avoid real or perceived conflicts of interest whenever possible, and disclose them to affected parties when they do exist.
- F. The confidentiality of business affairs, proprietary information, intellectual property, procedures, and restricted Society discussions and materials shall be respected.
- G. Each member is expected and encouraged to be committed to the code of ethics of his or her own professional or trade association in their nation and area of work.
- H. Activities crossing national and cultural boundaries shall respect the ethical codes of the seat of the principal activity.



**ASHRAE SSPC 90.1 MEETING AGENDA**  
 Winter Meeting, ASHRAE, Chicago, ILL  
 January 24-26 2015  
 Agenda 01/13/15, subject to change

- 2) **Review Agenda**
- 3) **Ron Burton Moment of Silence**
- 4) **Announcements (Erbe)**
  - a) Bias and Conflict Forms - Update with any changes - Send to ASHRAE HQ
  - b) Availability of Errata for Standard and Users Manual on public website (Ferguson)
  - c) Addendum AB status (Erbe)
  - d) PNNL Cost Effectiveness Report for 90.1-2013 (Erbe)
- 5) **Results of Standards Committee Actions (Ferguson)**
  - a) Update on Addenda
- 6) **Liaison Reports**

<b>Liaison</b>	<b>Report</b>
ASHRAE - Ferguson	
SPLS (Modera)	
IES (Harrold)	
CIS (VanGeem)	
INTERNATIONAL (Hoegling)	
TC 1.4 Control Applications (Young)	
TC 3.6 (Lindah)	
TC 4.4 Building Materials and Building Envelope Performance (Humble)	
TC 4.5 Fenestration (Hogan)	
TC 5.2 Duct Design (Wray)	
TC 5.4 Industrial Process Air Cleaning TC 5.7 Evap Clg, 5.8, Ind. Vent Systems. 9.2 Ind. Air Conditioning (???)	
TC 5.5 Air-to-air Energy Recovery (Dobbs)	
TC 6.1 Hydronic Systems (Towsley)	
TC 6.5 Radiant Heat & Cool (Watson)	
TC 6.9 Thermal Storage (McCracken)	
TC 8.6 Cooling Towers (Lindah)	
TC 7.6 Energy Utilization (Pierson)	
TC 9.9 Mission Critical Facilities (Pavlak)	
SSPC 62.1 (????)	
SPC 90.4 (Peglow)	
AEDG (Lane)	

- 7) **Approval of Minutes –**
  - a) October 2014
- 8) **Climate Zone Changes Impact – PNNL/McBride**
- 9) **Subcommittee Reports and Actions – (Energy Savings proposals first.)**



**ASHRAE SSPC 90.1 MEETING AGENDA**  
Winter Meeting, ASHRAE, Chicago, ILL  
January 24-26 2015  
Agenda 01/13/15, subject to change

- a) Lighting
    - Addendum E – publication with knowledge of negative voters
    - Addendum Y – response to comments
    - Addendum AH – response to comments
    - Response to Official Interpretations
    - Proposal: Modifications to exterior parking lot power requirements
  - b) ECB
  - c) Envelope
    - Addendum L – Response to comments/2<sup>nd</sup> PPR draft
    - Proposal: Fenestration prescriptive values (U-Factors and SHGC)
    - Proposal: Skylight prescriptive values
    - Addendum W – response to comments
    - Spath CMP response
    - Husted CMP response
    - Greenhouse proposal (tentative)
    - Addendum V – publication with knowledge of negative voters (tentative)
  - d) Format & Compliance
  - e) Mechanical
    - Addendum I – response to comments
    - Addendum AG – publication with knowledge of negative voters (tentative)
    - Addendum N – publication with knowledge of negative voters (tentative)
  - 10) Public time to address SSPC (30 minutes).** Persons wishing to address the Project Committee should contact the Chair (Drake Erbe – [drakeerbe@airxchange.com](mailto:drakeerbe@airxchange.com) ) by NOON January 21, 2015.
- End of Full Committee Meeting.....12 NOON**



**ASHRAE SSPC 90.1 MEETING AGENDA**  
Winter Meeting, ASHRAE, Chicago, ILL  
January 24-26 2015  
Agenda 01/13/15, subject to change

**Full Committee Sunday, January 25, 2015 .....9 am to 12 NOON**

- 1) Introductions**
  - a) Sign-in and Quorum Determination (ASHRAE Staff)
  - b) Introductions of members and guests (Erbe)
- 2) Announcements (Erbe)**
  - a) Bias and Conflict Forms
- 3) Subcommittee Reports –Votes:**
  - a) Envelope
  - b) Lighting
  - c) ECB
    - Addendum BM discussion/comment responses
  - d) Mechanical
  - e) Format & Compliance
- 4) Continuous Maintenance Proposals Status updates – Garrigus**
  - a) Review Proposals with expired deadline for SSPC response
- 5) Interpretations - Status updates – Garrigus**
  - a) Review Interpretations with expired deadline for SSPC response

**End of Full Committee Meeting.....12 NOON**



**ASHRAE SSPC 90.1 MEETING AGENDA**  
 Winter Meeting, ASHRAE, Chicago, ILL  
 January 24-26 2015  
 Agenda 01/13/15, subject to change

**Full Committee Monday, January 26, 2015 ..... 8:00 AM to Noon**

- 1) Introductions**
  - a) Sign-in and Quorum Determination (Ferguson)
  - b) Introduction of members and guests (Erbe)
- 2) Announcements (Erbe)**
  - a) Bias and Conflict Forms
  - b) Back to Liaisons
- 3) Future Meetings**
  - a) Spring Interim Meeting 2015 – Atlanta – April 16,17,18 with AES 15, 2015 at ASHRAE HQ
    - Meeting times
    - SSPC Full committee Friday 8 am-noon, Saturday 8 am-noon
      - (1) ECB: Thursday 3-7 pm, Friday 1-9 pm
      - (2) ENVELOPE: Thursday 8 am-9 pm, Friday 1-9 pm
      - (3) FORMAT & COMPLIANCE: Thursday 3-7 pm, Friday 1-9 pm
      - (4) LIGHTING: Thursday 8 am-9 pm, Friday 1-9 pm
      - (5) MECHANICAL: Thursday 8 am-9 pm, Friday 1-9 pm
  - b) Annual Meeting Atlanta-June 26-29
  - c) Fall Interim 2015 – Atlanta
    - Review Doodle poll results for availability.
- 4) International Energy Standards – (Hoegling)**
- 5) Subcommittee Votes**
  - a) Envelope
  - b) Lighting
  - c) ECB
    - Addendum BM discussion/comment responses
  - d) Format & Compliance
  - e) Mechanical
- 8) AES WG-Erbe**
- 9) Brief overview of subcommittee plans**
- 10) Membership Recommendation Results**
- 11) Other Business**
- 12) Adjournment ..... Noon**

6.4.3.2 SSPC 140 at the SHRAE Winter Conference in Chicago, Illinois, Jan 18-10 2015

**AGENDA – SSPC 140**  
**Standard MOT for the Evaluation of Building Energy Analysis Computer Programs**  
**Monday Jan 26, 2015; Chicago**

**Time: 2:15P – 6:15P**

**Location: Clark 9 (7<sup>th</sup> Floor)**

**Chair: Joel Neymark**

1. Introductions: Sign-in sheet, participant introductions, quorum (= 6 VMs).
2. Chair Announcements/Communications since last meeting [*10 min.*]
  - **Publication of 140-2014 Continuous Maintenance Revision**, see agenda below.
  - **Current IRS rules** (IRS notice 2008-40, published Apr 2008) relating to the deduction for energy efficient **commercial buildings** require software used for assessing tax credits be tested to Standard 140-2007. Currently **13 programs are qualified; 8** programs qualified updated versions. (Last check 22Jan2015). **New submittals [ron.judkoff@nrel.gov](mailto:ron.judkoff@nrel.gov)**  
**Qualified programs listed at <http://energy.gov/eere/buildings/qualified-software-calculating-commercial-building-tax-deductions>**
  - ASHRAE 90.1 and 189.1 reference Standard 140;
    - 90.1-2013, published Fall 2013 updated their reference to 140-2011.
  - RESNET lists **6** (last check 2Jan2015) tools as either accredited for HERS ratings, tax credit compliance, IECC performance verification, or existing home tax credit compliance. Required tests include NREL's HERS BESTEST (included in Std 140-2011,-2014), along with equipment modeling and other modeling tests developed by RESNET. **New submittals to RESNET (<http://www.resnet.us/professional/programs/software>).**
  - **2015 IECC cites 140-2011**; IGCC citation accords with IECC.
  - **ANSI EESCC Roadmap**: National framework for action and coordination on energy efficiency standardization (125 recommendations); chapter on simulation includes Std 140; agen. item later.
  - **Airside HVAC Equipment simulation trials**: Final round of updates to test spec and quasi-analytical solution and its documentation, distributed Oct 9; further discussion per agenda below.
  - **IEA BESTEST Update simulation trial**: Revised test specification distributed for first round sim trial July 22; 7 results sets received; further discussion per agenda item below.
3. Membership [*5 min.*]
  - VMs scheduled to roll off Jul 1, 2015: Sturm. Has agreed to re-up.
4. Acceptance of Previous Minutes [*5 min.*]
5. Adjustments to Agenda [*5 min.*]
  - New business or news briefs to include?
6. 140-2014 CM Revision [*5 min*]
  - Published hardcopy and with full standards set CD
    - PC received announcement from ASHRAE, Jan 8.
  - Content: 140-2011 + 140-2011-A Ground Coupled (GC) Slab-on-Grade Tests
    - N. Kruis present recent work on GC algorithms, if time; agenda item below.
- 7a. 140-2014-A: Adaptation of ASHRAE/RP-865 (air-side mechanical equipment): Modifications and Simulation Trials [*Neymark, 60 min*]
  - Progress report, Discussion, Next Steps/Action Items
    - Future Volume 2 discussion later on agenda, if time.

- 8a. 140-2014-B: Update Section 5.2 (IEA BESTEST envelope, 1995) test spec/example results [*Judkoff/Neymark, 60 min.*]
- Meeting summary, BESTEST Thermal Fabric Working Group:
    - Status Report: anonymous results, surf coeffs, comments, and next steps
  - Prioritize extension cases (weather driven infiltration, windows)
    - Discuss other extension cases later on agenda, if time.
9. Proposed Work Schedule (2013/14) for Above Addenda (Items 7, 8) [*Neymark, 10 min.*]
10. **References to Std 140-2014 in Std 90.1** [*Pegues, 10 min – hold until 4:15P for JP*]
- GC test cases part of Section 5.2 (as 5.2.4). Is that ok for future referencing by 90.1 and others? Plan meeting with 90.1 ECB.
11. SSPC 140 Website Update Volunteer Recruitment [*5 min.*]
- <http://sspc140.ashraeps.org/index.html> ; Not updated since 2010 ; multiple emails to JN
  - Who will volunteer to update/maintain?
12. DOE Empirical Validation Roadmap [*Judkoff/Roth 20 min.*]
13. Recent work using 140-2014 to test GC algorithms. [*Kruis, 10 min.*]
14. Other Related Activities [*as time permits*]
- IEA ECBCS Annex 58 task on whole building empirical validation (fyi) [*Hong, 5 min.*]
  - ANSI EESCC Roadmap [*Roth, 5 minutes*]
  - Incentives Programs [*Judkoff, 5 min*]
    - Comml: Sec 179
    - RESNET, Tax Credit/Supplemental Cases, IECC Section 404, Homestar Gold
  - COMNET and ASHRAE Building Energy Quotient (EQ) Ref. of Std 140 [*Haberl 5 min*]
  - *ASHRAE Handbook of Fundamentals*, Validation Methods [*Judkoff, 2 min.*]
  - ANSI/RESNET Calibration SMOT (fyi) [*Judkoff, 2 minutes*]
  - Residential empirical-data based tests) [*Neymark, 2 minutes*]
  - RTAR: Assess and implement natural and hybrid ventilation models in whole-building energy simulations [*Judkoff?, ? minutes*]
15. Addl. discussion, Airside HVAC Vol 2 or BESTEST Thermal Fabric cases [*Chair discretion*]
- 7b. Airside HVAC tests Volume 2: Possible additional test cases
- 8b. BESTEST thermal fabric: Possible additional test cases.
16. Additional Future Test Suites that could be adopted [*Judkoff, 5 min.*]
- Empirical Validation Data Sets
    - ETNA BESTEST (Electricité de France 2004)
    - IEA-34/43: Shading/Daylighting/Load Interaction by Switz. Hydronic Equipment by Germany, Double-Skin Façade empirical by Denmark.
  - Analytical Verification and Comparative Tests
    - Adaptation of NREL/IEA 34/43 Multi-Zone (MZ) Tests
    - Adaptation of BESTEST-EX Physics cases for Section 7
    - ASHRAE RP 1052 building thermal fabric analytical verification tests
    - IEA 34/43 Airflow Tests by Japan (final report still in progress),
    - RESNET mechanical equipment test cases (RESNET now qualified for ANSI)
    - IEA BCS Annex 42: Testing/Validation of Models for Resl. Cogen Devices
  - Other Existing Test Suites and new research
17. New business
18. Adjourn

6.4.3.3 Historical Committee at ASHRAE Winter Conference in Chicago, Illinois, January 24-26, 2015

**HISTORICAL COMMITTEE Sunday, January 25, 2015, 8:30 a.m. – 12:00 p.m.  
2015 Winter Conference, Chicago, Marshfield (3<sup>rd</sup> floor, Palmer)**

**A G E N D A**

1. Call to Order.....Arnold, Chair
2. Introduction of Members and Visitors .....Arnold  
2.1 2014–2015 Historical Committee Roster (**Attachment 1**)
3. Review of Agenda.....Arnold
4. Approval of Seattle Minutes (Attachment 2).....Arnold
5. Review of Motions from Previous Meeting .....Arnold  
Motion 1: Approved meeting minutes of January 19, 2014 in New York. 4-0-0 CV, Passed
6. Committee Reports .....Arnold
  - 6.1 Administrative Subcommittee Report ..... Vallort
  - 6.2 Archives Subcommittee Report.....Schrecengost
  - 6.3 Awards Subcommittee Report.....Arnold
  - 6.4 Communications Subcommittee Report..... Nagengast
  - 6.5 Leadership Recall Subcommittee Report ..... Anderson
  - 6.6 125<sup>th</sup> Anniversary Subcommittee Report ..... Haberl
  - 6.7 BOD Ex-Officio Comments ..... Wessel
7. New Business.....Arnold
  - 7.1 BOD Ex-Officio Comments ..... Wessel
  - 7.2 How can Historical Committee support the 2014 Strategic Plan.....Arnold
  - 7.3 Official policy or Rule of the Board.....Arnold  
Develop policy for retention of documents of historical importance.
  - 7.4 QA for selection and preservation of historical documents..... Committee  
Determine process to decide which “technical” records should be preserved. Establish basic criteria for quality of preservation: ability to search for terms, quality of image reproduction, preservation of original hard copy.
  - 7.5 Cost to digitize ..... Committee  
Seek out multiple sources for funding.
  - 7.6 Regional Historical Depository.....Schrecengost  
Assist Regions in determining how to set up each Region find a way for a Regional Historical depository for their historical Documents.
  - 7.7 Discuss Tim Dwyer’s method for preserving digital chapter historical records..... Committee
  - 7.8 Provide ASHRAE the development of a digital foundation of HVAC&R Knowledge.....Haberl  
Historical Committee can provide to ASHRAE is the development of a (digital) foundation of origins of the knowledge that HVAC&R engineers must have today to be successful in their careers
  - 7.9 Historical Committee reach out to YEA.....Haberl



7.10 Status of Wording of Membership of Committee in the Rules of the Board.....Arnold

7.11 Leadership Recall Strategic Plan for Future Videos.....Arnold

7.12 Recognition of Irene Reichart

8. Adjourn .....Arnold

6.4.3.4 ASHRAE TC 4.7 Energy Calculations at ASHRAE Winter Conference in Chicago, Illinois, January 24-26, 2015

**Agenda**  
**ASHRAE TC 4.7 Energy Calculations – Main Meeting**  
**Empire Ballroom, Palmer House, Chicago, Illinois**  
**Tuesday, January 29, 2015, 6:00-8:30 pm**

- |   |             |
|---|-------------|
| 1. Roll call and introductions (5 minutes)  | Balbach     |
| 2. Accept agenda & approve minutes of previous meeting (10 minutes)   | Huang       |
| 3. Announcements/Liaisons (5 minutes)   | Huang       |
| 4. Membership (5 minutes)   | Huang       |
| 5. Subcommittee reports   |             |
| 5.1 Applications (10 minutes)   | Huang       |
| 5.2 Data-Driven Modeling (10 minutes)   | Muehliessen |
| 5.3 Simulation and Component Models (10 minutes)  | Crawley     |
| 5.4 Research (15 minutes)   | Haberl      |
| 5.4.1 Research Projects   |             |
| • 1588-RP Representative Layer-by-Layer Descriptions for Fenestration Systems with Specified Bulk Properties Such as U-factor and SHGC (co-sponsored with TC 4.5)                       |             |
| • 1629-RP Testing and Modeling Energy Performance of Active Chilled Beam Systems (co-sponsored with TC 5.3)   |             |
| 5.4.2 Workstatements, RTARs, Requests for Co-sponsorship  |             |
| • 1661-RTAR Modelica Models for the Evaluation of Supervisory Control Strategies in the ASHRAE Handbook (sent back to Authors) – SCM  |             |
| • 1748-RTAR Assess and Implement Natural and Hybrid Ventilation Models in Whole-building Energy Simulations (Phase 2) - SCM   |             |
| • 1666-WS Experimental Evaluation of the Thermal and Ventilation Performance of Stratified Air Distribution Systems Coupled with Passive Beams – (request for co-sponsorship by TC 5.3) |             |
| • XXXX-RTAR Development of an Improved Inverse Model Toolkit (RP1050) and Diversity Factor Toolkit (RP1093) for Analyzing Building Energy Savings from Time Series Data.                |             |
| • Requests for co-sponsorship   |             |
| 5.5 Handbook (10 minutes) Kolderup  |             |
| 5.6 Program (15 minutes) Cockerham  |             |
| 5.7 Standards (15 minutes) Neymark  |             |
| SSPC 140 SMOT for Eval Bldg Energy Analysis Computer Programs Neymark   |             |
| SPC 205 – Std. Representation of Perf. Sim. Data for HVAC&R & Other Fac'l Equipment Barnaby   |             |
| SPC 209 Energy Simulation Aided Design Glazer   |             |
| 5.8 Web Site (5 minutes) New  |             |
| 6. Related activities reports (15 minutes)  |             |
| SPC 191 Water Conservation  |             |
| MTG.EAS Energy Eff AHU Systems  |             |
| MTG.BIM Building Information Modeling   |             |
| SGPC 20 Documenting HVAC&R Work Process and Data Exchange Requirements  |             |
| TC 2.8 Building Environmental Impacts and Sustainability  |             |
| TC 4.1 Load Calculation Data and Procedures   |             |
| TC 4.2 Climatic Information   |             |
| TC 4.3 Infiltration & Ventilation Requirements  |             |
| TC 4.5 Fenestration   |             |
| TC 6.5 Radiant Heating and Cooling  |             |
| TC 7.5 Smart Building Systems (now includes TC 7.4)   |             |

TC 7.6 Building Energy Performance

BuildingSMART (formerly IAI International Alliance for Interoperability)

IBPSA: USA, Canada, World

BPI-2400-S-2011 Standardization Qualification of Whole-house Energy Savings Est.

Guideline 14

IEA Annex 60

IEA Annex 66

ASHRAE Historical Committee

7. Old Business Huang

8. New business Huang

9. Executive Session Huang

10. Adjourn Huang

Note TC 4.7 Email list hosted at [onebuilding.org](http://onebuilding.org)

6.4.3.5 ASHRAE TC 4.7 Handbook Subcommittee at ASHRAE Winter Conference in Chicago, Illinois, January 24-26, 2015

**TC 4.7 Handbook Subcommittee  
Agenda  
Chicago  
Tuesday, January 27, 2015  
5:00-6:00pm,  
Room: Empire Ballroom (Lobby), Palmer House, Chicago, Illinois**

- 1) Introductions and Agenda Review (5 minutes)
- 2) Schedule for 2017 Fundamentals Handbook Revision
  - a. January 2015, 25% draft
  - b. June 2015, 50% draft
  - c. January 2016, 95% draft to TC for review
  - d. June 2016, TC approves revised chapter (final due June 21, 2016)
  - e. Early 2017, review galley prints
  - f. June 2017, publication
- 3) Reminder of target audience description
  - a. See doc link below
- 4) Editing process
  - a. 2013 Chapter 19 doc in Dropbox folder. See link below
  - b. Use track changes to add notes and edits. Otherwise changes will not make it into the 2017 version.
  - c. Files with tracked changes may be emailed to Erik Kolderup, erik@kolderupconsulting.com.
  - d. Source files and references may be uploaded to the Dropbox folder.
- 5) Review potential chapter outline changes. Assign responsible committee members.
  - a. See 2013 Outline link below for reference.
- 6) Assign action items

Resources:

- Word version of 2013 Chapter 19 for review and markup. In Dropbox folder: <https://www.dropbox.com/sh/9vnz7g99u6xyev2/Uv3Nv8LdeJ>
- Outline of all 2013 Chapter 19 sections. In Dropbox folder: <https://www.dropbox.com/sh/9vnz7g99u6xyev2/Uv3Nv8LdeJ>
- Description of target audience. Google Doc: [https://docs.google.com/document/d/174pP\\_sNyLlSMAlDZTMTtoMwh9wiUibwTdl7i4EY7nBrE/edit?usp=sharing](https://docs.google.com/document/d/174pP_sNyLlSMAlDZTMTtoMwh9wiUibwTdl7i4EY7nBrE/edit?usp=sharing)
- Working list of potential updates and assignments: <https://docs.google.com/document/d/1xMbwnU5erAxUoGqgePb508X0hD1yZ0LhLWKEmkKnI/edit?usp=sharing>

6.4.3.6 ASHRAE TC 4.7 Data-Driven Modeling Subcommittee at ASHRAE Winter Conference in Chicago, Illinois, January 24-26, 2015

**TC4.7 Data-Driven Modeling Subcommittee Monday January 26, 2014, 7:30–9:00 PM**  
**Location: Chicago, Palmer House, Monroe Room, 6<sup>th</sup> Floor**  
**Agenda**

- 7:30 Call to order / Introductions / Changes to the agenda
- 7:40 Discussion of Program (10 minutes)
- Winter Meeting 2015 (Chicago) Review (Calibration Seminar)
  - Summer Meeting 2015 (Atlanta)
  - Winter Meeting 2016 (Orlando)
  
  - 2015 ASHRAE Energy Modeling Conference (Atlanta)  
(no program discussion – just info/announcement)
- 7:55: Work Statements / RTAR's (50 minutes)
- Existing WS and RTAR's
    - Haberl: Inverse Modeling Tool Update RTAR “Development of an Improved Inverse Model Toolkit (IMT) for Analyzing Building Energy Savings from Time Series Data”
  
  - Ideas previously discussed:
    - David Jump idea from NY: Develop and test a methodology to validate public domain and proprietary energy baseline modeling capabilities well as savings estimation using inverse modeling methods on whole building data. The goal is to create a method of test of inverse models
    - AI for data-driven modeling
    - In-situ procedures for energy savings from renewable projects
    - In-situ procedures for actual energy performance of LEED-Certified buildings
    - Electricity demand savings
    - Water use in a facility
  
  - New ideas?
- 8:40 Discussion on: (15)
- Better ways to digest past research
  - Disseminate research results
    - What from DDM SC is in handbook?
  - Coordinate research and results with allied TC and SC (co-sponsoring RTAR's)
    - TC 7.5 Smart Buildings?
    - TC 7.6 Energy Performance?
  - Maintain expertise within SC even when membership changes.
- 8:50 Old Business
- 8:55 New Business
- 9:00 Adjourn

6.4.3.7 ASHRAE TC 4.7 Simulation and Component Models Subcommittee at ASHRAE Winter Conference in Chicago, Illinois, January 24-26, 2015

**Draft Agenda**  
**TC 4.7 Simulation and Component Models Subcommittee**  
**6:00-7:30 pm, Monday, 26 January 2015**  
**Monroe, 6<sup>th</sup> Floor, Palmer House, Chicago, Illinois**

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6:00	Call to order / introductions / changes to the agenda	Crawley
6:10	<b>Research Projects</b> <b>1629-RP</b> Testing and Modeling Energy Performance of Active Chilled Beam Systems (TC 5.3 / TC 4.7)	
6:20	<b>Draft Work Statements/RTARs</b> <b>1666-WS</b> Experimental Evaluation of the Thermal and Ventilation Performance of Stratified Air Distribution Systems Coupled with Passive Beams (TC 5.3 Room Air Distribution, requesting TC 4.7 co-sponsor) Bauman, Zimmerman <b>17xx-WS</b> Development of Improved and Integrated Energy Modeling Software for Data Centers (TC 9.9 / SPC 90.4P / TC 4.7) Davidson, Haves <b>17xx-WS</b> Development of a Reference Building Information Model (BIM) for Daylighting Optimization (TC 1.5 / TC 4.7) Haberl <b>1661-RTAR</b> Development of Modelica Models for the Evaluation of Supervisory Control Strategies in the ASHRAE Handbook Wetter <b>17xx-RTAR</b> (Phase 2 of 1456-RP Assess and Implement Natural and Hybrid Ventilation Models in Whole-Building Energy Simulations) (TC 4.10 / TC 4.7) Huang	
6:50	<b>New Research Topics/Research Plan</b> New Research Topics (RTARs and WSs can be submitted 4 times a year—six weeks before Winter and Annual meetings and 1 March/1 August.) Several new research topics at last meeting: Research for new ground heat transfer tables in the HOF (Kruis) Research for better simulations for occupants (Hong) Better hygrothermal modeling for highly efficient buildings, including VOC issues, etc. Current project supported by the IEA (Rode). Research in support of ASHRAE bEQ building rating system (Brandemuehl)	
7:20	<b>Program Ideas</b> 2015 Annual (Atlanta), 2016 Winter (Orlando), 2016 Annual (St. Louis)	
7:25	<b>New Business</b>	
7:30	<b>Adjourn</b>	

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**Next Meeting: Monday, June 29, 2015 Atlanta, Georgia**

6.4.3.8 ASHRAE TC 1.5 Computer Applications at ASHRAE Winter Conference in Chicago, Illinois, January 24-26, 2015

**ASHRAE 2015 Winter Conference – Chicago  
TC 1.5 Computer Applications- Agenda**

TC 1.5 Public Web site: <http://tc15.ashraetcs.org/>

TC 1.5 ListServ (mailing list) : [tc105\\_all\\_lst@listman.ashrae.org](mailto:tc105_all_lst@listman.ashrae.org) (Contact chair or vice chair to be added)

TC 1.5 Members-only Site: <https://sites.google.com/site/ashraetc15/> (Contact chair or vice chair for access)

**Main Committee Meeting Monday 6:30-9:00 PM Salon 12 (3)**

Sponsoring/Cosponsoring:

**Seminar 45:** BIM Pays its Way: Showing Return of Investment for BIM in Real Day- to-Day Applications

**1. Call to Order**

**2. Welcome:** Introductions

**3. Roll Call:** List of Voting members from 2014-2015 TC 1.5 Roster: Billedeaux, Bourassa, Branson (ch), Dwyer (NQ), Gottshall, Pouchak, Rosen, Roth

**4. Review of Agenda**

**5. Approval Of Minutes from 2014 Annual Conference in Seattle**

**6. Review Action Items from 2014 Annual Conference in Seattle**

**7. Subcommittee Reports:**

- a. Handbook: Krishnan Gowri
- b. Research: Todd Gottshall
- c. Emerging Applications: Norm Bourassa
- d. Program: Stephen Roth
- e. Web Page: Mike Galler
- f. E&P: Dave Branson

**8. YEA mixer with TCs:** Grondzik

**9. ASHRAExCHANGE update:** Pouchak

**10. Chair's Report:**

- a. Updates from TAC and RAC
- b. Discussion on changes to TPS
- c. Note to members to update ASHRAE profile when info changes
- d. Announcements
- e. Dinner plans

**11. Liaison Reports:**

- a. GPC-20
- b. IAI/BIM Society Subcommittee Report: Steven Rosen
- c. TC 7.3- WS 1609 - Defining the Capabilities, Needs and Current Limitations of Building Information Modeling (BIM) in Operations and Maintenance for HVAC&R
- d. TAC

**12. Old Business:**

- a. N/A

**13. New Business:**

- a. TC 1.5 Co-Sponsorship of College of Fellows Debate, 2015 Annual Meeting (Atlanta)
- b. Briefing of New EA effort re Big Data – Hallstrom
- c. Other

**14. Next Meeting Times:** ASHRAE Annual Conference, Atlanta, GA, June 27 – July 1, 2015

**15. Adjournment**

**TC 1.5 Meeting Schedule**

<b>TC 1.5 Computer Applications</b>	<b>Monday</b>	<b>6:30---9:00p</b>	<b>Salon 12 (3)</b>
<b>TC 1.5 Emerging Applications</b>	<b>Sunday</b>	<b>5:00---6:00p</b>	<b>Kimball (3)</b>
<b>TC 1.5 Research</b>	<b>Sunday</b>	<b>6:00---7:00p</b>	<b>Kimball (3)</b>
<b>TC 1.5 Program</b>	<b>Sunday</b>	<b>7:00---8:00p</b>	<b>Kimball (3)</b>
<b>TC 1.5 Handbook</b>	<b>Monday</b>	<b>6:00---6:30p</b>	<b>Salons 5/8 (3)</b>

**TC 1.5 Program Schedule**

**Tuesday, January 27 11:00 AM – 12:30 PM, Empire (Lobby)**

**SEMINAR 45 (INTERMEDIATE)**

**BIM Pays its Way: Showing Return of Investment for BIM in Real Day- to-Day Applications**

Track: Fundamental and Applications

**Sponsor: 01.05 Computer Applications, MTG.BIM Building Information Modeling**

*Chair: Tim Dwyer, Fellow ASHRAE, UCL Institute for Environmental Design and Engineering, The Bartlett, University*

*College London, London, United Kingdom*

This seminar shows how building information modeling (BIM) can drive a project from concept to completion and deliver

tangible benefits and profitable working in the process. The tools required at each stage are introduced by highlighting key

aspects where software enables the design, thus allowing an unprecedented flow of information through the process. Examples of real-world projects are used to evidence the positive benefit of integrated BIM working.

**1. Evolution of HVAC Software and the Revolution of BIM! Projects from Concept to Completion.** Joe Simmons,

P.E., Associate Member, HVAC Solution, Salt Lake City, UT

**2. BIM to SIM (Or, How do I get that Rich Data into Computer Simulations without Retyping it in Once Again?),**

Drury Crawley, Ph.D., Fellow ASHRAE, Bentley Systems, Inc., Washington, DC

**3. BIM Bang Bucks: What Is the True ROI?** Steven Rosen, R.G. Vanderweil Engineers, LLP, Boston, MA



6.4.3.9 ASHRAE TC 4.2 Climatic Information at ASHRAE Winter Conference in Chicago, Illinois, January 24-26, 2015

**AGENDA, ASHRAE TC 4.2 Climatic Information  
1:00 – 3:30 PM, Tuesday, 27 January 2015  
Buckingham, 5<sup>th</sup> Floor, Palmer House, Chicago, Illinois**

Scope: TC 4.2 is concerned with identification, analysis and tabulation of climatic data for use in analysis and design of heating, refrigeration, ventilation and air-conditioning systems. Promotion of effective use of weather information in these applications is also included.

1:00 PM	Call to order Roll call Introductions Approval of agenda Approval of minutes of Seattle meeting (July 2014) Report from the Chair/Announcements Introduction of liaisons (liaison announcements/requests)	<b>Crawley</b> <b>Baltazar</b>
1:15 PM	Membership Roster Rollovers (for July 2015)	<b>Crawley</b>
1:20 PM	Review of Action Items and Status	<b>Baltazar</b>
1:35 PM	Research Reports on status of current, future and completed research projects: 1561-RP, Procedures to Adjust Observed Climatic Data for Regional or Microclimate Variations 1699-RP, Update Climatic Design Data in Chapter 14 of the 2017 Handbook - Fundamentals Other potential research projects Long-term research plan	<b>Cornick</b>
2:15 PM	Handbook 1699-RP Update of Climatic Data for 2017 Handbook - Fundamentals Revisions and errata	<b>Thevenard</b>
2:30 PM	Program Chicago, January 24-28, 2015 Atlanta, June 27-July 1, 2015 Orlando, January 23-27, 2016 Future conferences	<b>Huang</b>
2:45 PM	Standards Report SSPC 169 Climatic Data for Building Design Standards	<b>Crawley</b>
3:00 PM	Old business	<b>Crawley</b>
3:10 PM	New business	
3:30 PM	Adjournment	

**Next Meeting: Atlanta, Georgia, Tuesday 30 June 2015**

6.4.3.10 ASHRAE TC 7.6 Building Energy Performance at ASHRAE Winter Conference in Chicago, Illinois, January 24-26, 2015

**TC 7.6 Building Energy Performance**

**<http://www.tc76.org/tc76news/>**

Chicago, IL

Tuesday, January 27, 2015, 1:00-3:30 pm, Palmer House Hilton, Salons 6/7

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

- |  |                    |
|--|--------------------|
| <b>1. Roll call and Introductions</b>                                    | <b>Peterson</b>    |
| <b>2. Accept agenda/approve minutes of Seattle meeting</b>               | <b>Peterson</b>    |
| <b>3. Announcements</b>  |                    |
| • Welcome new members and visitors                                       |                    |
| • Chicago Updates  |                    |
| <b>4. Standing Committee Liaisons TAC/RAC/StdCom/Program/SpecPub/ALI</b> |                    |
| <b>5. Subcommittee Reports</b>   |                    |
| <b>5.1 Membership</b>  | <b>Hunn</b>        |
| <b>5.2 Research</b>  | <b>Eldridge</b>    |
| <b>5.3 Handbook</b>  | <b>Stafford</b>    |
| <b>5.4 Standards</b>   | <b>Novosel</b>     |
| <b>5.4 Monitoring &amp; Energy Performance</b>                           | <b>Landsberg</b>   |
| <b>5.5 Energy Management</b>   | <b>Pearson</b>     |
| <b>5.6 Web Site</b>  | <b>Heinzerling</b> |
| <b>5.7 Commercial Building Audits</b>                                    | <b>Kelsey</b>      |
| <b>5.8 Program</b>   | <b>Carlson</b>     |
| <b>5.9 Federal Buildings (New)</b>                                       | <b>Zhivov</b>      |
| <b>5.10 DASH</b>   | <b>Hunn</b>        |
| <b>5.11 AEDG</b>   | <b>Friedrich</b>   |
| <b>5.12 BEDES (Building Energy Data Exchange Specification)</b>          | <b>Kelsey</b>      |
| <b>6. Old Business</b>   |                    |
| • Presidential Site Source Ad Hoc Committee                              | <b>Deru</b>        |
| • ASHRAE Energy Guideline for Historic Buildings                         | <b>Montgomery</b>  |
| • MTG on Energy Targets  | <b>Hunn</b>        |
| <b>7. New business</b>   |                    |
| • Review roster changes  | <b>Peterson</b>    |
| <b>8. Adjourn</b>  |                    |

#### 6.4.4 ASHRAE Summer Conference Standards Committee Activities in Atlanta, Georgia, June 30 and July 1, 2015

The following sections are the minutes and transactions of Standards Committee activities at the ASHRAE Summer Conference in Atlanta, Georgia, June 30 and July 1, 2015

##### 6.4.4.1 SSPC 140 at the SHRAE Summer Conference in Atlanta, Georgia, June 30 and July 1, 2015

### **SSPC 140 Meeting Summary –6/29/15 (submitted to TC4.7 6/30/15, resubmitted with minor edits 1/8/16)**

#### *Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs.*

- This is the 25<sup>th</sup> anniversary of the Std 140 committee; PC founded in 1990.
- **Current IRS rules** (IRS notice 2008-40, published Apr 2008) relating to the deduction for energy efficient **commercial buildings** require software used for assessing tax credits be tested to Standard 140-2007. Currently **13 programs are qualified**; 8 programs qualified updated versions. (Last check 22Jun2015). **New submittals** [ron.judkoff@nrel.gov](mailto:ron.judkoff@nrel.gov)  
**Qualified programs listed at** <http://energy.gov/eere/buildings/qualified-software-calculating-commercial-building-tax-deductions>
- RESNET lists **8 (up from 6, last check 22Jun2015)** tools as either accredited for HERS ratings, tax credit compliance, IECC performance verification, or existing home tax credit compliance. Required tests include NREL's HERS BESTEST (included in Std 140-2011,-2014), along with equipment modeling and other modeling tests developed by RESNET. **New submittals to RESNET** (<http://www.resnet.us/professional/programs/software>).
- **ASHRAE 90.1 and 189.1 reference Standard 140**;
  - 90.1-2013, published Fall 2013 updated their reference to 140-2011.
- **2015 IECC cites 140-2011**; IGCC citation accords with IECC.

#### **Standard 140-2014 Continuous Maintenance Revision Published:**

- Adds ground-coupled slab analytical verification tests to 140-2011 tests.
- **SSPC 140 agreed on continuous maintenance proposal to submit to SSPC 90.1, to update their reference from "140-2011" to 140-2014". Neymark to submit asap.**

#### **Proposed Addendum A to 140-2014. (ASHRAE RP-865 Airside-Mechanical Equipment tests adaptation):**

- Test suite based on ASHRAE RP-865; first 140 suite based on ASHRAE research.
- Airside analysis of Fan Coil (FC), Single Zone (SZ), Constant Volume (CV), and Variable Air Volume (VAV) systems.
  - These are steady-state analytical verification tests.
  - Provides basis for future Volume 2 test suite with hourly varying weather, and other steps toward testing performance in more realistic (less idealized/in-depth-diagnostic) context.
- Robust participation: 7 simulation trial participants from 4 countries + Quasi-Analytical Solution by NREL.
- Planning for NREL final report during late2015/early2016.
- Standard 140 adaptation during 2016.

**Building Thermal Fabric Tests Update (140, Section 5.2)**

- **Address advances in modeling state of the art since 1995**
- Iterate on spec revisions and simulation trials, with draft NREL final report including updated spec and example results.
- **Consideration of revisions to existing test cases and inclusion of additional excursion (parametric sensitivity) test cases continues in collaboration with SSPC 140.** Test case revisions must be compatible with current parsimonious framework of the test cases.
- Consider including version of the spec in OpenStudio ([gbXML](#) compatible) format for automated input.

**Test suite progress:**

- First round simulation trial
  - Updated test spec distributed July 22, 2014.
  - Results received Sep – Nov, 2014; compile by NREL Jan 2015
    - **7 participants from 7 countries**
    - Good/constructive comments on spec.
- 2<sup>nd</sup> round simulation trial revisions
  - 17 topical revisions, to address comments from January
    - Some work remains.
  - Working Group (software developers) addressing first round results disagreements
  - Add extension cases as time allows; extension cases can be completed during additional rounds.
    - Window excursion cases for other glass types, and including window frames.
    - Weather driven infiltration cases – keep constant infiltration rate cases in base case to reduce noise.

**Next steps:**

- Continue topical revisions
  - Equivalent constant surface coefficients for programs that do not automatically calculate convective and/or radiative surface heat transfer.
  - A couple others remain.

**Empirical Validation:** SSPC 140 is interested in including empirical validation test suites IF they are worthy (high quality experimental data, with well vetted test specifications). On this topic we heard presentations from”

- R. Judkoff of NREL re forthcoming DOE sponsored data sets
- T. Hong on IEA BCS Annex 58
- J. New on ORNL.

**References to Standard 140.** Standard 140 is referenced by:

- IRS, Standard 90.1
- Standard 189 (High Performance Green Building Design) Appendix D
- IECC, IGCC
- The newly developing [COMNet](#) (BPI, Energy Foundation et al) User's Manual.
- Implicitly referenced for ASHRAE Building Energy Quotient IF that is based on the [COMNet](#) User's Manual;
- RESNET references Section 7 tests (adapted from HERS BESTEST 1995).
- Florida Building Commission
- Various international references.

**Full SSPC 140 meeting notes are available from the Chair on request.**

6.4.4.2 SSPC 189.1 at the ASHRAE Summer Conference in Atlanta, Georgia, June 30 and July 1, 2015

The following paragraphs track the changes and discussion in the ASHRAE 189.1 Standard at the ASHRAE summer conference in Atlanta, Georgia in 2015.

**ASHRAE/USGBC/IES SSPC 189.1  
Standard for High-Performance Green Buildings Except Low-Rise Residential Buildings  
June 30 and July 1, 2015 Annual Meeting, Atlanta GA  
6/30/2015 (7:30 a.m. to 9:30 a.m.) Atlanta Hilton, Crystal Ballroom CD (1)**

**A G E N D A**

**1. Call to order**

**2. Logistics – Staff**

- Bias/conflict announcement
- Voting members (Alevantis, Boldt, Conrad, Contoyannis, Crawley, Cross, Dolin, Eley, Floyd, Francis Gitlin, Gress, Horn, Hubbard, Jacobs, Jouaneh, Lawrence, Leslie, Lord, McBride, McGuire, McHugh, Pape, Persily, Rainey, Rosenstock, Ross-Bain, Schoen, Setty, Stoppelmoor, Sullens, Taber, VanGeem, Williams, Whittet, Zhang)
- Guest Introductions

**3. Review agenda – Persily**

- Andy Persily reminded the committee to respond to an upcoming offer to have a presidential thank you letter to be sent to their employers.
- ICC has provided Andy Persily with their own comparison of IgCC and 189.1. This was sent out to working group leaders and will be send to the full SSPC.
- Update on 189.3
  - The committee is preparing an ISC to address comments received from the 1<sup>st</sup> public review.

**4. Review of Action Items – Persily**

**5. Chair’s Report**

**6. Approval of Meeting Minutes**

- PC meeting of 5/26/2015
  - **Motion 1** was made by Josh Jacobs and seconded by Dan Whittet to approve the 5/26/2015 minutes. The motion was approved by hand vote (23-0-1) with the Chair abstaining.
  - There was no discussion

**7. Users Manual update – Eley**

- Comments on the 95 % draft of Section 7 are due this Friday and Section 6 comments are due July 13<sup>th</sup>.
- The contractor is planning to submit the User’s Manual to the full committee for approval at the October meeting.

**8. Membership update – Persily reporting for Schoen**

- The recommendations were submitted and must still be approved by all 4 co-sponsors.

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

**10. CMP status (submission date)**

- 15-12-0002/001, Gerry Coons (Turfgrass in section 6.3.1.1.1) assigned to WG 6 (2/215)
- 14-12-0002/001, Wagdy Anis, (Commissioning Reference) assigned to WG 10 (6/5/14)

**11. Addenda Status Update**

- Addendum c being prepared for ASHRAE BOD to approve for publication
- Addendum d, e, f and g sent to co-sponsors and ASHRAE StdC for PR approval
- Addendum ce, b, and by ready for ASHRAE BOD to approve for publication
- SSPC vote on addendum h for public review failed.

**12. Working Group Plans for today's WG meetings**

- **WG 5**
  - The Working Group has identified some areas (sidewalks and green roofs) that could be aligned better with the IgCC.
- **WG6**
  - The Working Group is currently discussing irrigation, dual plumbing and submetering.
- **WG7**
  - The Working Group is currently discussing an addendum that aligns the envelope requirements with the requirements in the IgCC.
  - Response to public review comment on addendum a (outdoor DCV sensor placement)
    - Brief overview was provided by Tom Lawrence and Martha VanGeem
    - **Motion 2** was made by Martha VanGeem and seconded by Tom Lawrence to approve the response as shown on 6/30/2015 to the public review comment made on addendum a. The motion was approved by hand vote (23-0-1) with chair abstaining.
      - o There was no discussion
- **WG8**
  - The Working Group is currently discussing an acoustics and occupant surveys.
  - The Working Group is also discussing daylighting and glare control.
- **WG9**
  - The Working Group is currently discussing the User's Manual.
  - The Working Group will be looking further at the IgCC/189.1 comparison.
- **WG10**
  - The Working Group is currently discussing some lingering addenda.
  - Wes Sullens will be taking over the leadership of WG 10 at this meeting.

**13. AIA/ASHRAE/ICC/IES/USGBC alignment:**

- Presentation by Steering committee chair followed by Q&A with committee
- Some points raised during discussion:
  - How will this merger going play out with respect to the Green Building Council of Canada?
  - ICC will have editorial rights with ICC staff being the primary editors. The editorial changes would primarily involve adding informative references to the I-Codes.

- Will the project and jurisdictional electives go away?
  - The Steering Committee is expected to remain in place until the consolidation is complete.
  - Will the final document be available for approval during the code hearings? No, but the administrative procedures will be approved. What if they are rejected by the members? That decision ultimately resides with the ICC Board of Directors.
  - The administrative provisions will be moved from Code C Cycle to the Code B Cycle.
  - Will mid cycle addenda be automatically included with the IgCC?
  - Obtaining a Silver rating in the ICC 700 will allow compliance with 189.1. Would this be considered a normative change to the IgCC?
- The chair took an action item to request additional questions from the SSPC.

**7/1/2015 (8:00 a.m. to Noon) Atlanta Hilton, Rooms 303/304**

**14. Call to order**

**15. Logistics – Staff**

- Bias/conflict/sign-in
- Bias/conflict announcement
- Voting members (Alevantis, Boldt, Conrad, Contoyannis, Crawley, Cross, Dolin, Eley, Floyd, Francis, Gitlin, Gress, Horn, Hubbard, Jacobs, Jouaneh, Lawrence, Leslie, Lord, McBride, McGuire, McHugh, Pape, Persily, Rainey, Rosenstock, Ross-Bain, Schoen, Setty, Stoppelmoor, Sullens, Taber, VanGeem, Williams, Whittet, Zhang)
- Guest Introductions

**16. 2017 Workplan**

- The draft workplan was discussed and edited.

**17. Revised TPS (Addendum WG00DA01)**

- Purpose discussion
  - Including the term “minimum” was debated.
    - Proponents stated that establishing minimum requirements are the reason for standards
    - Others felt that the standard has minimum and maximum requirements.
    - Andy proposed to put some wording in the Foreword to explain why the word minimum is used.
- Scope discussion
  - There was discussion about including “building projects” as opposed to just including “building”
- Additional changes were discussed, which will be reflected in the next draft

**18. Working Group Reports**

- **WG 5**
  - WG05DA1 (walkways and bike paths)
    - o Brief overview was provided by Anthony Floyd

o **Motion 6** was made by Gregg Gress and seconded by Anthony Floyd to recommend approval of addendum i (WG05DA01 – walkways and bike paths) for publication public review as shown on 7/1/2015.

- Opinions expressed during discussion
  - Care needs to be taken when enforcing something outside the property.
  - The intent was to require a sidewalk along the property road frontage.
  - This requirement would require sidewalks to nowhere in certain circumstances. This was the working group’s intent. Eventually development would catch up but you have to start building sidewalks somewhere.
  - The previous language could require a 5 mile sidewalk, where the new language doesn’t.

• **Motion 7** made by Josh Jacobs and seconded by Jon McHugh to withdraw motion 6. The consent was unanimous.

- There was no discussion

• **WG05DA2 (vegetated roofs)**

o Brief overview was provided by Anthony Floyd

o **Motion 8** was made by Gregg Gress and seconded by Susan Gitlin to recommend approval of addendum i (WG05DA02 – vegetated roofs) for publication public review as shown on 7/1/2015. The motion stands by roll call vote (24-0-2), pending the completion of a continuation letter ballot, with the chair abstaining.

- Opinions expressed during discussion
  - Vegetated roofs can use a lot of water.
  - Reclaimed water is required for irrigation.
  - This addendum was a result of the attempt to align 189.1 with the IgCC.

• **Outstanding addenda:**

o Addendum bg (landscapes)

• **WG 6**

• **Update on activities**

o The reclaimed water proposal was shown on the screen. The working group is seeking some feedback from the committee.

- There was some desire to expand the proposal to include other sources of water.
- Signage is already required by the plumbing code.
- There are some jurisdictions that do not allow the use of reclaimed water.
- There may need to be some climate zone and building type exemptions.
- It is cost prohibitive to put this pipe in after the building is constructed.

o This draft will circulate to the SSPC for comment.

• **WG 7**

• **Outstanding addenda:**

o Addendum a (outdoor DCV sensor placement)

o Addendum bl (refrigeration equipment efficiencies)

• **Update on activities** o Working Group 7 is working on reference updates and will be soliciting feedback from the other working groups shortly.



• **WG 7.5**

- Update on activities
  - o Demand response is an ongoing issue in the working group.
  - o The working group has a new proposal that allows for a 3<sup>rd</sup> compliance path.

• **WG 8**

- Outstanding addenda: be (unvented combustion devices)
  - o Postponed debate and discussion on “be” because of experts being absent from meeting.
- Update on activities
  - Currently working on an acoustic addendum and an occupant survey. The occupant survey draft will be sent to working group 10.

• **WG 9**

- Update on activities
  - o The group is currently working on LCA’s and will be looking at some ASTM standards.
  - o Will the compliance forms be available on the website?

• **WG 10**

- Anis CMP on envelope commissioning
  - o Brief Overview provided by Jeff Ross-Bain
  - o **Motion 3** made by Jeff Ross-Bain and seconded by John Cross to approve the response to CMP 189.1-14-12-0002/001 as shown on 7/1/2015. The motion was approved by hand vote (26-0-1) with the chair abstaining.
    - There was no discussion
- Outstanding addenda:
  - o Addendum p (remove acceptance testing)
    - o Brief overview was provided by Jeff Ross-Bain
    - o **Motion 4** was made by Jeff Ross-Bain and seconded by Tom Lawrence to recommend discontinuance addendum p. The motion stands (23-0-3) with the chair abstaining pending the outcome of a continuation letter ballot.
      - There was no discussion
  - o Addendum ai (controls in commissioning)
  - o Brief overview was provided by Jeff Ross-Bain
    - o **Motion 5** was made by Jeff Ross-Bain and seconded by Dan Whittet to recommend discontinuance addendum ai. The motion stands (26-0-1) with the chair abstaining pending the outcome of a continuation letter ballot.
      - There was no discussion

**19. New Business**

**20. Future Meetings • Scheduled web meetings:**

- July 28, August 25, October 9 (replacing September 29 meeting)

## **21. Adjournment**

### **Action Items**

#### **6/30/2015 & 7/1/2015**

1. Committee to provide feedback to Tom Pape on the reclaimed water proposal.
2. Bert Etheredge to discuss the possibility of adding 189.1 compliance forms to the ASHRAE website in addition to including them in the user's manual with Steve Comstock.

#### **5/26/15**

1. All: Send comments on draft Workplan to Chair by June 5. COMPLETE

#### **4/28/15**

1. Persily to look at rescheduling the September 29<sup>th</sup> call due to ICC meetings.

6.4.4.5 Historical Committee at ASHRAE Summer Conference in Atlanta, Georgia, June 30 and July 1, 2015



**HISTORICAL COMMITTEE**  
Minutes  
Sunday, June 28, 2015  
ASHRAE Annual Conference Atlanta

**Call to Order:**

Chair Dr. Arnold called the meeting to order, 8:31 am

**Introduction of Members and Visitors:**

**Voting Members present:**

David Arnold, Chair  
Ron Vallort, Vice Chair  
John Clark  
Jeff Haberl

Randy Schrecengost

**Voting members Not Present:**

Kent Anderson

**Region Historians Present**

Pam Immekus, Region IV  
Bruce Flaniken, Region VIII  
Gary E Grange, Region IX  
Clayton A Lampman, Region X

**Guests – Incoming committee, Bod Ex-Officio,**

**Coordinating Officer:**

**BOD Ex-Officio:** William McQuade

**Coordinating Officer:** Chuck Gullledge

**Incoming Committee:** Oswaldo Bueno; Prof.

Essam Eldin Khalil;

**YEA Leadership U:** Lindsey King; Mitesh Kumar

**Visitors:** Amanda Webb; visitor from RAL; Norm

Grusnick; Darryl Boyce; Livio di Santol; Luca

Pitera; Jojo Castro

**Staff present:**

Steve Comstock

Emily Sigman, Staff liaison

**Consultant:**

Bern Nagengast, Consultant

**BOD Ex-Officio:** Dennis Wessel

**Coordinating Officer:** Darryl Boyce

### Review of Agenda

The agenda was reviewed and accepted.

### Approval of Minutes

Mrs. Sigman sent the draft minutes of the Historical Committee's Chicago meeting to the committee for review.

**Motion 1:** It was moved that the minutes of the meeting of January 25, 2015 in Chicago be approved.

Dr. Arnold proposed the motion, Mr. Clark seconded it. Approval of minutes passed unanimously.

### Subcommittee reports

#### **Administration Subcommittee Report:**

**Chair:** Ron Vallort

Mr. Vallort announced the chairs and members of the Historical Committee subcommittees for the coming year. **Attachment A.**

#### **Archives Subcommittee Report:**

**Chair:** Randy Schrecengost

Mr. Schrecengost discussed the proposed rule of the board to establish a policy for Chapter and Regional Historians and other interested parties for the purpose of determining what documents, records and physical items to keep and what to discard. Discussion of the state of the art facility in Texas and the feasibility of using it took place. Pros include the ability to preserve and still provide access to documents. Cons include yielding ownership of items permanently, including any say so regarding their disposal by state of Texas. **Attachment B**

Dr. Arnold summed up the needs as: 1. What will we keep? 2. Where would we keep it? 3. What would it cost?

Dr. Haberl added: 4. ASHRAE should scan documents.

Mr Schrecengost stated we would need some sort of storage, servers, CDs, DVDs, the cloud. In order to access scanned documents we would need a database or some method to access scanned data.

Mr. Schrecengost added that some Region Historians have a vast amount of materials, both scanned and physical. The discussion segued into RVC activities. The draft guidelines incorporate guides, suggestions for storage, etc. The RVCs can provide assistance and guidance to Regions. Region Historians need to have policies/steps/guidelines to know which items to keep and how to preserve and store them.

Since the Texas offer was not well-received, the following action item was created.

**Action item:** Mr. Flaniken to create a statement of method to supplement the draft RVC Guidelines.

#### **Awards Subcommittee Report:**

**Chair:** David Arnold

Dr. Arnold made a commitment to be sure one of the nominations for the Lou Flagg Award is voted on and submitted by the deadline next year (Sunday of the Winter Conference).

Mr. Nagengast listed the general requirements for both Pioneers of Industry and Hall of Fame Awards. In both cases the person must be deceased. The Pioneer of Industry nominees are not required to have been a member of an ASHRAE or predecessor society, but nominations for Hall of Fame must have be for individuals who were an ASHRAE or predecessor society member. In both cases there is a December deadline for the nomination.

Nominations can be made by Region Historians and Chapter Historians. It would be good to remind them of that. It was suggested that Historical Committee officially put in a nomination. There can be two awards made each year for Pioneers of Industry and one award for Hall of Fame.

**Action item:** Mr. Nagengast to submit Frederick Wittenmeier for Pioneer of Industry.

#### **Communications Subcommittee**

**Chair:** Bern Nagengast

Mr. Nagengast publishes the Historical newsletter two-three times a year. He has made the request for readers to respond to these questions:

...what are the most important advancements? The subcommittee would like your suggestions.  
What has impacted our technology that resulted in a changed direction in that technology?  
Although the period covered is the last 125 years, we are particularly interested in the period after the 1930's.

To date, Mr. Nagengast has only received five responses.

Work will continue to decide on how broad or narrow the specific topic(s), what format to use, who will actually create. The suggestion was made to contact the heads of TCs.

**Action item:** Mr. Nagengast to write letter to all TC chairs seeking topics of interest for the 125<sup>th</sup> anniversary.

Discussion arose regarding the use of electronic communication to allow Region Historians and others to participate in Historical Committee meetings via an online connection of some kind. It was pointed out that the use of wi-fi in a hotel can be expensive and response time can be degraded depending on volume of traffic. E&P (Electronic & Present) meetings are possible and the responsibility for them falls under Tech Council. Go to meeting was mentioned as perhaps the best option for right now. This topic was continued.

Mr. Bueno mentioned that Region XII now allowed for electronic meetings and had used Skype to successfully allow a member to join in electronically.

#### **Leadership Recall Subcommittee**

**Chair:** Kent Anderson

During the 2015 Atlanta Conference, Leadership Recall interviews were conducted with both Bill Bahnfleth and Ron Jarnagin. Ron Vallort interviewed Dr. Bahnfleth and Pam Immekus interviewed Mr. Jarnagin. These interviews will be posted on the ASHRAE website, since they have been completed.

Mr. Bueno mentioned that the Brasil Chapter had conducted four leadership interviews.

Action Item: Mr. Bueno is to provide an example of ABRAVA leadership interview article. **Attachment C** (Brasil-Leadership-Interviews.pdf).

Dr. Haberl suggested that the committee draft a list of about 10 potential interviewees.

Action Item: Mrs. Sigman to locate a list that was proposed during a recent meeting of the committee. **Attachment D.**

Mr. Nagengast commented on just how important it is to interview people important to both ASHRAE and the industry before they are gone. Transcribing interviews is also important to make sense of any segments that might not have recorded clearly. The suggestion was made that encouraging YEA members to conduct interviews would be one way not only to involve younger members but also to inspire their interest in Society and industry history.

Mr Bueno mentioned that the ABRAVA society journal (Brasil) has published several interviews of a similar nature. **Attachment C**

Mr. Boyce thanked the committee for their efforts to preserve the past so that those in the future can learn from it.

#### **125<sup>th</sup> Anniversary Subcommittee**

**Chair: Jeff Haberl**

The efforts of this subcommittee are in a holding pattern, as they work to determine the book or other kind of publication to best commemorate the anniversary. Mr. Nagengast has continued to collect ideas for potential projects. There has been some discussion about a potential book, but no one has been able to commit the time that would be required to write one. Dr Arnold reiterated that Historical Committee will focus on technical history only. Mr. Nagengast put out a call for suggestions, but to date had received only four or five. **Attachment E**

Dr. Haberl suggested a conference call among subcommittee members possibly once a month or every other month. This meeting of the subcommittee via conference call would allow them to continue to brainstorm, explore possible ideas and map out a plan of action. Some ideas floated included articles for ASHRAE Journal, possible activities and celebrations to take place during the conference(s), seminars, and conference papers.

#### **RVC Guidelines Subcommittee**

**Chair: Randy Schrecengost**

Mr. Schrecengost again mentioned the use of E&P meetings which was also covered in the Communications Subcommittee discussion. Although further discussion ensued, the committee didn't reach any specific conclusions. Mr. Schrecengost suggested the use of Go to Meetings as a possible alternative.

### PAOE

Mr. Schrecengost informed the committee that PAOE points can now be earned by YEA members. A general suggestion was made that the committee formulate ideas on how to make the history of the society and industry appeal to YEA members. Mr. Schrecengost shared that in his chapter, a couple of YEA members were tasked with condensing the monthly newsletters

YEA Leadership U participant and visitor Lindsey King stated that maintaining a balance between learning history vs. boring a young member. She said that contact with an older member or possibly a video would help to engage the person more than the written word.

Dr. Haberl reached out to a student member at his university. He asked the grad student to translate an old French publication in the HVAC&R field. The project was interesting to both student and professor. He suggested working with chapters. He mentioned that student advisors can also influence topics for projects and provide guidance.

### BOD/ExO

Outgoing BOD/ExO Mr. Wessel extended a welcome to the new members of the committee. He also thanked the current members for a job well done.

### Further Discussion on 125<sup>th</sup> Anniversary

Mr. Comstock stated two things are needed to get going on the 125<sup>th</sup>.

1. Update of Society History: The 1995 book on the history of the Society, *Proclaiming the Truth* needs to be updated – Steve will take on.
2. Update of industry history. One possibility would be to continue the series begun as 100 Best Papers from the ASHRAE Archives. Selecting papers from the last 25 years significant to industry history.

Action item: Mr. Nagengast to set up group to choose papers from last 25 years.

One option discussed was to write a smaller book on one topic rather than attempting a larger project.

Dr. Haberl spoke about simulation stating that analysis has caught up with technology; calculation methods; analysis, computer simulation.

Mr. Comstock discussed that it was important to look at history from multiple viewpoints: not just the how, but the why, reach out. What will book cover? Tag team approach? Would the person who wrote the Carrier book be interested in working with us; maybe Gail Cooper? Mr. Nagengast could set basis for



book. What is the scope? What is important? How do we create? Put together? Need good artwork. Whatever choice we make the project should be something that would appeal to the world at large. When do we celebrate? January meeting of 2020? Scope needs to be done in next few months.

Mr. Vallort asked for what the board's thoughts were.

Mr. Comstock mentioned that the Board of Directors wants to do a little more – maybe provide a road map.

Mr. Vallort reiterated the committee's need for leadership from the Board of Directors.

Dr. Haberl stated that he will work with Mr. Comstock to get calls going.

Mr. Gulledge, incoming Coordinating Officer stated that each PEC committee has an MBO to complete the 2015-16 year with a defined actionable road map for the 125<sup>th</sup> Anniversary.

### Final Discussions

Mr. Gulledge expressed his thanks to Mr. Wessel for his service as BOD Ex-O. Mr. McQuade will serve as a director and BOD Ex-O to the committee in the coming year.

Mr. Wessel expressed amazement at the conversations that took place via email regarding confusion over roster issues. He said the conversation was good, but stated that it is the prerogative of the board as to committee assignments.

Mr. Nagengast asked if there were any objection to keeping Dr. Haberl on the 125<sup>th</sup> Anniversary subcommittee. He will need to be able to commit time from his schedule.

Mr. Wessel mentioned that much was discussed at BOD level which he would be sharing with Publications/Education council.

Dr. Arnold mentioned that a section for YEA members to earn PAOE points is now included for the Historical Criteria.

Dr. Arnold initiated a wide discussion of a proposal to change the Willis Carrier Award description.

### **Attachment F.**

Mr. Nagengast stated that the Carrier Corporation is aggressive about this issue. The Historical Committee issued an official letter when Don Rich was Society president (1990-91 time frame). ASHRAE also takes issue with the statement that "Carrier is father of air conditioning".

Dr. Arnold stated the Historical Committee does not approve of the change to the carrier award description. However, he stated his belief that the age limit for nominees from the Award should be raised from 32 to 35.

Mr. Schrecengost proposed the motion that Historical Committee does not agree with the proposed change. Dr. Arnold seconded the motion.



The Motion that Historical Committee does not agree with the proposed change to the award description passed by unanimous vote.

Query: There is a lack of consistency between the age limit for the Willis Carrier Award and YEA membership. How can that issue be resolved?

Dr. Arnold plans to propose a seminar where historical buildings have been renovated according to proposed guideline GPC 34P – *Energy Guideline for Historical Buildings*. He would serve as chair for the seminar which must be proposed by August 10, 2015.

Dr. Haberl proposed a session for the Atlanta Conference. He gathered a number of authors to speak, including Jeff Spitler, Walter Grondzik, Glenn Freeman, and himself. The proposal was turned down for the Atlanta Conference.

Mr. Wessel suggest that Dr. Haberl resubmit the proposal, but to first select the best track as presentations are expected to fit within the parameters of a set of specific tracks.

Mr. Vallort stated that a number of people had volunteered to serve on the 125<sup>th</sup> Anniversary subcommittee. He is willing to accept more names for Historical Committee subcommittees. He is looking forward to Region Historians being more involved. Ms. Immekus also volunteered to serve on the 125<sup>th</sup> Anniversary subcommittee.

Mr. Vallort also mentioned that the committee will have a lot of work to do moving forward, because Dr. Arnold has set a lot of things in motion. Mr. Vallort expressed the hope that Dr. Arnold will continue to be involved with the committee and also on the subcommittee for the 125<sup>th</sup>.

The meeting adjourned at 10:45.

6.4.4.6 ASHRAE TC 4.7 Energy Calculations at ASHRAE Summer Conference in Atlanta, Georgia, June 30 and July 1, 2015

**Agenda**  
**ASHRAE TC 4.7 Energy Calculations – Main Meeting**  
**Salon C, Atlanta Hilton, Atlanta, Georgia**  
**Tuesday, June 30, 2015, 6:00-8:30 pm**

- |  |           |
|--|-----------|
| 1. Roll call and introductions (5 minutes)   | Ballbach  |
| 2. Accept agenda & approve minutes of previous meeting (10 minutes)  | Huang     |
| 3. Announcements/Liaisons (5 minutes)  | Huang     |
| 4. Membership (5 minutes)  | Huang     |
| 5. Subcommittee reports  |           |
| 5.1 Applications (10 minutes)  | Judkoff   |
| 5.2 Data-Driven Modeling (10 minutes)  | Muehlen   |
| 5.3 Simulation and Component Models (10 minutes)   | Crawley   |
| 5.4 Research (15 minutes)  | Haberl    |
| 5.4.1 Research Projects  |           |
| • 1588-RP Representative Layer-by-Layer Descriptions for Fenestration Systems with Specified Bulk Properties Such as U-factor and SHGC (co-sponsored with TC 4.5)                                  |           |
| • 1629-RP Testing and Modeling Energy Performance of Active Chilled Beam Systems (co-sponsored with TC 5.3) (completed ?)  |           |
| 5.4.2 Workstatements, RTARs, Requests for Co-sponsorship   |           |
| • 1661-RTAR Modelica Models for the Evaluation of Supervisory Control Strategies in the ASHRAE Handbook (sent back to Authors) – SCM (contact Wangda Zuo for status)                               |           |
| • 1748-RTAR Assess and Implement Natural and Hybrid Ventilation Models in Whole-building Energy Simulations (Phase 2) – SCM (Tony says he will be sending a draft this week YJH)                   |           |
| • 1686-WS Experimental Evaluation of the Thermal and Ventilation Performance of Stratified Air Distribution Systems Coupled with Passive Beams – (request for co-sponsorship by TC 5.3) (status ?) |           |
| • XXXX-RTAR Development of an Improved Inverse Model Toolkit (RP1050) and Diversity Factor Toolkit (RP1093) for Analyzing Building Energy Savings from Time Series Data.                           |           |
| • Requests for co-sponsorship  |           |
| 5.5 Handbook (10 minutes)  | Kolderup  |
| 5.6 Program (15 minutes)   | Cockerham |
| 5.7 Standards (15 minutes)   | Neymark   |
| SSPC 140 SMOT for Eval Bldg Energy Analysis Computer Programs  | Neymark   |
| SPC 205 – Std. Representation of Perf. Sim. Data for HVAC&R & Other Fac'l Equipment  | Barnaby   |
| SPC 209 Energy Simulation Aided Design   | Glazer    |
| 5.8 Web Site (5 minutes)   | New       |
| 6. Related activities reports (15 minutes)   |           |
| SPC 191 Water Conservation   |           |
| MTG.EAS Energy Eff AHU Systems   |           |
| MTG.BIM Building Information Modeling  |           |
| SGPC 20 Documenting HVAC&R Work Process and Data Exchange Requirements   |           |
| TC 2.8 Building Environmental Impacts and Sustainability   |           |
| TC 4.1 Load Calculation Data and Procedures  |           |
| TC 4.2 Climatic Information  |           |
| TC 4.3 Infiltration & Ventilation Requirements   |           |
| TC 4.5 Fenestration  |           |
| TC 6.5 Radiant Heating and Cooling   |           |
| TC 7.5 Smart Building Systems (now includes TC 7.4)  |           |
| TC 7.6 Building Energy Performance   |           |
| BuildingSMART (formerly IAI International Alliance for Interoperability)   |           |
| IBPSA: USA, Canada, World  |           |
| BPI-2400-S-2011 Standardization Qualification of Whole-house Energy Savings Est. Guideline 14  |           |
| IEA Annex 60   |           |
| IEA Annex 66   |           |
| ASHRAE Historical Committee  |           |
| 7. Old Business  | Huang     |
| 8. New business  | Huang     |
| 9. Executive Session   | Huang     |
| 10. Adjourn  | Huang     |

Note TC 4.7 Email list hosted at onebuilding.org

6.4.4.7 ASHRAE TC 4.7 Handbook Subcommittee at ASHRAE Summer Conference in Atlanta, Georgia, June 30 and July 1, 2015

**TC 4.7 Handbook Subcommittee  
Agenda  
Atlanta  
Tuesday, June 30, 2015  
5:00-6:00pm,  
Room: Salon C, Atlanta Hilton**

- 1) Introductions and Agenda Review (5 minutes)
- 2) Schedule for 2017 Fundamentals Handbook Revision
  - a. June 2015, 50% draft (not there yet)
    - September 2015 (50%)
    - December 2015 (90%)
  - b. January 2016, 95% draft to TC for review
  - c. June 2016, TC approves revised chapter (final due June 21, 2016)
  - d. Early 2017, review galley prints
  - e. June 2017, publication
- 3) Reminder of target audience description
  - a. See doc link below
- 4) Reminder of editing process
  - a. 2013 Chapter 19 doc in Dropbox folder. See link below
  - b. Use track changes to add notes and edits. Otherwise changes will not make it into the 2017 version.
  - c. Files with tracked changes may be emailed to Erik Kolderup, [erik@kolderupconsulting.com](mailto:erik@kolderupconsulting.com).
  - d. Source files and references may be uploaded to the Dropbox folder.
- 5) Review outline of proposed changes and discuss assignments for committee members.
  - a. See 2013 Outline link below for reference.
- 6) Assign action items

Resources:

- Word version of 2013 Chapter 19 for review and markup. In Dropbox folder: <https://www.dropbox.com/sh/9vuz7g99u6xyev2/Uv3Nv8LdeJ>
- Outline of Chapter 19 including proposed changes for 2017 with committee member work assignments. In Dropbox folder: <https://www.dropbox.com/sh/9vuz7g99u6xyev2/Uv3Nv8LdeJ>
- Description of target audience. Google Doc: [https://docs.google.com/document/d/174pP\\_sNvLlSMAldZTMT0Mwh9wiUibwTdl7i4EY7nBrE/edit?usp=sharing](https://docs.google.com/document/d/174pP_sNvLlSMAldZTMT0Mwh9wiUibwTdl7i4EY7nBrE/edit?usp=sharing)

6.4.4.8 ASHRAE TC 4.7 Data-Driven Modeling Subcommittee at ASHRAE Summer Conference in Atlanta, Georgia, June 30 and July 1, 2015



TC4.7 Data-Driven Models Subcommittee Monday June 29, 2015, 7:30–9:00 PM

Location: Atlanta Hilton, Crystal CD, 1<sup>st</sup> Floor

**Agenda:**

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

Attendees: Ralph Muehleisen, Jeff Haberl, Ron Judkoff, Chris Balbach, Joe Huang, Jaya Mukhopadhyay, Amir Roth, Bass Abushakra, Clinton Davis, Mitchell Paulus, Jim Spielbauer, Peter Armstrong, Peter Luttik, Anthony Fontanini, Zulfikar Sumali, Sukjoo Oh, Mini Malhotra, Kris Kinney

7:40 Discussion of Program (10 minutes)

- Summer Meeting 2015 (Atlanta) Review
- Winter Meeting 2016 (Orlando)

Tracks of interest:

- Track 6 Cutting Edge Technologies: creative ways to improve efficiencies in the effort to achieve net zero buildings
- Track 7: The Great Debate: sessions present divergent methods for accomplishing the same task

Ron Judkoff had interest in presenting Resnet/ANSI calibration validation work. Committee decided that a Calibration 2.0 session with 2 or 3 different methods of calibration, ended with Ron presenting the MOT would fit Track 7. Jaya Mukhopadhyay to chair session.

Seminar Ideas: M&V / Whole Building DDM?

- 2015 ASHRAE Energy Modeling Conference (Atlanta)  
(no program discussion – just info/announcement)
- Summer Meeting 2016 (St. Louis)

Tracks of Interest:

- Track 5: Smart Building Systems / Remote Monitoring and Diagnostics
- Track 8: Renewable Energy Systems and Net Zero Buildings

Conference Paper or Seminar Ideas

- DDM related to monitoring and diagnostics?

Chris B. Announced that deadlines for conference paper session submission for St. Louis was mid Sep. No specific session discussions for St. Louis

8:00: Work Statements / RTAR's (50 minutes)

- Existing WS and RTAR's
  - Haberl: Inverse Modeling Tool Update RTAR "Development of an Improved Inverse Model Toolkit (IMT) for Analyzing Building Energy Savings from Time Series Data" (RP 1050)

Jeff H: RTAR 1763 for 1050 (IMT) +1093 (diversity toolkit) update has gone up to RAC and returned with comments.

Jeff said there were several comments important for others considering writing an RTAR:

- statements need to be clear on deliverables for enforcing contracts
- Statement of why this is needed and different from other commercial offerings might be similar
- Question of how many users of the previous toolkit.
- How is this software going to be maintained in the future.

- Data Driven Schedules? (David Bosworth, Raloh Muehleisen)

Muehleisen said nothing has been done but he's still interested and he will follow up with D. Bosworth before next meeting and he will talk with Tienzhen Hong who has been doing related work with Annex 66  
 Amir Roth said to check with Ruchi Chaudary of U. Cambridge. Ron J. says to check also with Da Yan of Tsinghua (working on Annex 66) to see where they are before starting any work.  
 Jeff Haberl says to look at the diversity factor toolkit and planned redo thereof in RTAR to see what overlap there is with this possible research project.

- o Inverse Modeling Test Scheme / Standards? (Chris Balbach)
- o David Jump idea from NY: Develop and test a methodology to validate public domain and proprietary energy baseline modeling capabilities well as savings estimation using inverse modeling methods on whole building data. The goal is to create a **method of test of inverse models**

Joe Huang mentioned that David Jump was emailing [he](#) and Jeff Haberl about this and sent a one-pager to Jeff Hand Joe H. Jeff was helping him. Muehleisen will look over this and will follow up with Jeff J and David Jump. Muehleisen was directed to pester Jeff H. to make sure this goes somewhere

There was a fairly long discussion about the topic relating to the general idea. Discussion points included

- What sorts of data would be used?
- Could this be done with variations of the validation MOT?
- Could we do this with synthetic data done via simulation?
- Do we want to do another shootout? (Haberl says it's a \*LOT\* of work)

8:45: Handbook Contributions

- Looking for volunteers to update/review relevant sections of Fundamentals Chapter related to DDM
  - o Table 1
  - o Fundamentals 19.22-19.28
    - Add Machine learning other than ANN?
    - Add non-parametric regression techniques (Gaussian Process or Kriging models)?

Muehleisen says that DDM section is fairly long but focused on simple regression methods. This could be trimmed to expand the section to more advanced methods including new machine learning and non-parametric regression).

Bass A. is interested in being part of any revisions.

Jeff H. says current table is a mishmash, needs updating  
 Dynamic and static methods, forward and inverse are all mixed up.

TC 7.5 is not addressing MPC, should it be here? Peter Armstrong volunteers to look at this.

Muehleisen will try to coordinate efforts between DDM subcommittee and 4.7 handbook chair Kolderup.  
 Muehleisen will pester people to get stuff done related to DDM.

8:55 New Business

No New Business

9:00 Adjourn

Meeting Adjourned at 8:30

6.4.4.9 ASHRAE TC 4.7 Simulation and Component Models Subcommittee at ASHRAE Summer Conference in Atlanta, Georgia, June 30 and July 1, 2015



## Draft Agenda

### TC 4.7 Simulation and Component Models Subcommittee

6:00-7:30 pm, Monday, 29 June 2015

Crystal C/D, Lobby, Atlanta Hilton  
Atlanta, Georgia

- 
- 6:00 Call to order / introductions / changes to the agenda Crawley
- 6:10 **Research Projects**
- **1629-RP** Testing and Modeling Energy Performance of Active Chilled Beam Systems (TC 5.3 / TC 4.7)
- 6:20 **Draft Work Statements/RTARs**
- **1666-WS** Experimental Evaluation of the Thermal and Ventilation Performance of Stratified Air Distribution Systems Coupled with Passive Beams (TC 5.3 Room Air Distribution, requesting TC 4.7 co-sponsor) Bauman, Zimmerman
  - **17xx-WS** Development of Improved and Integrated Energy Modeling Software for Data Centers (TC 9.9 / SPC 90.4P / TC 4.7) Amistadi, Davidson
  - **17xx-WS** Development of a Reference Building Information Model (BIM) for Daylighting Optimization (TC 1.5 / TC 4.7) Haberl
  - **1661-WS** Development and Validation of Dynamic Models for the Evaluation of Chilled-Water Systems Control Strategies in the ASHRAE Handbook (TC 4.7/ TC 7.5 / TC 1.4) Wangda/Wetter
  - **1748-WS** Assess and Implement Natural and Hybrid Ventilation Models in Whole-Building Energy Simulations – Phase 2 (TC 4.7 / TC 4.10) Fontanini/Huang
- 6:50 **New Research Topics/Research Plan**
- New Research Topics (RTARs and WSs can be submitted 4 times a year—six weeks before Winter and Annual meetings and 1 March/1 August.)
    - Several new research topics at last meeting:
      - Research for new ground heat transfer tables in the HOF (Kruis)
      - Research for better simulations for occupants (Hong)
      - Better hygrothermal modeling for highly efficient buildings, including VOC issues, etc. Current project supported by the IEA (Rode).
      - Mixed mode / ventilation
- 7:20 **Program Ideas**
- 2016 Winter (Orlando), 2016 Annual (St. Louis), 2017 Winter (Las Vegas)
- 7:25 **New Business**
- 7:30 **Adjourn**
- 

**Next Meeting: Monday, January 25, 2016 Orlando, Florida**

6.4.4.10 ASHRAE TC 4.2 Climatic Information at ASHRAE Summer Conference in Atlanta, Georgia, June 30 and July 1, 2015

**AGENDA, ASHRAE TC 4.2 Climatic Information**

**1:00 – 3:30 PM, Tuesday, 30 June 2015**

**Room 402, 4<sup>th</sup> Floor, Atlanta Hilton, Atlanta, Georgia**

Scope: TC 4.2 is concerned with identification, analysis and tabulation of climatic data for use in analysis and design of heating, refrigeration, ventilation and air-conditioning systems. Promotion of effective use of weather information in these applications is also included.

1:00 PM	Call to order Roll call Introductions Approval of agenda Approval of minutes of Chicago meeting (January 2015) Report from the Chair/Announcements Introduction of liaisons (liaison announcements/requests)	<b>Crawley</b> <b>Baltazar</b>
1:15 PM	Membership Roster Rollovers (for July 2015)	<b>Crawley</b>
1:20 PM	Review of Action Items and Status	<b>Baltazar</b>
1:35 PM	Research Reports on status of current, future and completed research projects: 1561-RP, Procedures to Adjust Observed Climatic Data for Regional or Microclimate Variations 1699-RP, Update Climatic Design Data in Chapter 14 of the 2017 Handbook - Fundamentals Other potential research projects Long-term research plan	<b>Cornick</b>
2:15 PM	Handbook 1699-RP Update of Climatic Data for 2017 Handbook - Fundamentals Revisions and errata	<b>Thevenard</b>
2:30 PM	Program Atlanta, June 27-July 1, 2015 Orlando, January 23-27, 2016 Future conferences	<b>Huang</b>
2:45 PM	Standards Report SSPC 169 Climatic Data for Building Design Standards	<b>Crawley</b>
3:00 PM	Old business NASA/MERRA Validation	<b>Crawley</b> <b>Westberg</b>
3:10 PM	New business	
3:30 PM	Adjournment	

**Next Meeting: Orlando, Florida, Tuesday 26 January 2016**

## 6.4.5 Other Meetings

### 6.4.5.1 North Central Texas Council Government (NCTCG) Meetings from 2015.

The following pages are meeting notes, agendas, and summaries from the NCTCG meetings from 2015.



North Central Texas Council of Governments

## SUMMARY

### Regional Codes Coordinating Committee

Tuesday, January 13, 2015

9:00 AM, William J. Pitstick Executive Board Room

NCTCOG Offices, CPII

616 Six Flags Drive, Arlington, Texas 76011

Chair: David Kerr, City of Plano  
Vice Chair: Paul Ward, City of Southlake

#### 1. Welcome and Introductions.

The Chair welcomed the attending members, alternates, and guests.

#### ACTION/PRESENTATION/DISCUSSION ITEMS

2. **October 14, 2014 Meeting Summary.** The October 14, 2014 draft meeting summary is available online for your review and consideration.

Larry Bartlett made a motion to approve the October 14, 2014 meeting summary. Carroll Pruitt seconded the motion. The Regional Codes Coordinating Committee (RCCC) was unanimous in its approval.

3. **Approval will be sought for Appointment of Advisory Board Members.** The Fire Advisory Board Chair, Bob Morgan, and the Energy and Green Advisory Board Chair, Ed Dryden, will seek appointment of advisory board members for vacant advisory board seats.

Carroll Pruitt, at the request of Bob Morgan, asked the RCCC to approve the following people for service on the Fire Advisory Board:

Morkita Anthony, City of Arlington  
Tony Aspden, City of Plano  
Kelly Clements, City of Southlake  
Dwight Freeman, City of Dallas

Dwayne Henderson, City of McKinney  
David Lehde, Home Builders Association of  
Greater Dallas  
Scott Tittle, City of Carrollton

The RCCC was unanimous in its approval.

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



Ed Dryden requested that the RCCC approve Eddie Wilson, City of Colleyville, and Suzanne Arnold, City of Garland, for service on the Energy and Green Advisory Board. The RCCC was unanimous in its approval.

- 4. North Central Texas Council of Governments Regional Model Construction Code Survey.** The North Central Texas Council of Governments (NCTCOG) staff will review the Regional Model Construction Code Survey results and seek direction from the Regional Codes Coordinating Committee (RCCC).

Due to the low response return of 28 on the initial survey request, the NCTCOG staff will send out a second email and hardcopy mailing, requesting responses no later than Friday, February 6, 2015.

#### INFORMATION ITEMS

- 5. Updates on Progress made by Advisory Board Task Groups.** Each advisory board chair will share information regarding the progress made by their task groups.

Building and Residential Advisory Board (BRAB): Selso Mata reported that the five working groups are on schedule with their respective sections and should have their tasks completed by June 2015. The Existing Codes Working Group will need a consulting meeting with the BRAB, the Fire Advisory Board (FAB), the Electrical Advisory Board (EAB), and the Plumbing and Mechanical Advisory Board (PMAB) to insure that any new code amendments do not conflict.

FAB: Carroll Pruitt reported that FAB is on schedule and will meet its deadline.

PMAB: Gilbert Urvina reported that PMAB is on target and will have their tasks completed by April 2015.

Energy and Green Advisory Board (EGAB): It was noted that the Energy Code must be reviewed by June 2015. The RCCC requested that the EGAB cease its review process of the Green Code in order to begin reviewing the Energy Code and complete it in a timely manner.

- 6. State Energy Conservation Office (SECO) HVAC Loan Announcement.** SECO has announced the "Notice of Loan Fund Availability (NOLFA) – Small School District HVAC Loan Program." The Application deadline is February 9, 2015, 2 p.m. CT. Application information can be found at the following SECO website:  
<http://seco.cpa.state.tx.us/funding/nolfa/121914/>

Bahman Yazdani gave a brief overview of the history of SECO funding for this program. The application deadline is February 9, 2015.

#### OTHER BUSINESS AND ROUNDTABLE DISCUSSION

- 7. Future Agenda Items.**

There were no future agenda items.

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

It was noted that Selso Mata was awarded Building Official of the Year by the Building Officials Association of Texas.

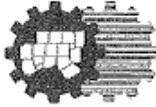
There was discussion on whether the seismic activity in Irving would impact any of the building codes. The issue will be discussed at a Construction Research Center meeting in March 2015. The Cities of Dallas and Irving may set up a task force. However, it was doubted that the small earthquakes would require any changes to the building codes.

- 9. Schedule for the Next RCCC Meeting.** The next RCCC meeting has been scheduled as follows:

Regional Codes Coordinating Committee Meetings	
Tuesday, April 14, 2015, at 9 a.m.	William J. Pitstick Executive Board Room, NCTCOG Offices, CPII
Tuesday, June 9, 2015, at 9 a.m.	William J. Pitstick Executive Board Room, NCTCOG Offices, CPII

- 10. Adjournment.**

The meeting was adjourned at 10:15 a.m.



North Central Texas Council of Governments

# AGENDA

## Energy and Green Advisory Board

Thursday, January 15, 2015

9:00 AM -11:30 AM

William J. Pitstick Executive Board Room (CPII), NCTCOG Offices  
616 Six Flags Drive, Arlington, Texas 76011

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

### 1. Welcome and Introductions.

## DISCUSSION

**Continuation of Recommended Regional Amendments of the 2012 Edition of the International Green Construction Code (IgCC).**

**Review remaining sections of Chapter 7.**

- Chapter 7 Water Resource Conservation Quality and Efficiency  
Section 702.7 Municipal Reclaimed Water.

## OTHER BUSINESS AND ROUNDTABLE DISCUSSION

- Future Agenda Items.** EGAB Members and NCTCOG staff may suggest future agenda items.
- Roundtable Topics/Other Business.** EGAB members and NCTCOG staff may share additional items of interest as time allows.
- Schedule for the Next EGAB Meeting.** The next EGAB meeting has been scheduled as follows:

Energy and Green Advisory Board Meeting Dates	
Thursday, January 15, 2015 @ 9:00 am	William J. Pitstick Executive Board Room (CPII)
Thursday, February 19, 2015 @ 9:00 am	William J. Pitstick Executive Board Room (CPII)
Thursday, March 19, 2015 @ 9:00 am	William J. Pitstick Executive Board Room (CPII)
Thursday, April 16, 2015 @ 9:00 am	William J. Pitstick Executive Board Room (CPII)
Thursday, May 28, 2015 @ 9:00 am	William J. Pitstick Executive Board Room (CPII)

### 5. Adjournment.

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



**Regional Codes Coordinating Committee**  
9 a.m., Tuesday, January 13, 2015  
William J. Pitstick Executive Board Room

**MEMBER SIGN IN SHEET**

<b>NAME</b>	<b>SIGNATURE</b>	<b>ORGANIZATION</b>
Judy Armstrong		Ellis County
Larry Bartlett		TDIndustries
Joe Bass		Hillwood
Jack Baxley		TEXO
Steve Covington		City of Frisco
Jack Craycroft		Craycroft McElroy Hendryx
Phil Crone		Home Builders Association of Great Dallas
Ed Dryden		City of Dallas
Stan Folsom		EECCO
Tommy Ford		Tommy Ford Construction Company
Allison Gray		City of Fort Worth
Danny Hartz		Town of Flower Mound
Gary Jones		G.W. Jones Consulting
David Kerr		City of Plano
Selso Mata		City of Plano
Gary Miller		City of Irving
Bob Morgan		City of Fort Worth
Ted Padgett, Jr.		City of Dallas
Carroll Pruitt		Pruitt Consulting
Rick Ripley		City of Arlington
Keith Smith		City of Mesquite
Jack Thompson		City of DeSoto
Gilbert Urvina		City of Frisco
Paul D. Ward		City of Southlake
Scott Williams		City of Grapevine
Richard Wright		City of Mansfield
Bahman Yazdani		Texas A&M Energy Systems Laboratory





North Central Texas Council of Governments

# AGENDA *(Summary)*

## Energy and Green Advisory Board

Thursday, February 19, 2015

9 AM, William J. Pitstick Executive Board Room

NCTCOG Offices, CP11

616 Six Flags Drive, Arlington, Texas 76011

Chair: Ed Dryden, City of Dallas

Vice Chair: Evan Roberts, City of Fort Worth

### 1. Welcome and Introductions.

### ACTION/PRESENTATION/DISCUSSION ITEMS

### 2. Begin Review of the 2015 Edition of the International Energy Conservation Code.

EGAB review and motions regarding the Energy Systems Lab review of Chapter 11, 2015 IRC & 2015 IECC during July 4-August 4, 2014 Period.

### ATTACHEMENT C

#### TAB C-1

- o R402.4.1.2 Testing (Mandatory)  
Remove the word "Mandatory" to make identical to 2012 Amendments.  
1<sup>st</sup> Motion: David Lehde  
2<sup>nd</sup> Motion: Stan Folsom  
Opposition: None

#### TAB C-2

- o R102.1.1 Above Code Programs  
Not to accept this amendment.  
1<sup>st</sup> Motion: Stan Folsom  
2<sup>nd</sup> Motion: Stan Covington  
Opposition: David Lehde

#### TAB C-3

- o 402.3.3 Glazed Fenestration SHGC Exception  
Replace the table with table with ASHARE Table 5.5.4.4.1 and determine section numbering.  
1<sup>st</sup> Motion: Bahman Yazdani  
2<sup>nd</sup> Motion: Izzy Rivera  
Opposition: None

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**TAB C-4**

- o R402.4 Multi Family Air Leakage Testing – Discussion but no action  
IECC Table R402.1.1 and Table R402.1.3 – carry forward the  
2012 amendments to the 2015

Parking lot items to be considered at subsequent meetings:

- o Universal form for demonstrating compliance
- o Universal form for door blower and duct blaster testing reporting
- o Energy Star sampling discussion

**OTHER BUSINESS AND ROUNDTABLE DISCUSSION**

3. **Future Agenda Items.** Members of the Energy and Green Advisory Board (EGAB) and North Central Texas Council of Governments (NCTCOG) staff may suggest future agenda items.
4. **Roundtable Topics/Other Business.** EGAB members and NCTCOG staff may share additional items of interest as time allows.
5. **Schedule for the Next EGAB Meeting.** The next EGAB meetings have been scheduled as follows, on Thursdays, from 9:00 AM to 12:00 PM:

**William J. Pitstick Executive Board Room, NCTCOG Offices, CPII:**

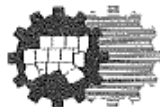
February 19, 2015, March 19, 2015, April 16, 2015, May 28, 2015, June 18, 2015, and  
August 20, 2015.

**Regional Forum Room, NCTCOG Offices, CPII: July 16, 2015**

6. **Adjournment.**

If you have any questions regarding the meeting or agenda items, please contact Sandra Barba at (817) 608-2368 or [sbarba@nctcog.org](mailto:sbarba@nctcog.org).

If you plan to attend this public meeting and you have a disability that requires special arrangements at the meeting, please contact Sandra Barba by phone at (817) 608-2368 or by email at [sbarba@nctcog.org](mailto:sbarba@nctcog.org), 72 hours in advance of the meeting. Reasonable accommodations will be made to assist your needs.



North Central Texas Council of Governments

# AGENDA (Summary)

## Energy and Green Advisory Board

Thursday, March 19, 2015

9:00 AM – 12:00 PM William J. Pitstick Executive Board Room

NCTCOG Offices, CPII

616 Six Flags Drive, Arlington, Texas 76011

Chair: Ed Dryden, City of Dallas

Vice Chair: Evan Roberts, City of Fort Worth

### 1. Welcome and Introductions.

## PRESENTATION/DISCUSSION/ACTION ITEMS

- 2. **Presentation by Mr. Norm Alston, Principal, LEED AP of Norman Alston Architects.** Mr. Alston will address the Energy and Green Advisory Board on the 2015 IECC Sections R501.6 and C501.6- Historic Buildings.

Mr. Alston shared information regarding Historic Buildings and answered a few questions.

- 3. **Continuation of Group Review.** EBAG will continue its review of the 2015 Edition of the International Energy Conservation Codes.

#### Section CE501.6 and RE501.6 Historic Buildings

Motion to Drop Amendment 1<sup>st</sup>: Christine Herbert 2<sup>nd</sup>: Stan Folsom Opposition: None

#### Section: C202 and R202 DEFINITIONS

Motion to Drop "Glazing Area" 1<sup>st</sup>: Danny Hartz 2<sup>nd</sup>: Evan Roberts Opposition: None

Motion Passed

Motion to Add "Projection Factor" 1<sup>st</sup>: Izzy Rivera 2<sup>nd</sup>: Christine Herbert Opposition: None

Motion Passed

Motion to Add "Glazing, Dynamic" to R202 1<sup>st</sup>: Shirley Ellis 2<sup>nd</sup>: Jason Vandever Opposition: None

Motion Passed

#### TABLE R402.1.2 and Table R402.1.4

Motion to Continue the R13 and U-factor 0.082 Amendment

1<sup>st</sup>: David Ledhe 2<sup>nd</sup>: Stan Folsom Opposition: 4 In Favor: 9

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**R402.2.2 Ceilings without attic spaces.**

Motion to drop the amendment      1<sup>st</sup>: Stan Folsom      2<sup>nd</sup>: Izzy Rivera      Opposition: None  
Motion passed

**R402.3.2 Glazed Fenestration SHGC**

Motion to add a paragraph and table from 90.1 following the exception  
1<sup>st</sup>: Evan Roberts      2<sup>nd</sup>: Stan Folsom      Opposition: None  
Motion Passed

**R402.4.1.2 Testing.** The previous code cycle's amendment to change the minimum air changes from 3 ACH to 5 ACH did not receive any motions. The amendment will carry forward to the 2015 code cycle.

**R402.4.1.2 Testing.** This was a very involved discussion regarding the added paragraph from the 2012 package. There was a motion to delete the amended language that died of a second. There was a second motion to delete the amendment that failed by vote. The third motion and second came with a friendly amendment and second to add a last paragraph to read as follows:

Mandatory testing shall only be performed by individuals that are certified to perform air infiltration testing certified by national or state organizations as approved by the building official. The certified individuals must be an independent third-party entity, and may not be employed; or have any financial interest in the company that constructs the structure.

1<sup>st</sup>: Christine Herbert      2<sup>nd</sup>: Shirley Ellis      Friendly amendment by CT Lloyd      Opposition: None  
Motion Passed

**R403.3.3 Duct Testing (Mandatory)**

Motion to keep as amended, using same/similar language as R402.4.1.2. by adding a last paragraph to read as follows:

Mandatory testing shall only be performed by individuals that are certified to perform duct testing leakage testing certified by national or state organizations as approved by the building official. The certified individuals must be an independent third-party entity, and may not be employed; or have any financial interest in the company that constructs the structure.

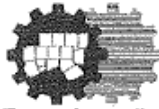
1<sup>st</sup>: Shirley Ellis      2<sup>nd</sup>: Stan Folsom      Opposition: None  
Motion Passed

**R403.3.5 Building Cavities (Mandatory) Motion to drop the local amendment**

1<sup>st</sup>: Jason Vandever      2<sup>nd</sup>: Stan Folsom      Opposition: None  
Motion Passed

**OTHER BUSINESS AND ROUNDTABLE DISCUSSION**

4. **Future Agenda Items.** Members of the Energy and Green Advisory Board (EGAB) and North Central Texas Council of Governments (NCTCOG) staff may suggest future agenda items.
5. **Roundtable Topics/Other Business.** EGAB members and NCTCOG staff may share additional items of interest as time allows.



**North Central Texas Council of Governments**

6. **Schedule for the Next EGAB Meeting.** The next EGAB meetings have been scheduled as follows, on Thursdays, from 9:00 AM to 12:00 PM:

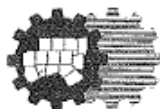
- **William J. Pitstick Executive Board Room, NCTCOG Offices, CPII:**
- April 16, 2015, May 12, 2015, June 18, 2015, and August 20, 2015.
- **Regional Forum Room, NCTCOG Offices, CPII:** July 16, 2015

7. **Adjournment.**

If you have any questions regarding the meeting or agenda items, please contact Sandra Barba at (817) 608-2368 or [sbarba@nctcog.org](mailto:sbarba@nctcog.org).

If you plan to attend this public meeting and you have a disability that requires special arrangements at the meeting, please contact Liz Zecckine by phone at (817) 695-3231 or by email at [ezecckine@nctcog.org](mailto:ezecckine@nctcog.org), 72 hours in advance of the meeting. Reasonable accommodations will be made to assist your needs.

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North Central Texas Council of Governments

## SUMMARY

### Energy and Green Advisory Board

Thursday, April 16, 2015

9:00 AM – 12:00 PM William J. Pittstick Executive Board Room

NCTCOG Offices, CPII

616 Six Flags Drive, Arlington, Texas 76011

Chair: Ed Dryden, City of Dallas

Vice Chair: Evan Roberts, City of Fort Worth

#### 1. Welcome and Introductions.

#### DISCUSSION/ACTION ITEMS

2. **Continuation of Group Review.** EGAB will continue its review of the 2015 Edition of the International Energy Conservation Codes.

- Chapter 4 R406 **Energy Rating Index Compliance Alternative**
  - o Table R406.4 Maximum Energy Rating Index
    - Motion: Modify the ERI from 51 to 65 in Climate Zone 3
    - 1<sup>st</sup> Motion: Phil Crone
    - 2<sup>nd</sup> Motion: Jack Baxley
    - Opposed: None

The EGAB also addressed items they had previously placed on hold.

The EGAB completed their discussion and review of the 2015 IECC and voted on the 2015 Amendments that will apply.

#### OTHER BUSINESS AND ROUNDTABLE DISCUSSION

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

On May 12, 2015 the EGAB will address all proposed amendments to the DRAFT 2015 IECC Amendments in preparation for submittal to the RCCC in June.

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

Information was shared with the advisory board regarding HB 1736 as well as the upcoming SPEER Conference as well as PACE and home energy loan information HB 2392 and HB 3363. COG staff reminded everyone about the upcoming 23<sup>rd</sup> BPI Event to be held at UTA May 18-22, 2015.

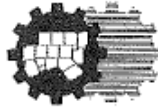
5. **Schedule for the Next EGAB Meeting.** The next EGAB meetings have been scheduled as follows, on Thursdays, from 9:00 AM to 12:00 PM:

- **William J. Pitstick Executive Board Room, NCTCOG Offices, CPII:**  
May 12, 2015, June 18, 2015, and August 20, 2015.
- **Regional Forum Room, NCTCOG Offices, CPII:**  
July 16, 2015

6. **Adjournment.**

If you have any questions regarding the meeting or agenda items, please contact Sandra Barba at (817) 608-2368 or [sbarba@nctcog.org](mailto:sbarba@nctcog.org).

If you plan to attend this public meeting and you have a disability that requires special arrangements at the meeting, please contact Liz Zecckine by phone at (817) 695-3231 or by email at [ezecckine@nctcog.org](mailto:ezecckine@nctcog.org), 72 hours in advance of the meeting. Reasonable accommodations will be made to assist your needs.



North Central Texas Council of Governments

## AGENDA

### Regional Codes Coordinating Committee

Tuesday, April 28, 2015

9:00 AM, Metroplex Conference Room

NCTCOG Offices, CP11

616 Six Flags Drive, Arlington, Texas 76011

Chair: David Kerr, City of Plano

Vice Chair: Paul Ward, City of Southlake

#### 1. Welcome and Introductions.

#### ACTION/PRESENTATION/DISCUSSION ITEMS

2. **January 13, 2015 Meeting Summary.** The January 13, 2015 draft meeting summary is available online for your review and consideration.
3. **Presentation of Plumbing & Mechanical/Fuel and Gas 2015 Regional Code Amendments and the Draft 2015 International Residential Amendments.** Gilbert Urvina will present and seek approval for the Plumbing & Mechanical/Fuel and Gas 2015 Regional Code Amendments and the 2015 International Residential Amendments.
4. **Discussion of RCCC Membership Appointments for A Two Year Term Beginning FY2016, as well as Chair and Vice Chair Appointments.** The Regional Codes Coordinating Committee (RCCC) Chair will conduct a discussion regarding RCCC membership updates.
5. **Discussion of Advisory Board Membership Appointments.** The RCCC Chair will call on Advisory Board Chairs to conduct a discussion regarding advisory board membership updates.
6. **North Central Texas Council of Governments Regional Model Construction Code Survey.** The North Central Texas Council of Governments (NCTCOG) staff will review and discuss the Regional Model Construction Code Survey results and seek direction from the RCCC.

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#### INFORMATION ITEMS

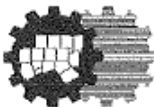
7. **Updates on Progress Made By Remaining Advisory Board Task Groups.** Each advisory board chair will share information regarding the progress made by their task groups: Building, Energy, Fire, and Green. They will report their final 2015 Regional Code Amendments at the June 9 RCCC meeting.

#### OTHER BUSINESS AND ROUNDTABLE DISCUSSION

8. **Future Agenda Items.** Voting for membership appointments will take place at the next RCCC meeting.
9. **Roundtable Topics/Other Business.** The RCCC members and the NCTCOG staff may share additional items of interest as time allows.
10. **Schedule for the Next RCCC Meeting.** The next RCCC meeting is scheduled for Tuesday, June 9, 2015, at 9 a.m., in the William J. Pitstick Executive Board Room, NCTCOG Offices, CP II.
11. **Adjournment.**

If you have any questions regarding the meeting or agenda items, please contact Sandra Barba by phone at (817) 608-2368, or by email at sbarba@nctcog.org.

If you plan to attend this public meeting and you have a disability that requires special arrangements at the meeting, please contact Liz Zecckine by phone at (817) 695-9231 or by email at ezecckine@nctcog.org, 72 hours in advance of the meeting. Reasonable accommodations will be made to assist your needs.



North Central Texas Council of Governments

## AGENDA

### Energy and Green Advisory Board

Tuesday, May 12, 2015

9:00 AM – 12:00 PM William J. Pitstick Executive Board Room

NCTCOG Offices, CPII

616 Six Flags Drive, Arlington, Texas 76011

Chair: Ed Dryden, City of Dallas

Vice Chair: Evan Roberts, City of Fort Worth

1. **Welcome and Introductions.**

#### PRESENTATION

2. **Presentation by Richard “Larry” Howe regarding the 2015 IECC Appendix RB.** Mr. Howe is a volunteer with the Plano Solar Advocates and a member of the Texas Solar Energy Society Board. Mr. Howe will offer a presentation about the solar ready provision outlined in the 2015 IECC Appendix RB.

#### DISCUSSION/ ACTION ITEMS

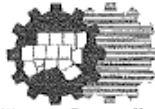
3. **Continued discussion of proposed amendments to the IECC.**
4. **Finalization of Proposed 2015 IECC Amendments.** EGAB will discuss items that were previously set aside; as well as forms; and review all proposed 2015 International Energy Conservation Codes Amendments.

#### OTHER BUSINESS AND ROUNDTABLE DISCUSSION

5. **Future Agenda Items.** Members of the Energy and Green Advisory Board (EGAB) and North Central Texas Council of Governments (NCTCOG) staff may suggest future agenda items.
6. **Roundtable Topics/Other Business.** EGAB members and NCTCOG staff may share additional items of interest as time allows.
7. **Schedule for the Next EGAB Meeting.** The next EGAB meetings have been scheduled as follows, on Thursdays, from 9:00 AM to 12:00 PM:
  - **William J. Pitstick Executive Board Room, NCTCOG Offices, CPII:**  
June 18, 2015, and August 20, 2015.
  - **Regional Forum Room, NCTCOG Offices, CPII:**  
July 16, 2015
8. **Adjournment.**

If you have any questions regarding the meeting or agenda items, please contact Sandra Barba at (817) 608-2368 or [sbarba@nctcog.org](mailto:sbarba@nctcog.org). If you plan to attend this public meeting and you have a disability that requires special arrangements at the meeting, please contact Liz Zecckline by phone at (817) 696-3231 or by email at [ezecckline@nctcog.org](mailto:ezecckline@nctcog.org), 72 hours in advance of the meeting. Reasonable accommodations will be made to assist your needs.

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North Central Texas Council of Governments

## AGENDA

### Regional Codes Coordinating Committee

Tuesday July 7, 2015

9:00 AM, Regional Forum Room

NCTCOG Offices, CP11

616 Six Flags Drive, Arlington, Texas 76011

Chair: David Kerr, City of Plano

Vice-Chair: Paul Ward, City of Southlake

#### 1. Welcome and Introductions.

#### ACTION/PRESENTATIONS

2. **Summary of the April 28, 2015 Meeting.** The April 28, 2015 draft meeting summary is available online for your review and consideration.
3. **Regional Codes Coordinating Committee (RCCC) Reappointments.** Of the 27 members of the RCCC, 13 are scheduled for reappointment for a two-year term beginning October 1, 2015. The reappointment acceptance form was due to the North Central Texas Council of Governments (NCTCOG) on May 27, 2015. NCTCOG staff is seeking a vote on the slate of reappointees for recommendation to the NCTCOG Executive Board.
4. **RCC Officer Elections.** NCTCOG staff is seeking a vote on the Chair and Vice Chair to take forward to NCTCOG's Executive Board.
5. **Approval sought for Appointment of Advisory Board Members.** Each Advisory Board Chair will seek approval of advisory board member(s) appointments.
6. **Presentation and voting on the Recommended Regional 2015 Draft International Building Code Amendments; 2015 Draft International Fire Code Amendments; 2015 Draft International Residential Codes Amendments; 2015 Draft International Energy Conservation Code Amendments; and Updates on the 2012 International Green Construction Code.** Each Advisory Board Chair will present and seek approval for their respective 2015 amendments.

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## INFORMATION ITEMS

### OTHER BUSINESS AND ROUNDTABLE DISCUSSION

7. **Future Agenda Items.** NCTCOG staff will review and discuss the Regional Model Construction Code Survey results and seek direction from the RCCC at the July RCCC meeting.
8. **Roundtable Topics/Other Business.** RCCC members and NCTCOG staff may share additional items of interest as time allows.
9. **Schedule for the Next RCCC Meeting.** The next RCCC meeting is scheduled for Tuesday, July 21, 2015, at 9 a.m., in the Regional Forum Room, NCTCOG Offices, CPII.
10. **Adjournment.**

If you have any questions regarding the meeting or agenda items, please contact Sandra Barba by phone at (817) 608-2368, or by email at sbarba@nctcog.org.

If you plan to attend this public meeting and you have a disability that requires special arrangements at the meeting, please contact Liz Zeockine by phone at (817) 695-2931 or by email at [ezackine@nctcog.org](mailto:ezackine@nctcog.org), 72 hours in advance of the meeting. Reasonable accommodations will be made to assist your needs.

# AGENDA

## Energy and Green Advisory Board

Thursday, October 15, 2015

9:00 AM – 12:00 PM Tejas Conference Room

NCTCOG Offices, CPIII, 3<sup>rd</sup> floor

600 Six Flags Drive, Arlington, Texas 76011

Chair: Ed Dryden, City of Dallas

Vice Chair: Evan Roberts, City of Fort Worth

1. **Welcome and Introductions.**

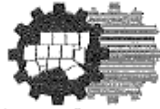
### DISCUSSION

2. **Begin discussion of the 2015 IgCC.** The board will begin reviewing the 2015 Edition of the IgCC and incorporate previous work as applicable.

### OTHER BUSINESS AND ROUNDTABLE DISCUSSION

3. **Future Agenda Items.** Members of the Energy and Green Advisory Board (EGAB) and North Central Texas Council of Governments (NCTCOG) staff may suggest future agenda items.
4. **Roundtable Topics/Other Business.** EGAB members and NCTCOG staff may share additional items of interest as time allows.
5. **Schedule for the Next EGAB Meeting.** The next EGAB meetings have been scheduled as follows, on Thursdays, from 9:00 AM to 12:00 PM:
  - **William J. Pittstick Executive Board Room, NCTCOG Offices, CPII:**  
November 19, 2015
  - **Metroplex Conference Room, NCTCOG Offices, CPII:**  
January 21, 2016
6. **Adjournment.**

If you have any questions regarding the meeting or agenda items, please contact Sandra Barba at (817) 608-2368 or [sbarba@nctcog.org](mailto:sbarba@nctcog.org). If you plan to attend this public meeting and you have a disability that requires special arrangements at the meeting, please contact Liz Zecckine by phone at (817) 695-3231 or by email at [ezecckine@nctcog.org](mailto:ezecckine@nctcog.org), 72 hours in advance of the meeting. Reasonable accommodations will be made to assist your needs.



North Central Texas Council of Governments

## AGENDA

### 2015 International Building and Fire Code Workshop

Thursday, November 5, 2015

9:00 AM-11:00 AM, Mike Eastland Training Center

NCTCOG Offices, CP111, 2<sup>nd</sup> floor

600 Six Flags Drive, Arlington, Texas 76011

Chair: David Kerr, City of Plano

Vice-Chair: Jack Thompson, City of DeSoto

1. **Welcome and Introductions.** Michael Eastland, Executive Director of NCTCOG, will welcome attendees and call attention to the importance of the work put forth by the Regional Codes Coordinating Committee (RCCC) and the five advisory boards.
2. **Presentation of 2015 International Building and Fire Code Amendments.** David Kerr, RCCC Chair, will present the approved amendments to the 2015 International Building and Fire Codes.
3. **International Energy Conservation Code Panel Discussion.** Bahman Yazdani, Texas A&M Energy Systems Laboratory, Ed Dryden with the City of Dallas, and Christine Herbert of the South-central Partnership for Energy Efficiency as a Resource, will offer a short review of statewide initiatives and codes.
4. **Building Information Modeling Technology Discussion.** Mark Clayton, PhD, SMARTreview and Jack Thompson with the City of DeSoto, will share information regarding technology for expediting building code compliance and the release of building permits.
5. **Regional Model Construction Code Survey.** Sandra Barba, NCTCOG planner, will share the survey results.
6. **Upcoming Training Opportunities.** Fred Yebra, State Energy Conservation Office, will provide information regarding training opportunities.
7. **Breakout Session with Advisory Board Chairs and Presenters.** Workshop attendees may address questions to a specific advisory board(s) and/or members. (approximately 30 minutes if needed)
8. **Adjournment.**

If you have any questions regarding the meeting or agenda items, please contact Sandra Barba by phone at (817) 608-2368, or by email at sbarba@nctcog.org.

If you plan to attend this meeting and you have a disability that requires special arrangements at the meeting, please contact Nadajalah Bennett by phone at (817) 695-9139 or by email at nbennett@nctcog.org, 72 hours in advance of the meeting. Reasonable accommodations will be made to assist your needs.

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# AGENDA

## Energy and Green Advisory Board

Thursday, November 19, 2015

9:00 AM – 12:00 PM William J. Pitstick Executive Room

NCTCOG Offices, CPII

616 Six Flags Drive, Arlington, Texas 76011

Chair: Ed Dryden, City of Dallas

Vice Chair: Evan Roberts, City of Fort Worth

### 1. Welcome and Introductions.

#### ACTION ITEM

2. **Discussion and consideration to delete the previously recommended amendments.** Table R402.1.2, Table R402.1.4 and Section R402.4.1.2 of the 2015 Edition of the IECC.

#### DISCUSSION

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

#### OTHER BUSINESS AND ROUNDTABLE DISCUSSION

4. **Future Agenda Items.** Members of the Energy and Green Advisory Board (EGAB) and North Central Texas Council of Governments (NCTCOG) staff may suggest future agenda items.
5. **Roundtable Topics/Other Business.** EGAB members and NCTCOG staff may share additional items of interest as time allows.
6. **Schedule for the Next EGAB Meeting.** The next EGAB meetings have been scheduled as follows, on Thursdays, from 9:00 AM to 12:00 PM:
  - **Metroplex Conference Room, NCTCOG Offices, CPII:**  
January 21, 2016
7. **Adjournment.**

If you have any questions regarding the meeting or agenda items, please contact Sandra Barba at (817) 608-2368 or [sbarba@nctcog.org](mailto:sbarba@nctcog.org). If you plan to attend this public meeting and you have a disability that requires special arrangements at the meeting, please contact Liz Zeckline by phone at (817) 695-3231 or by email at [ezeckline@nctcog.org](mailto:ezeckline@nctcog.org), 72 hours in advance of the meeting. Reasonable accommodations will be made to assist your needs.

6.4.5.2 North Texas Association of Energy Engineers (NTAEE).

The following pages are meeting notes, agendas, and summaries from the NTAEE meetings from 2015.

Jim Phillips invited you to

## NTAEE January Meeting

Thursday, January 22, 2015 from 11:30 AM - 01:00 PM

**Brookhaven Country Club**

**Message From Host:**

"SUBJECT: "Why 1% Efficiency ..."

[read more](#)

Will you attend?

Yes Maybe No



**Tammy Persky**

---

**From:** Jim Phillips <info@mailva.evite.com>  
**Sent:** Thursday, February 05, 2015 7:07 PM  
**To:** byazdani@tamu.edu  
**Subject:** NTAEE Februaru Meeeting

You've received an invitation from **Jim Phillips!** [View Invitation](#)



[View Invitation](#)

Jim Phillips invited you to

## NTAEE Februaru Meeeting

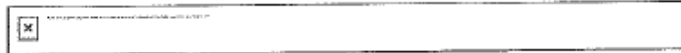
Thursday, February 19, 2015 from 11:30 AM - 01:00 PM  
Brookhaven Country Club

**Tammy Persky**

---

**From:** Jim Phillips <info@mailva.evite.com>  
**Sent:** Wednesday, March 04, 2015 1:59 PM  
**To:** byazdani@tamu.edu  
**Subject:** NTAEE March Meeting

You've received an invitation from **Jim Phillips** | [View Invitation](#)



[View Invitation](#)

Jim Phillips invited you to

## NTAEE March Meeting

Thursday, March 19, 2015 from 11:30 AM - 01:00 PM  
Brookhaven Country Club

**Tammy Persky**

---

**From:** Jim Phillips <info@mailva.evite.com>  
**Sent:** Thursday, April 02, 2015 11:53 AM  
**To:** byazdani@tamu.edu  
**Subject:** NTAEE April Meeting

You've received an invitation from **Jim Phillips!** [View Invitation](#)



[View Invitation](#)

Jim Phillips invited you to

## NTAEE April Meeting

Thursday, April 16, 2015 from 11:30 AM - 01:00 PM  
Pappadeaux Seafood Kitchen



**Tammy Persky**

---

**From:** Jim Phillips <info@mailva.evite.com>  
**Sent:** Friday, May 08, 2015 11:27 AM  
**To:** byazdani@tamu.edu  
**Subject:** NTAAE May Meeting

You've received an invitation from **Jim Phillips!** [View Invitation](#)



[View Invitation](#)

Jim Phillips invited you to

## NTAAE May Meeting

Thursday, May 21, 2015 from 11:30 AM - 01:00 PM

**Brookhaven Country Club**

**Tammy Persky**

---

**From:** Jim Phillips <info@mailva.evite.com>  
**Sent:** Tuesday, June 16, 2015 3:37 AM  
**To:** byazdani@tamu.edu  
**Subject:** Event Reminder: NTAEE June Meeting

### Reminder! Upcoming Event

**Jim Phillips** invited you to **NTAEE June Meeting**  
on Thursday, June 18, 2015 from 11:30 AM - 1:00 PM

So far **40** guests replied Yes  
See who's coming, [view event details](#), and let the host  
know if you can attend!

[RSVP Now!](#)



**Tammy Persky**

---

**From:** Jim Phillips <info@mailva.evite.com>  
**Sent:** Tuesday, July 14, 2015 3:37 AM  
**To:** byazdani@tamu.edu  
**Subject:** Event Reminder: NTAEE July Meeting

---

### Reminder! Upcoming Event

**Jim Phillips** invited you to **NTAEE July Meeting**  
on Thursday, July 16, 2015 from 11:30 AM - 1:00 PM

So far **38** guests replied Yes  
See who's coming, [view event details](#), and let the host  
know if you can attend!

[RSVP Now!](#)



**Tammy Persky**

---

**From:** Jim Phillips <info@mailva.evite.com> on behalf of Jim Phillips  
**Sent:** Tuesday, August 18, 2015 3:34 AM  
**To:** byazdani@tamu.edu  
**Subject:** Event Reminder: NTAEE August Meeting

---

### Reminder! Upcoming Event

**Jim Phillips** invited you to **NTAEE August Meeting**  
on Thursday, August 20, 2015 from 10:45 AM - 12:45 PM

So far **44** guests replied Yes  
See who's coming, [view event details](#), and let the host  
know if you can attend!

RSVP Now!



**Tammy Persky**

---

**From:** Jim Phillips <info@mailva.evite.com> on behalf of Jim Phillips  
**Sent:** Tuesday, September 15, 2015 3:38 AM  
**To:** byazdani@tamu.edu  
**Subject:** Event Reminder: NTAEE September Meeting

---

### Reminder! Upcoming Event

**Jim Phillips** invited you to **NTAEE September Meeting**  
on Thursday, September 17, 2015 from 11:30 AM - 1:00 PM

So far **41** guests replied Yes  
See who's coming, [view event details](#), and let the host  
know if you can attend!

[RSVP Now!](#)



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

The following pages are meeting notes, agendas, and summaries from the SAEAG meetings from 2015.

## SAEAG MEETING

### State Agency Energy Advisory Group

**Wednesday, January 21, 2015**  
**9:00 a.m. – 11:30 a.m.**  
**Office of the Attorney General**  
**William Clements Building**  
**NW Corner of 15<sup>th</sup> and Lavaca**  
**12<sup>th</sup> Floor Large Conference Room by Receptionist Area**  
**Austin, Texas 78701**

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### AGENDA

- 9:00 a.m. – 10:00 a.m. Case Update from OAG
- 10:00 a.m. – 10:15 a.m. BREAK
- 10:15 a.m. – 11:00 a.m. Guest speaker: Brad Jenkins, SWMCO, will discuss the Transformer Retrofit program.
- 11:00 a.m. – 11:15 a.m. SECO Report
- 11:15 a.m. – 11:30 a.m. General discussion of current and upcoming issues and events

If you are going to join the meeting via telephone conference please call 1-888-391-2102 and during the message punch in 7253903#.

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

You may pre-register to obtain unescorted clearance (you will still need to bring a picture I.D.) to our floor by emailing or calling before our meeting is scheduled [nancy.villarreal@texasattorneygeneral.gov](mailto:nancy.villarreal@texasattorneygeneral.gov) [512-475-4164] or [melinda.pettengill@texasattorneygeneral.gov](mailto:melinda.pettengill@texasattorneygeneral.gov) [512-475-4240]

## **SAEAG MEETING AGENDA**

Wednesday, February 18, 2015

9:00 a.m. – 11:15 a.m.

LBJ Office Building

111 E. 17th Street, Room 212B

Austin, Texas 78711

### **AGENDA**

- |             |  |
|-------------|--|
| 9:00-9:45   | Case Update from OAG (not open to the public)  |
| 9:45-10:00  | Break  |
| 10:00-10:30 | SECO Update / Review of TX Government Code   |
| 10:30-11:15 | Markus Hogue, University of Texas<br>Breaking News on the UT Irrigation and Water Conservation Efforts |

For the individuals that are not on site, here is the link to download the presentation -  
<https://utexas.box.com/s/g5nd11iocjlrptl7co0th6mmcenmfd29>

# SAEAG MEETING

## State Agency Energy Advisory Group

Wednesday, March 18, 2015  
9:00 a.m. – 11:30 a.m.  
Office of the Attorney General  
William Clements Building  
NW Corner of 15<sup>th</sup> and Lavaca  
12<sup>th</sup> Floor Large Conference Room by Receptionist Area  
Austin, Texas 78701

### AGENDA

- 9:00 a.m. – 10:00 a.m. Case Update from OAG
- 10:00 a.m. – 10:15 a.m. BREAK
- 10:15 a.m. – 11:00 a.m. Guest speaker: Sylvania Lighting Services, will discuss the Lighting and Energy Management Programs.
- 11:00 a.m. – 11:15 a.m. SECO Report
- 11:15 a.m. – 11:30 a.m. General discussion of current and upcoming issues and events

If you are going to join the meeting via telephone conference please call 1-888-391-2102 and during the message punch in 7253903#.

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

You may pre-register to obtain unescorted clearance (you will still need to bring a picture I.D.) to our floor by emailing or calling before our meeting is scheduled [nancy.villarreal@texasattorneygeneral.gov](mailto:nancy.villarreal@texasattorneygeneral.gov) [512-475-4164] or [melinda.pettengill@texasattorneygeneral.gov](mailto:melinda.pettengill@texasattorneygeneral.gov) [512-475-4240]



**State Agency Energy Advisory Group**

**Wednesday, April 15, 2015  
9:00 a.m. – 11:30 a.m.  
LBJ Office Building  
17<sup>th</sup> and Brazos  
Room 212B  
Austin, Texas 78711**

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**AGENDA**

- 9:00 a.m. – 10:00 a.m. Case Update from OAG
- 10:00 a.m. – 10:15 a.m. BREAK
- 10:15 a.m. – 10:30 a.m. SECO Report
- 10:30 a.m. – 11:00 a.m. Guest speaker: Texas State University - Sheri Lara (Director of Utility Operations) and Doug Bynum (Director Facilities Operations)  
Energy and Water Conservation Efforts Update at Texas State University  
(Very Cool Energy and Water Conservations Effort Activities at the University)
- 11:00 a.m. – 11:15 a.m. Q&A
- 11:15 a.m. - 11:30 a.m. General discussion of current and upcoming issues and events

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

For those attending remotely, using the following log-in information

<https://attendee.gotowebinar.com/register/6002398169069955585>

Webinar ID: 146-622-499

If you will be calling in and not viewing the presentation,

Long distance: +1 (646) 307-1720 (Access Code: 947-031-694)

# SAEAG MEETING

## State Agency Energy Advisory Group

Wednesday, May 20, 2015  
9:00 a.m. – 11:30 a.m.  
Office of the Attorney General  
William Clements Building  
NW Corner of 15<sup>th</sup> and Lavaca  
12<sup>th</sup> Floor Large Conference Room by Receptionist Area  
Austin, Texas 78701

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## AGENDA

- 9:00 a.m. – 10:00 a.m. Case Update from OAG
- 10:00 a.m. – 10:15 a.m. BREAK
- 10:15 a.m. – 11:00 a.m. Guest speaker: Ed Serna, Deputy Executive Director of the Texas Workforce Commission will discuss Energy Star Certified.
- 11:00 a.m. – 11:15 a.m. SECO Report
- 11:15 a.m. – 11:30 a.m. General discussion of current and upcoming issues and events

If you are going to join the meeting via telephone conference please call 1-866-215-5503 and during the message punch in 9683688#.

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

You may pre-register to obtain unescorted clearance (you will still need to bring a picture I.D.) to our floor by emailing or calling before our meeting is scheduled [nancy.villarreal@texasattorneygeneral.gov](mailto:nancy.villarreal@texasattorneygeneral.gov) [512-475-4164] or [melinda.pettengill@texasattorneygeneral.gov](mailto:melinda.pettengill@texasattorneygeneral.gov) [512-475-4240]

**State Agency Energy Advisory Group**

**Wednesday, June 17, 2015  
9:00 a.m. – 11:00 a.m.  
LBJ Office Building  
17<sup>th</sup> and Brazos  
Room 305  
Austin, Texas 78711**

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**AGENDA**

- 9:00 a.m. – 9:30 a.m. Case Update from OAG
- 9:30 a.m. – 9:45 a.m. SECO Report
- 9:45 a.m. – 10:00 a.m. BREAK
- 10:00 a.m. – 10:30 a.m. Guest speaker: McKinstry ([www.mckinstry.com](http://www.mckinstry.com)) - Thursten Simonsen and Rich Oliver  
**Design Build and High Performance Design Build**  
Should you care about the contract structure?
- 10:30 a.m. – 10:45 a.m. Q&A
- 10:45 a.m. - 11:00 a.m. General discussion of current and upcoming issues and events

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

Register now if you will be attending remotely!

<https://attendee.gotowebinar.com/register/8979505122997117954>

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

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# SAEAG MEETING

## State Agency Energy Advisory Group

Wednesday, July 15, 2015  
9:00 a.m. – 11:00 a.m.  
Office of the Attorney General  
William Clements Building  
NW Corner of 15<sup>th</sup> and Lavaca  
12<sup>th</sup> Floor Large Conference Room by Receptionist Area  
Austin, Texas 78701

### AGENDA

- |                         |  |
|-------------------------|--|
| 9:00 a.m. – 9:30 a.m.   | Case Update from OAG   |
| 9:30 a.m. – 9:45 a.m.   | BREAK  |
| 9:45 a.m. – 10:30 a.m.  | Guest speaker: Fred Yebra, Texas State Conservation will discuss Accessing Utility Incentives and Support. |
| 10:30 a.m. – 11:00 a.m. | Alison Nathan will discuss the Texas Administrative Code update.   |

If you are going to join the meeting via telephone conference please call 1-866-215-5503 and during the message punch in 9683688#.

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

You may pre-register to obtain unescorted clearance (you will still need to bring a picture I.D.) to our floor by emailing or calling before our meeting is scheduled [nancy.villarreal@texasattorneygeneral.gov](mailto:nancy.villarreal@texasattorneygeneral.gov) [512-475-4164] or [melinda.pettengill@texasattorneygeneral.gov](mailto:melinda.pettengill@texasattorneygeneral.gov) [512-475-4240]

# SAEAG MEETING

## State Agency Energy Advisory Group

Wednesday, September 16, 2015  
9:15 a.m. – 11:15 a.m.  
Office of the Attorney General  
William Clements Building  
NW Corner of 15<sup>th</sup> and Lavaca  
12<sup>th</sup> Floor Large Conference Room by Receptionist Area  
Austin, Texas 78701

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### AGENDA

- 9:15 a.m. – 9:45 a.m. Case Update from OAG
- 9:45 a.m. – 10:00 a.m. BREAK
- 10:00 a.m. – 10:30 a.m. Guest speaker: Kathleen Baireuther, University of Texas at Austin Clean Energy Incubator will discuss Southwest Regional Clean Energy Incubation Initiative (SRCEII).
- 10:30 a.m. – 11:00 a.m. SECO Report
- 11:00 a.m. – 11:15 a.m. General discussion of current and upcoming issues and events

If you are going to join the meeting via telephone conference please call 1-866-215-5503 and during the message punch in 9683688#.

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

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

**State Agency Energy Advisory Group**

**Wednesday, October 21, 2015  
9:00 a.m. – 11:15 a.m.  
LBJ Office Building  
17<sup>th</sup> and Brazos  
Room 212C  
Austin, Texas 78711**

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**AGENDA**

- |                         |  |
|-------------------------|--|
| 9:00 a.m. – 9:30 a.m.   | Case Update from OAG   |
| 9:30 a.m. – 9:45 a.m.   | SECO Report  |
| 9:45 a.m. – 10:00 a.m.  | BREAK  |
| 10:00 a.m. – 10:45 a.m. | Guest speaker: Stuart Moulder, Vice President - EnVinta<br><b>What is Strategic Energy Management?</b> |
| 10:45 a.m. – 11:00 a.m. | Q&A  |
| 11:00 a.m. - 11:15 a.m. | General discussion   |

# SAEAG MEETING

## State Agency Energy Advisory Group

Wednesday, November 18, 2015  
9:00 a.m. – 10:45 a.m.  
Office of the Attorney General  
William Clements Building  
NW Corner of 15<sup>th</sup> and Lavaca  
12<sup>th</sup> Floor Large Conference Room by Receptionist Area  
Austin, Texas 78701

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### AGENDA

- 9:00 a.m. – 9:15 a.m. Case Update from OAG
- 9:15 a.m. – 9:45 a.m. SECO Report  
(Include Texas Administrative Code Discussion, see  
October 2, 2015 Notice,  
<http://www.seco.cpa.state.tx.us/tbec/notices.php>)
- 9:45 a.m. – 10:00 a.m. BREAK
- 10:00 a.m. – 10:30 a.m. Guest speaker: Dana Lazarus, Electric Reliability Council of  
Texas, Inc. will discuss the Clean Power Plan.
- 10:30 a.m. – 10:45 a.m. General discussion of current and upcoming issues and  
events

If you are going to join the meeting via telephone conference please call 1-866-215-5503 and during the message punch in 9683688#.

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

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

6.4.5.4 The South-central Partnership for Energy Efficiency as a Resource (SPEER) Meetings from 2015. The following pages are meeting notes, agendas, and summaries from the SPEER meetings from 2015.

**SPEER's Third Annual Summit** was held in Dallas April 13-14, 2015 and featured keynote addresses from Dr. Kathleen Hogan, Deputy Assistant Secretary for Energy Efficiency, U.S. Department of Energy, Hunter Lovins, co-author with Amory Lovins of Natural Capitalism, President of Natural Capitalism Solutions (NCS), and Tom Kerber, Director, Research, Home Controls & Energy, Parks Associates.

Participants heard plenary presentations on a dozen topics and had the opportunity to attend breakout sessions to deeper dive into those topics. A list of all the plenary presentations and breakout discussions is below.

- **Status of Utility Efficiency Programs in the Region**

Introduced by: Lark Lee, TetraTech, the State of Texas EM&V Contractor

Recent years have seen big changes for utility efficiency programs in Texas and Oklahoma. The investor-owned utilities have increased their budgets in the last five years. Texas has contracted out the evaluation, measurement and verification (EM&V) of programs and made program improvement suggestions, and Oklahoma is completing a potential study as part of an ongoing demand-side management expansion. Rising baselines, advancing technologies, and changing consumer and political expectations assure programs continue to evolve. Attend this session to discuss with utility program managers and other stakeholders, the status and evolving nature of electric and natural gas incentive programs in both states. Discuss new program ideas and emerging technologies.

- **Utility of the Future: Integrating EE, DR, DG, and Storage**

Introduced by: Michael Quinn, CTO of Oncor

Distributed energy resources, increasing renewable energy generation, electrification of transportation, big data and the internet of things, are creating either a perfect storm or a perfect opportunity for the distribution utility of the future. This working session was formed to address the complexity of this converging set of issues from the perspective of the utility and utility regulatory framework. How are utilities addressing these challenges? How can consumers and the industry driving these trends benefit from this convergence without undermining the health of our utilities? Are there new services or partnership opportunities opening up? Oncor has proposed a massive storage project which would see the regulated utility's role change significantly. Can utilities embrace distributed energy resources as Oncor proposes, and what does this mean for the utility business model and for utility regulation? Come to this session to learn the latest thinking on this in our region, give your input, and help us develop a way forward.

- **Energy Codes: Challenges and Opportunities**

Introduced by: Ian Hughes, Bayer Material Science

State of Energy Codes in the Region: With 98,700 single family permits issued in 2014, Texas builds far more homes than any other state, and this trend is likely to continue. Oklahoma builds another 10,400 and is in the top quartile of states for new home starts. In a region known more for producing energy than for conserving it, energy codes are a hot topic, with at least one energy code bill being considered in the Texas Legislature this year. Oklahoma also has a bill that recommends extending the Tax Credit to 2018 for builders who meet higher levels of energy efficiency. SPEER is also engaged in a Field Study to collect data through a sampling of homes during construction and assess the state of building practices in Texas. Findings from this study will be used to identify training needs and resources and may be instrumental in developing new utility programs and builder incentives. Our Energy Code Ambassadors are providing local assistance with energy code issues in both states. With all of this as background, we will discuss the adoption of the 2015 International Energy Conservation Code (IECC), compliance challenges, and industry engagement needed to make this next level of efficiency achievable.

- **Lighting: Has the Market Transformed?**

Introduced by: Christopher Lubeck, OSRAM Sylvania

Did you know that the commercial buildings sector uses a third of its electricity on lighting, so what better place for the market to look for energy savings? In the last 30 years, many improved and more efficient lighting technologies, like LEDs, have been introduced to the market, but have not yet reached substantive market transformation. In



existing buildings' fluorescent fixture systems, almost half the sockets in the US, still use T12 lighting applications. While T8 and T5 fluorescent fixtures are known to be much more efficient than the older T12 application, T12 fixtures still dominate the commercial sector due to the ease of replacement and the lower cost of replacement versus retrofit. In the residential sector there are many efficient lighting technology options, but the consumer or homeowner often places higher value on the price of the fixture rather than the efficiency of the product. This sector gravitates toward "not dark, cheap" and is typically uninterested in efficacy or lifetime performance. This session will focus on how we can encourage more interest in lighting efficacy, lifetime performance, and energy efficiency, including use of LEDs. Can SPEER, its members and Summit participants help to identify ways to accelerate trends supporting efficient lighting in residential, commercial and outdoor applications?

- **Voluntary Challenges: 2030, Better Buildings and More**

Introduced by David Low, Architecture 2030

Organizations and individuals in the SPEER region are demonstrating leadership in the energy sector by committing to reduce energy consumption through participation in a variety of volunteer programs. Participation in voluntary energy efficiency initiatives provides public recognition, brings prestige, and provides real value in terms of energy and cost savings. These programs give participant's in the Architecture 2030 Districts, Better Building Challenge initiatives, and other local voluntary challenges the opportunity to compare notes and learn from each other's experiences. Local districts demonstrate the value these initiatives are bringing to their communities, join or initiate similar efforts, and what resources are needed to make these programs successful.

- **Financing Residential Retrofits**

Introduced by: Colin Bishopp, Renewable Funding

The residential retrofit market for energy efficiency is extremely low in Texas and Oklahoma. One of the most cited reasons is the up-front cost and lack of financing options. This session will explore multiple ways the region could support efficiency financing: Warehouse for Energy Efficiency Loans (WHEEL), Property Assessed Clean Energy (PACE), and a variety of USDA or clean air/clean water funds could be deployed. The SPEER Commission on Texas Efficiency Policy strongly recommended these new financing vehicles and more be used to facilitate additional investments in efficiency. Many of these options have scaled in other regions but Texas and Oklahoma homeowners still have extremely limited options when it comes to financing energy efficiency retrofits. We'll talk about how these programs work and how we can help get the programs started quickly.

- **Financing Commercial Retrofits**

Introduced by: Matt Golden, Investor Confidence Project

Lack of upfront capital is consistently the #1 cited reason among building owners for not moving forward with retrofit projects. But new solutions have emerged to help overcome this hurdle and major changes are underway in the energy efficiency financing space. A number of new financing methods are becoming available as investors and building owners gain confidence that savings will materialize. Large sums of investment dollars are flowing into the space from private investors, and Texas has enabled PACE districts statewide which will allow a scale of commercial building retrofits previously unattainable. How can we drive adoption of PACE districts around the region and the state? What other financing vehicles are available—or could be available—and how do we scale them? What is necessary to increase private investment in commercial retrofit projects? This session will tackle all of these questions and more as we seek to increase financing available for commercial buildings.

- **Local Government Initiatives to Accelerate Energy Efficiency**

Introduced by: Sam Gunderson, City of Fort Worth

Cities and counties are often the best laboratories for efficiency innovation. Many efficiency initiatives and policies originate at the local level, including building codes, PACE districts, benchmarking programs, public building retrofits, and more. Cities are at the forefront of energy efficiency initiatives throughout the region. Recently, three cities in the region (El Paso, Tulsa, and Dallas) have been designated as Resilient Cities by the Rockefeller Foundation to both prepare for the impacts of climate change and implement policies that will help mitigate those impacts. Houston is one of ten cities selected for the City Energy Project to drive a suite of efficiency policies

forward. Many cities in Texas and Oklahoma have energy saving goals, benchmark their energy performance to track progress, and implement aggressive energy efficiency projects to save taxpayer money. Cities also engage their communities with private building challenges like DOE's Better Buildings Challenge, the Dallas 2030 District, and Houston's Green Office Challenge.

- **Distributed Energy Resources**

Introduced by: David Walters, Walters Power, former Governor of Oklahoma

New technology and open markets are ushering in a new renaissance in distributed energy resources, particularly on-site generation and energy storage. Regulatory systems and markets rules are having to adjust to market innovations. The Texas PUCT has a rulemaking underway that will update the interconnection process, determine the role and responsibilities that a third-party generator will be able to assume, and will even determine whether to alter the definition of distributed generation itself. ERCOT has developed a detailed model of the transmission system, but still does not have transparency into the distribution grid of local utilities, which is limiting the ability to recognize (and compensate) the contribution of small-scale loads and on-site generation to the market. Attend this session to hear the challenges to development of distributed generation in the region from the perspective of the developer/customer, or get engaged in industry initiatives to overcome the existing barriers.

- **Critical Infrastructure and CHP**

Introduced by: Lynn Crawford, Affiliated Engineers

CHP's resurgence is being catalyzed by low natural gas prices, environmental pressures, and policymaker support. This breakout invites industry professionals and municipal leaders to share benefits and barriers encountered in the adoption of CHP technologies. Texas Law HB 1864, passed in 2013 requires ALL local and state governments to consider CHP when updating or building new critical infrastructure. Attendees will learn about the US DOE CHP Technical Assistance Partnership and its resources to support building owners and decision makers to determine whether CHP is a feasible option for their facility to improve energy efficiency and resiliency. Industry stakeholders will discuss CHP's efficiency cost savings benefits, new tariffs, and other policy and economic drivers influencing CHP development.

- **Creating a Smart Energy Roadmap: Using Data to Drive Efficiency**

Introduced by: Cade Burks, Big Data Energy Services

How do we make it as easy as possible for customers to use energy more intelligently and efficiently? Texas has deployed smart meters to nearly every customer in the competitive regions of the state, covering approximately 80% of the state's consumption. Customers can access their data, or share their energy data with third-party energy management providers through the Smart Meter Texas portal. Retail Electric Providers are increasing the number of offerings that utilize smart meter data and provide price signals for their customers to shift their usage. Taking advantage of customer data, Oklahoma Gas and Electric has pioneered one of the largest residential demand response programs in the country. While there is some initial success in utilizing this granular data, the potential is significant. SPEER is developing a "Roadmap" to increase smart energy data usage which will be finalized after the Summit. This session will discuss some of the concepts and stakeholder's ideas to further develop the Roadmap.

- **Efficiency as an Emissions Reduction Strategy**



Introduced by: John Hall, Environmental Defense Fund

Energy efficiency can help reduce emissions of all air pollutants, alleviating air quality compliance issues facing the region. In fact, many states, local governments, and utilities are exploring how to get environmental credit for their efficiency efforts. As carbon emission regulations under the Clean Air Act (section 111(d)) are finalized, and as many areas strive for attainment (or to remain in attainment) with ozone, NOx, SO2, mercury, and particulate matter standards, energy efficiency efforts may be among the most cost-effective methods for Texas and Oklahoma to comply. But how do we increase efficiency's role in cleaning the air? What kinds of activities will have the most impact, and how do we track them to receive appropriate credit? Texas has counted building energy codes and received credit for codes as a full control measure. What about public building efficiency efforts like Oklahoma's 20% by 2020 legislation? The SPEER Commission on Texas Energy Efficiency Policy recommended establishing


an efficiency registry so that public building retrofits, building codes, CHP, financing programs, and even efficiency delivered in Texas' competitive market could potentially be counted for air quality compliance. Oklahoma and Texas have both established Ozone Advance initiatives in many of their local communities which include energy efficiency; can efficiency within these plans be increased? This session will explore the opportunity to address air quality compliance with energy efficiency.

## SPEER Summit • Monday, April 13, 2015

### Day 1

8:30am to 9:30am	Registration and Breakfast			
9:30am	<u>Grand Ballroom:</u> Welcome			
9:45am	SPEER Highlights			
10:00am to 10:45am	Keynote Speaker: Dr. Kathleen Hogan, Deputy Assistant Secretary for Energy Efficiency, U.S. Department of Energy			
10:45am to 11:30am	Recommendations of the SPEER Commission on Texas Energy Efficiency Policy The Honorable Margaret Keliher; The Honorable Will Wynn; Kenneth Mercado, SVP, CenterPoint Energy; Ned Ross, VP, Direct Energy; Garrett Boone, Co-Founder, Container Store			
11:30am to 12:30pm	Networking Lunch - Sponsored by:			 MITSUBISHI ELECTRIC COOLING & HEATING <i>Live Better</i>
12:30pm to 1:15pm	<u>Grand Ballroom:</u> Introductory Plenary Panel			
	Ian Hughes, Bayer Material Science	David Low, Architecture 2030	John Hall, Environmental Defense Fund	Lark Lee, TetraTech, the State of Texas EM&V Contractor
1:30 pm to 2:30 pm	Breakout Sessions			
	<u>Preston Trail:</u> Energy Codes: Challenges and Opportunities	<u>Bent Tree:</u> Voluntary Challenges: 2030 District, Better Buildings, and more	<u>Mesquite I:</u> Efficiency as an Emissions Reduction Strategy	<u>Mesquite II:</u> Status of Utility Efficiency Programs in the Region
	Break			
3:00pm to 3:45pm	<u>Grand Ballroom:</u> Introductory Plenary Panel			
	Sam Gunderson, City of Fort Worth	Matt Golden, Investor Confidence Project	Lynn Crawford, Affiliated Engineers	Michael Quinn, Oncor
4:00 pm to 5:00 pm	Breakout Sessions			
	<u>Preston Trail:</u> Local Government Initiatives to Accelerate Energy	<u>Bent Tree:</u> Financing Commerical Retrofits	<u>Mesquite I:</u> Critical Infrastructure and CHP	<u>Mesquite II:</u> Utility of the Future: Integrating EE, DR, DG and Storage
5:00 pm to 6:00pm	Networking Reception - Sponsored by:			

**Day 2**

8:00am to 9:30am	SPEER Member Meeting (Members Only)			
9:00am to 10:00 am	Networking Breakfast - Sponsored by: 			
10:00am to 11:00am	<u>Grand Ballroom:</u> Keynote: Hunter Lovins, President of Natural Capitalism Solutions			
11:00am to 11:45am	<u>Grand Ballroom:</u> Introductory Plenary Panel			
	Christopher Lubeck, OSRAM Sylvania	Colin Bishopp, Renewable Funding	Cade Burks, Mission: Data	David Walters, Walters Power, former Governor of Oklahoma
12:00pm to 1:00pm	<u>Breakout Sessions</u>			
	<u>Preston Trail:</u> Lighting: Has the Market Transformed?	<u>Bent Tree:</u> Financing Residential Retrofits	<u>Mesquite I:</u> Creating a Smart Energy Roadmap: Using Data to Drive Efficiency	<u>Mesquite II:</u> Distributed Energy Resources
1:00pm to 2:30pm	Lunch with Guest Speaker: <i>The Future of Smart Technology: What Consumers Want.</i> Tom Kerber, Director, Research, Home Controls & Energy - Parks Associates			

Thank you to our Summit 2015 Sponsors!



**THE MEADOWS FOUNDATION**  
serving the people of Texas



6.4.5.5 Clean Air Through Energy Efficiency (CATEE 2015)

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

The following pages are conference program and list of sponsors from the CATEE 2015.

**CATEE 2015 Program**

<b>Tuesday, Dec. 1 – Pre-Conference Workshops</b>	
9:00am – 12:00pm	Putting PACE Into Action (.275 CEU/2.75 PDH) <ul style="list-style-type: none"> <li>• Moderator: Gavin Dillingham, Ph.D., Research Scientist, City of Houston and Houston Advanced Research Center</li> <li>• Jonathon Blackburn, Managing Director, Texas PACE Authority</li> <li>• Stephen Block, Attorney, Thompson &amp; Knight, LLP</li> <li>• Charlene Heydinger, Executive Director, Texas PACE Authority. Keeping PACE in Texas</li> <li>• Heather Lepaska, Program Manager, City of Dallas</li> <li>• Craig Smith, Assistant Travis County Attorney, Travis County Attorney’s Office</li> <li>• David Robins, Partner, Jackson Walker LLP</li> </ul>
9:00am – 12:00pm	Continuous Commissioning® (.275 CEU/2.75 PDH) <ul style="list-style-type: none"> <li>• Joseph Martinez, PCC, Associate Director, Energy Systems Laboratory</li> <li>• Carlos Yagua, P.E., Assistant Research Engineer, Energy Systems Laboratory</li> </ul>
1:30pm – 5:30pm	School Facilities EE/RE Strategies (Sponsored by McKinstry) (.35 CEU/3.5 PDH) <ul style="list-style-type: none"> <li>• Moderator: Michael Grabham, Regional Director – South, McKinstry</li> <li>• Bobbie Reilly, Sales Engineer, LG Electronics (VRF Technology)</li> <li>• Eric Cotney, Vice President of Sales and Marketing, Axiom Solar</li> <li>• Jim Watt, P.E., Principal Engineer, Green Star Engineering</li> <li>• Thursten Simonsen, P.E., Account Executive, McKinstry</li> <li>• Eddy Trevino, P.E., CEM, Program Manager, State Energy Conservation Office</li> </ul>
<b>Wednesday, Dec. 2 – Day One of Conference (.575 CEU/5.75PDH)</b>	
7:30am – 5:00pm	Registration & Information Desk Open
8:00am – 8:00pm	<b>Expo Arena Open</b>
9:00am – 10:30am	<b>Opening Plenary:</b> <ul style="list-style-type: none"> <li>• Conference Opening &amp; Introductions, Betin Santos, CATEE Conference Executive Director</li> <li>• Welcome, James V. A. Abbey, Ph.D., Director for Global and Corporate Partnerships, The Texas A&amp;M University System</li> <li>• Keynote Speaker: Community at its Core – Climate, Energy and the EPA’s Clean Power Plan, Matthew Tejada, Ph.D., Director, Office of Environmental Justice, Environmental Protection Agency</li> </ul>
10:30am – 11:00am	<b>Refreshment Break in Expo Arena</b>
11:00am – 12:30pm	<b>Concurrent Breakout Sessions:</b> <ul style="list-style-type: none"> <li>• Collaborative Efforts to Support Adoption of New Building Energy Codes, Moderator: Fred Yebra, P.E., State Energy Conservation Office                             <ul style="list-style-type: none"> <li>○ Chris Herbert, Managing Director, SPEER</li> </ul> </li> </ul>



	<ul style="list-style-type: none"> <li>○ Shirley Ellis, <i>Energy Codes Specialist, Energy Systems Laboratory</i></li> <li>○ Kevin Taylor, <i>Vice President, Code Consultant, Texas BBG Construction, Inc.</i></li> <li>• Texas Transportation, Mobility and Air Quality, <i>Moderator: Tom Fitzpatrick, Tom Fitzpatrick Consulting</i> <ul style="list-style-type: none"> <li>○ TERP Program Update, Steve Dayton, <i>Technical Specialist, Implementation Grants Section, TCEQ</i></li> <li>○ Austin and Rocky Mountain Institute – <i>Transform Mobility, Greg Rucks, Principal, Rocky Mountain Institute</i></li> <li>○ New Bus Service and Light Rail, Christof Spieler, <i>Board Member, METRO</i></li> <li>○ DFW Airport Energy Efforts, James M. Crites, <i>Executive Vice President, Operations, Dallas/Fort Worth International Airport</i></li> </ul> </li> <li>• Financing Energy Efficiency and Renewable Energy Projects, <i>Moderator: Doug Lewin, Executive Director, SPEER</i> <ul style="list-style-type: none"> <li>○ 179d Tax Credit/Financing, Will Volker, <i>Partner, Efficiency Energy LLC</i></li> <li>○ SECO Loanstar Funding, Eddy Trevino, P.E., <i>CEM, Program Manager, State Energy Conservation Office</i></li> <li>○ WHEEL, Colin Bishopp, <i>Vice President, Renew Financial</i></li> <li>○ Solar Financing Options, Eric Cotney, <i>Vice President of Sales and Marketing, Axiom Solar</i></li> </ul> </li> </ul>
12:30pm – 1:45pm	<p><b>Lunch Presentation</b>  <b>Welcome, Dr. David Claridge, Director, Energy Systems Laboratory The State of the State, Jeff Haberl, Ph.D., Associate Director, Energy Systems Laboratory</b></p>
1:45pm – 3:00pm	<p><b>Concurrent Breakout Sessions:</b></p> <ul style="list-style-type: none"> <li>• Inside Scoop on Texas’s IOU Energy Efficiency Programs, Amy Martin, <i>Vice President of Consulting, Frontier Associates, LLC (EUMMOT)</i> <ul style="list-style-type: none"> <li>○ David Dziarski, <i>Program Manager, CenterPoint Energy</i></li> <li>○ Ashley Mitchell, <i>Energy Efficiency Specialist, Texas-New Mexico Power</i></li> <li>○ Pam Osterloh, <i>Principal Energy Efficiency/Demand Response Coordinator, American Electric Power Texas</i></li> </ul> </li> <li>• Industrial and Large Scale Energy Efficiency Projects, <i>Moderator: Jennifer Ronk, Program Director, Environmental Science and Energy Efficiency, Houston Advanced Research Center</i> <ul style="list-style-type: none"> <li>○ Energy Efficiency in Data Facilities, Ward Wilson, <i>Senior Business Development Manager, Panduit, AFCOM</i></li> <li>○ IAC Study Results, Bryan Rasmussen, Ph.D., <i>Director, Industrial Assessment Center, Texas A&amp;M University</i></li> <li>○ Barriers to Energy Efficiency in Industrial Sector, Jennifer Ronk, <i>Program Director, Environmental Science and Energy Efficiency, Houston Advanced Research Center</i></li> </ul> </li> </ul>
3:00pm – 3:30pm	<b>Utility Speed Dating – Texas Utilities</b>
3:00pm – 3:30pm	<b>Refreshment Break in Expo Arena</b>
3:30pm – 5:00pm	<p><b>Plenary Session, Texas and the Clean Power Plan (111d) Policy Update, Moderator: Kate Zerrenner, Manager, Energy-Water Initiative, Environmental Defense Fund</b></p> <ul style="list-style-type: none"> <li>• Clean Power Plan Overview, Doug Lewin, <i>Executive Director, SPEER</i></li> <li>• Clean Power Plan White Paper, John Hall, <i>Texas State Director,</i></li> </ul>



	<p><i>Clean Energy, Environmental Defense Fund</i></p> <ul style="list-style-type: none"> <li>• <i>Panel Discussant, Matthew Tejada, Ph.D., Director, Office of Environmental Justice, Environmental Protection Agency</i></li> </ul>
5:30pm – 8:00pm	<b>Reception in Expo Arena</b>
8:00pm	<b>End of Day One</b>
<b>Thursday, Dec. 3 – Day Two of Conference (.45 CEU/4.5 PDH)</b>	
7:30am – 3:00pm	<b>Registration &amp; Information Desk Open</b>
8:00am – 3:00pm	<b>Expo Arena Open</b>
8:00am – 8:45am	<b>Utility Shark Tank Competition – Texas Utilities</b>
9:00am – 10:30am	<p><b>Plenary Panel – Are We There Yet? Solar Energy’s Road to Grid Parity in Texas,</b></p> <p><i>Moderator: Lenae Shirley, Senior Director, Technology Innovation and Market Adoption, Environmental Defense Fund</i></p> <ul style="list-style-type: none"> <li>• <i>Vishal Shah, Managing Director Deutsche Bank</i></li> <li>• <i>Joshua Rhodes, Ph.D., Postdoctoral Research Fellow, Energy Institute, The University of Texas at Austin</i></li> <li>• <i>Shannon Wagner, Strategic Research &amp; Innovation Manager, Product Development, CPS Energy</i></li> </ul>
10:30am – 10:45am	<b>Refreshment Break in Expo Arena</b>
10:45am – 12:15pm	<p><b>Concurrent Breakout Sessions:</b></p> <ul style="list-style-type: none"> <li>• <i>Innovative Municipal and Regional Programs, Moderator: Lisa Lin, Sustainability Manager, City of Houston</i> <ul style="list-style-type: none"> <li>○ <i>City Energy Project, City of Houston, Marina V. Badoian-Kriticos, Senior Advisor at City of Houston</i></li> <li>○ <i>Energy Efficient Buildings (EEB) Regional Coalition, Claude Griffin, Social Investment Manager Environment, Shell Oil Company</i></li> <li>○ <i>San Antonio and Dallas 2030 Districts, Chris Herbert, Managing Director, SPEER</i></li> </ul> </li> <li>• <i>Energy and Water Efficiency Solutions for Texas, Moderator: Betin Bilir Santos, CATEE Executive Director</i> <ul style="list-style-type: none"> <li>○ <i>The Energy-Water Nexus, Kate Zerrenner, Manager, Energy-Water Initiative, Environmental Defense Fund</i></li> <li>○ <i>Water Supply and Drought Risk in the Electric Reliability Council of Texas (ERCOT), Dana Lazarus, Planning Analyst, Resource Adequacy, Electric Reliability Council of Texas, Inc.</i></li> <li>○ <i>Water Usage and Efficiency in Buildings, Keith Reihl, Commercial Regional Sales Manager, Mitsubishi Electric Cooling and Heating</i></li> </ul> </li> </ul>
12:15pm – 1:45pm	<p><b>CATEE Awards Lunch Presentation</b></p> <p><b>Comments, Representative Tony Dale</b></p> <p><b>Awards Emcee, Betin Bilir Santos</b></p> <p><b>Dessert in Expo Arena</b></p>
1:45pm – 3:15pm	<p><b>Concurrent Breakout Sessions:</b></p> <ul style="list-style-type: none"> <li>• <i>Higher Education Forum on Energy Efficiency, Moderator: Thea Junt, Energy Conservation and Sustainability Manager, The University of Texas at Dallas</i> <ul style="list-style-type: none"> <li>○ <i>UTD Energy Efficiency Sustainability Efforts – Revolving Fund, Thea Junt, Energy Conservation and Sustainability Manager, The University of Texas at Dallas</i></li> <li>○ <i>Alamo College, John Strybos, P.E., Associate Vice Chancellor of Facilities Operation and Construction</i></li> </ul> </li> </ul>

	<p><i>Management, Alamo Colleges</i></p> <ul style="list-style-type: none"> <li>• <i>Power Resilience and Combined Heat and Power (CHP), Moderator: Gavin Dillingham, Ph.D., Research Scientist, Clean Energy Policy, Houston Advanced Research Center</i> <ul style="list-style-type: none"> <li>○ <i>Satish Ravindran, P.E., CEM, LEED Green Associate, Research Associate, Houston Advanced Research Center</i></li> <li>○ <i>Lynn Crawford, P.E., Market Leader Energy and Utilities, AEI/Affiliated Engineers, Inc.</i></li> <li>○ <i>Marcel Blanchard, Associate Vice President – Utilities &amp; Fleet Operations, UTMB-Galveston</i></li> <li>○ <i>Cliff Braddock, Manager Business Development, Pepco Energy Services</i></li> <li>○ <i>Bud Leavell, Regional Sales Manager, Southeast/Southwest, Piller USA Inc.</i></li> </ul> </li> </ul>
3:15pm	<b>Conference Adjourns</b>
3:15pm – 4:15pm	<b>Tour of UTMB new CHP Facility</b>

#### 6.4.5.6 Other Meetings

##### 6.4.5.6.1 The Blue Bonnet Chapter Association Meetings from 2015.

The following pages are meeting notes, agendas, and summaries from the Blue Bonnet Chapter Association meetings from 2015.



## **AGENDA**

**MEETING DATE:** Thursday, February 19, 2015  
**TIME:** Meeting starts at 6:30 please try to arrive early so we can start on time.  
**LOCATION:** Yank Sing, Killeen Texas 1705 E CTE

- 1. CALL TO ORDER**
  - A. Rob Henning, Chapter President  
Prayer / Pledge
- 2. New Members ?**
- 3. GUEST SPEAKER:**
  - Richard Morgan with SPEER
- 4. APPROVE / DISAPPROVE MINUTES:**
- 5. TREASURERS REPORT:**
- 6. OLD BUSINESS:**
  - A. Membership forms need to be updated
- 7. NEW BUSINESS:**
  - A. Scholarship updates
  - B. Meeting place schedules
- 8. ADJOURN**

**PLEASE CHECK OUT OUR WEB SITE AT [www.bluebonneticc.com](http://www.bluebonneticc.com) FOR MEETING DATES/ EVENTS / TRAINING**



## AGENDA

**MEETING DATE:** Thursday, March 19, 2015  
**TIME:** Meeting starts at 6:30 please try to arrive early so we can start on time.  
**LOCATION:** Schoepf's BBQ, 702 East Central Ave, Belton, Texas

1. **CALL TO ORDER**
  - A. Rob Henning, Chapter President  
Prayer / Pledge
2. **New Members?**
3. **GUEST SPEAKER:**
  - Lisa Hill with TSBPE
4. **APPROVE / DISAPPROVE MINUTES:**
5. **TREASURERS REPORT:**
6. **OLD BUSINESS:**
  - A. Update on Electrical Class
  - B. Update on Scholarships from Education Committee
  - C. Discuss and vote on options for updating the Website
  - D. New membership form (check tax number)
  - E. Update financial audit
7. **NEW BUSINESS:**
  - A. Define goals of Education Committee – evaluate scholastic funding investments
  - B. Purchasing promotional stickers and magnets
  - C. Chapter to purchase logo shirts for Officers, committee members and volunteers
  - D. Budget for reoccurring expenses
8. **ADJOURN**

**PLEASE CHECK OUT OUR WEB SITE AT [www.bluebonneticc.com](http://www.bluebonneticc.com) FOR MEETING DATES/ EVENTS / TRAINING**



## AGENDA

**MEETING DATE:** Thursday, July 16, 2015  
**TIME:** Meeting starts at 6:30 please try to arrive early so we can start on time.  
**LOCATION:** Ramonds Southern Kitchen, 417 S Frontage Road I-35, Lorena

1. **CALL TO ORDER**
  - A. Rob Henning, Chapter President  
Prayer / Pledge
2. **New Members?**
3. **GUEST SPEAKER:**
  - John Lain with TDLR-HVAC Enforcement
4. **APPROVE / DISAPPROVE MINUTES:**
5. **TREASURERS REPORT:**
6. **OLD BUSINESS:**
  - A. Financial audit – is being done
  - B. Still need sponsors for CEU class
  - C. Did a proxy vote to fund CEU classes first week in August
  - D. Discussion of By-Laws about opening in Board Members.
7. **NEW BUSINESS:**
  - A. Membership dues
  - B. Any other topic as needed
8. **ADJOURN**

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## AGENDA

**MEETING DATE:** Thursday, September 17, 2015  
**TIME:** 6:30 pm  
**LOCATION:** Ramonds Southern Kitchen, 417 S Frontage Road I-35, Lorena

1. **CALL TO ORDER**
  - A. Rob Henning, Chapter President  
Prayer / Pledge
2. **New Members?**
3. **GUEST SPEAKER:** Julie Caler City of College Station Code Enforcement Supervisor to speak about hoarding.
4. **APPROVE / DISAPPROVE MINUTES:**
5. **TREASURERS REPORT:**
6. **OLD BUSINESS:**
  - A. Financial audit – is being done
  - B. Annual meeting - tabled
  - C. Reminder about Membership dues coming up
7. **NEW BUSINESS:**
  - A. Any other topic as needed
8. **ADJOURN**

**PLEASE CHECK OUT OUR WEB SITE AT [www.bluebonneticc.com](http://www.bluebonneticc.com) FOR MEETING DATES/ EVENTS / TRAINING**



## AGENDA

**MEETING DATE:** Thursday, December 17, 2015  
**TIME:** 6:30 pm  
**LOCATION:** Yank Sing, 1705 E CTE, Killeen Texas

- 1. CALL TO ORDER**
  - A. Rob Henning, Chapter President  
Prayer / Pledge
- 2. New Members?**
- 3. GUEST SPEAKER: TDLR Representative**
- 4. APPROVE / DISAPPROVE MINUTES:**
- 5. TREASURERS REPORT:**
- 6. OLD BUSINESS:**
  - A. No outside audits- Not cost effective
  - B. Member of the year nominations needed ASAP
  - C. Discuss chapter scholarships
  - D. Annual meeting- January 9, 2016
  - E. Vote on 2016 officers
- 7. NEW BUSINESS:**
  - A. Code enforcement classes
- 8. ADJOURN**

**PLEASE CHECK OUT OUR WEB SITE AT [www.bluebonneticc.com](http://www.bluebonneticc.com) FOR MEETING DATES/ EVENTS / TRAINING**

6.4.5.6.2 Other

The following pages are meeting notes, agendas, and summaries from the multiple meetings from 2015.



**ICC Region X Coalition**  
**ICC Region X Coalition Meeting**  
**August 19, 2015 in room #3 at 5:30 PM**  
**2015 Boat Conference**  
**Hilton Garden In and Convention Center**  
**2910 South Cowhorn Creek Loop**  
**Texarkana, TX 75503**  
**MEETING AGENDA**

Note: The Board may discuss, vote to approve, vote to disapprove, vote to table or decide not to discuss any item on the agenda.

- I. Call to order and recording of members present and absent
- II. Introductions
- III. Action Items:
  - A. Approval of May 15, 2015 Meeting Minutes
  - B. Treasurer's Report
  - C. Membership update
  - D. ICC Committees and Appointments
  - E. Assistance to attend the 2015 Annual Conference in Long Beach, California
  - F. Future meeting dates and locations
  - G. Discuss support request for ICC Board of Directors
  - H. Discuss "What's Next"
  - I. ICC update
  - J. Open Discussion
- IV. New Business/Old Business
- V. Adjournment





# GLOBAL FORUM 2015 PROGRAM

*Earthquake Preparedness and Recovery within the Frame of Disaster Risk Reduction (DRR) in the World: Are Building Codes the Ultimate Solution?*

Long Beach, CA

September 28

1:30 — 1:40 GLOBAL FORUM OPENING



- Introduction - **Raj Nathan**, Head ICC Global Services
- Words by **Dominic Sims**, CEO, ICC
- Words by **Guy Tomberlin**, CBO, ICC Board President

1:40 — 2:10 Keynote Address



*"When Life Safety Isn't Enough"* by **Dr. Lucile M. Jones**, US Geological Survey Seismologist, and Visiting Research Associate at the Seismological Laboratory of Caltech, **USA**

2:10 — 2:20



*"L.A. City Wood Soft Story Building Retrofit Program"* by **Mr. Raymond S. Chan**, General Manager, Los Angeles Department of Building and Safety, **USA**

2:20 — 3:05 PANEL 1



*"The Role of International Support in Building Regulatory Capacity for Disaster Risk Reduction in Low and Middle-income Countries"* by **Thomas Moullier**, Senior Private Sector Development Specialist, Trade & Competitiveness, The World Bank, **GLOBAL**



**AND**  
**Dr. Frederick Krimgold**, Director, Disaster Risk Reduction Program, Advanced Research Institute, Virginia Polytechnic Institute and State University, **USA**

3:05 — 3:10 *Coffee Break*



3:10 — 3:30



*"Earthquake Preparedness and Recovery in Japan"* by **Mr. Ogasawara Izumi**, Manager, Building and Environment Coordination Division, Building Instruction Department, Housing and Architecture Bureau, City of Yokohama, Kanagawa Prefecture, **JAPAN**

3:30 — 4:10 **PANEL 2**

*"Development and Implementation of National Building Code in Nepal: Experiences and Challenges"* by **Dr. Amod Dixit**, Executive Director, National Society for Earthquake Technology (NSET) – **NEPAL**



*"Strengthening Building Code Implementation and Compliance in Developing Countries: A Case Study of Nepal"* by **Dr. Ayse Hortacsu**, Director of Projects at the Applied Technology Council (ATC) and Member of the EERI Housner Fellows, **USA**

4:10 — 4:30



*"Improving Community Resilience Through Public-Private Partnerships: The BORP Strategy"* by **David Cocke, S.E., F. SEI, F. ASCE**, Principal, Structural Focus Consulting; EERI Board of Directors, Structural Engineers Institute, Board of Governors, **USA**

4:30 — 5:25 **PANEL 3**

*"Partnership Response Effectiveness Immediately Following the Christchurch Earthquake 22 February 2011"* by **Nicholas W. Hill**, Chief Executive, Building Officials Institute, **NEW ZEALAND**

**AND**

**Stu Geddes**, President, Building Officials Institute, **NEW ZEALAND**



*"Christchurch Earthquake Recovery: The Long Journey"* by **Ron Dickinson**, Chair of the Alliance of Canadian Building Official's Associations, **CANADA**

5:25 — 5:30 **CONCLUSIONS, RECOGNITIONS AND CLOSING REMARKS**

by **Mr. Chuck Ramani**, ICC Global Services; President, International Accreditation Service

\*Earn CEUs for attending the Global Forum. See **Nancy Libby** for details.

**2015 PUBLIC COMMENT HEARINGS SCHEDULE  
September 30 – October 5, 2015  
Long Beach Convention Center  
Long Beach, CA**

The upcoming 2015 ICC Annual Conference, Group A Public Comment Hearings and Expo will be utilizing the same schedule as last year. The Annual Business meeting will be on Monday, September 28<sup>th</sup> and the conference activities will conclude on Tuesday, September 29<sup>th</sup> with the Annual Banquet. [Click here](#) for the conference schedule.

The Public Comment Hearings will start on Wednesday, September 30<sup>th</sup> at 8:00 am. The schedule anticipates that the hearings will be completed no later than 7:00 pm on Monday, October 5<sup>th</sup>. This may require adjustments to the daily start/end times based on hearing progress. As was done for the Committee Action Hearings, the codes are scheduled with the Plumbing/Mechanical/Fuel Gas (PMG) codes followed by the Building related codes, starting with the IPMZC.

Unless noted by "Start no earlier than 11:00 am", the hearing on each code will begin immediately upon completion of the hearing for the prior code. This includes moving the code up or back from the day indicated based on hearing progress. Actual start times for each code cannot be stipulated due to uncertainties in hearing progress. Be sure to review the tentative hearing order in the Public Comment Agenda (to be posted by August 28<sup>th</sup>) for code changes that are heard with a code other than that indicated by the code change prefix (see note 4).

Wednesday September 30	Thursday October 1	Friday October 2	Saturday October 3	Sunday October 4	Monday October 5
Start 8 am	Start 8 am	Start 8 am	Start 8 am	Start 10 am	Start 8 am
ISPSC	IRC – M	IEBC	IBC – FS	IBC – G	IBC - G
IFGC	IMC	IBC – E	IBC - G		
IPC/IPSDC	IPMZC (Start no earlier than 11:00 am)	IBC – FS			
IRC – P					
IRC - M	IEBC				
End 7 pm	End 7 pm	End 7 pm	End 7 pm	End 7 pm	Finish 7 pm

**SEE PAGE TWO FOR NOTES AND LIST OF CODES**

**Hearing Schedule Notes:**

1. Daily start and end hearing times are subject to change based on progress.
2. Mid-morning, lunch and mid-afternoon breaks to be announced. The hearings are scheduled without a dinner break.
3. Due to the uncertainties in the hearing process, the start time indicated as "Start no earlier than 11 am" is conservatively estimated and is not intended to be a scheduled target.
4. Consult the hearing order for code changes to be heard with a code other than the code under which the code change is designated.

**Codes: (be sure to consult the Cross Index of Proposed Code Changes with Public Comments for changes heard with a different code)**

IBC – E: International Building Code – Egress provisions

IBC – FS: International Building Code – Fire Safety provisions

IBC – G: International Building Code – General provisions

IEBC: Non-structural provisions in the International Existing Building Code

IFGC: International Fuel Gas Code

IMC: International Mechanical Code

IPC/IPSDC: International Plumbing/Private Sewage Disposal Code (no public comments received to the IPSDC)

IPMZC: International Property Maintenance and Zoning Codes (no code changes received to the IZC)

IRC – M: Mechanical provisions in the IRC

IRC – P: Plumbing provisions in the IRC

ISPSC: International Swimming Pool and Spa Code

**2015 IECC: Not Just a Good Idea, It's (Soon) the Law: Updating Commercial and Residential Buildings to Comply with the New Energy Code**

*In 2015, the Texas legislature passed a law requiring all single-family construction to meet the energy chapter of the 2015 IRC by September, 2016. In addition, the State Energy Conservation Office (SECO) is proposing rules requiring cities to adopt the 2015 IECC (or its equivalent) for other buildings. Learn what these codes will mean for the cities that must adopt them, and the builders and service providers who must comply with them. Participants will earn three hours of CEU credit while learning about the 2015 IECC. Light snack and refreshments provided.*

**Agenda - November 11, 2015**

**1:05 PM to 1:20 PM:** Introduction to Building Energy Codes Training and Upcoming Decision-Making Timelines

Cyrus Reed, Conservation Director, Lone Star Chapter, Sierra Club

**1:25 to 2:00 PM.** Legislative and Administrative Directives and the State's Role on 2015 IRC and 2015 IECC Adoption  
Fred Yebra, Texas State Energy Conservation Office (SECO)

**2:05 to 2:45 PM.** Implementing 2015 IECC at the local level: Opportunities and Challenges from Austin Energy's perspective  
John Umphress, Conservation Program Specialist, Austin Energy Green Building Program

**2:45 to 3:00 PM:** Coffee and Snacks

**3:05 to 4:25 PM.** 2015 IECC/IRC Building Energy Code Training  
Shirley Ellis, Codes Specialist, Energy Systems Laboratory, TX A&M University

## **2015 IECC: Not Just a Good Idea, It's (Soon) the Law: Updating Commercial and Residential Buildings to Comply with the New Energy Code**

*In 2015, the Texas legislature passed a law requiring all single-family construction to meet the energy chapter of the 2015 IRC by September, 2016. In addition, the State Energy Conservation Office (SECO) is proposing rules requiring cities to adopt the 2015 IECC (or its equivalent) for other buildings. Learn what these codes will mean for the cities that must adopt them, and the builders and service providers who must comply with them. Participants will earn three hours of CEU credit while learning about the 2015 IECC. Light snack and refreshments provided.*

### **Agenda, Day 1. Residential Codes - November 16, 2015**

#### **10:00 to 10:15 AM: Registration and Introductions**

Ron Roth, City of El Paso and Ray Aduato, El Paso Association of Builders

#### **10:15 to 10:35 AM: Introduction to Building Energy Codes Training and Upcoming Decision-Making Timelines**

Cyrus Reed, Conservation Director, Lone Star Chapter, Sierra Club

#### **10:35 to 11:05 AM. Legislative and Administrative Directives and the State's Role on 2015 IRC and 2015 IECC Adoption**

Fred Yebra, Texas State Energy Conservation Office (SECO)

#### **11:05 to 12:00 PM. Looking forward to the 2015 Austin Energy Code: Opportunities and Challenges from Austin Energy's perspective on residential codes**

John Umphress, Conservation Program Specialist, Austin Energy Green Building Program

#### **12:00 to 1:00 PM: Lunch Break**

#### **1:00 to 4:00 PM. 2015 IECC/IRC Building Energy Code Training**

Shirley Ellis, Codes Specialist, Energy Systems Laboratory, TX A&M University



## **2015 IECC: Not Just a Good Idea, It's (Soon) the Law: Updating Commercial and Residential Buildings to Comply with the New Energy Code**

*In 2015, the Texas legislature passed a law requiring all single-family construction to meet the energy chapter of the 2015 IRC by September, 2016. In addition, the State Energy Conservation Office (SECO) is proposing rules requiring cities to adopt the 2015 IECC (or its equivalent) for other buildings. Learn what these codes will mean for the cities that must adopt them, and the builders and service providers who must comply with them. Participants will earn three hours of CEU credit while learning about the 2015 IECC. Light snack and refreshments provided.*

### **Agenda, Day 1. Commercial Codes** *November 17, 2015*

#### **9:00 to 9:15 AM: Registration and Introductions**

Ron Roth, City of El Paso and Ray Aduato, El Paso Association of Builders

#### **9:15 to 9:35 AM: Introduction to Building Energy Codes Training and Upcoming Decision-Making Timelines**

Cyrus Reed, Conservation Director, Lone Star Chapter, Sierra Club

#### **9:35 to 10:05 AM. Legislative and Administrative Directives and the State's Role on 2015 IRC and 2015 IECC Adoption**

Fred Yebra, Texas State Energy Conservation Office (SECO)

#### **11:05 to 11:00 AM. Looking forward to the 2015 Austin Energy Code: Opportunities and Challenges from Austin Energy's perspective in commercial space**

John Umphress, Conservation Program Specialist, Austin Energy Green Building Program

#### **11:00 to 12:00 PM. 2015 IECC/IRC Building Energy Code Training** Shirley Ellis, Codes Specialist, Energy Systems Laboratory, TX A&M University

#### **12:00 to 1:00 PM: Lunch Break**

#### **1:00 to 4:00 PM. 2015 IECC/IRC Building Energy Code Training** Shirley Ellis, Codes Specialist, Energy Systems Laboratory, TX A&M University

AGENDA

San Antonio Chapter of CSI Chapter Meeting  
Outback Steak House  
April 21, 2015, 5:00 p.m.

1. Network/ Socialize
2. Dinner
3. Welcome/ Call to Order
4. Program – Shirley Ellis – 2015 IECC Changes to the Building Code
5. Old Business
  - Chapter's Scholarships – Update
  - South Central Region Conference – Spring, 2015, Lubbock
  - Other?
6. New Business
  - Next Meeting at Outback Steak House on May 19, 2015 at 5:00 p.m.?
  - Other?
7. Adjournment



## **Texas Energy Code Compliance Collaborative**

**December 10, 2015**

Texas Municipal League Office  
1821 Rutherford Lane, Suite 400,  
Austin, Texas 78754

### **Agenda**

This is the quarterly meeting of the Collaborative.

1. Code Adoption & Training Update
2. 2015 Residential Energy Code - ERI
3. Alternative Compliance & Affected Counties
4. SPEER Resources
  1. 2015 Adoption Toolkit
  2. Ambassador Recruitment and Training
5. Texas Field Study Initial Results



## Women in Code Enforcement and Development



Women in Code Enforcement and Development  
Chapter Meeting Agenda  
September 28, 2015  
Long Beach Convention Center, Room 202A  
Long Beach, CA  
5:30 PM (PDT)

1. Call to Order: 5:30 PM
2. Roll Call:  
  
Officers  
President, Eirene Oliphant, MCP  
Vice President, Amber Armstrong, CBO  
Secretary/Treasurer, Kecia Lara, CFM  
Past President, Shirley Ellis
3. Approval of Minutes  
September 28, 2014 Meeting
4. Treasurer's Report
5. Old Business  
Chapter training benefit
6. New Business  
Proposed bylaw changes  
Virginia Subchapter  
Habitat for Humanity
7. Announcements and Acknowledgements
8. Adjournment

#### 6.4.6 Papers, Theses, etc.

##### 6.4.6.1 Theses and Dissertations.

###### 6.4.6.1.1 Published Theses and Dissertations in 2015

There are no TERP related theses or dissertations in 2015.

###### 6.4.6.1.2 Theses and Dissertations to be published in 2016

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

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

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

To accomplish the peak cooling load method comparisons, three steps were taken.

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

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

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

## 6.4.6.2 Papers

### 6.4.6.2.1 Published Papers in 2015

The following papers were published in 2015 incorporating work related to the Texas Emissions Reduction Plan (TERP).

- Kim, K.H.; Haberl, J. S., October 2015 “Development of a home energy audit methodology for determining energy-efficient, cost-effective measures in existing single-family houses using an easy-to-use simulation.” *Building Simulation*, Vol. 8 Issue 5.

This study developed a home energy audit methodology for determining energy-efficient, cost-effective measures in existing single-family houses using an easy-to-use simulation. The overall goal of this study was to provide an easy-to-use, time-saving home energy audit for users who are not familiar with building physics and building energy simulation programs such as homeowners, etc. The methodology that was developed can identify the cause of over-consumption in a house prior to a walk-through investigation by showing where the energy is inefficiently being used when compared to houses of similar sizes in similar climates. In order to accomplish this, a methodology for an easy-to-use, calibrated simulation that can determine potential energy conservation measures for existing single-family houses was developed. In addition, to verify the methodology, the results were compared to those obtained from a detailed, as-built residential energy simulation to determine if both the simulation results identified the same potential energy conservation measures. As a result, it was found that the easy-to-use simulation can be used as an as-built simulation for a home energy audit procedure with acceptable results for the case-study house.

Link: <http://link.springer.com/article/10.1007%2Fs12273-015-0238-3>

- Kim, K.H.; Haberl, J. S., March 2015. “Development of Methodology for Calibrated Simulation in Single-family Residential Buildings Using Three-parameter Change-point Regression Model.” *Energy and Buildings* 99.

This study developed a methodology for a calibrated simulation of single-family residential buildings using a three-parameter change-point regression model. This new method provides a reproducible systematic and consistent calibration procedure. The procedure consists of two parts: a sensitivity analysis that can analyze the characteristics of the building; and a calibration procedure that uses the results of the sensitivity analysis. In the first part, the characteristics of the case-study house were analyzed using a detailed sensitivity analysis with a three-parameter change-point regression model. In this procedure, the most to least influential parameters for each three-parameter coefficient for the house were identified. Next, the identified parameters for each three-parameter coefficient were adjusted to closely match the actual building energy use of the house. Using the procedure, the 36.9% global CV (RMSE) of the initial simulation was improved to 8.8% after calibrated simulation, which is within the accuracy criterion according to the ASHRAE Guideline 14-2014. This study was conducted using a case-study house in a hot and humid climate. However, the procedure developed should be useful for other climates as well. In addition, the results of calibrated simulation can help determining energy efficient measures that are appropriate for the house in the future.

Link: [https://www.researchgate.net/publication/276155011\\_Development\\_of\\_Methodology\\_for\\_Calibrated\\_Simulation\\_in\\_Single-family\\_Residential\\_Buildings\\_Using\\_Three-parameter\\_Change-point\\_Regression\\_Model](https://www.researchgate.net/publication/276155011_Development_of_Methodology_for_Calibrated_Simulation_in_Single-family_Residential_Buildings_Using_Three-parameter_Change-point_Regression_Model)

- Jeong, W. S.; Kim, J. B.; Clayton, M. J.; Haberl, J. S.; Yan, W., 2015. "A framework to integrate object-oriented physical modelling with building information modelling for building thermal simulation." *Journal of Building Performance Simulation* Volume 9, Issue 1, 2016

This paper presents a framework for integrating building information modelling (BIM) and object-oriented physical modelling-based building energy modelling (BEM) focusing on thermal simulation to support decision-making in the design process. The framework is made of a system interface between BIM and Modelica-based BEM and the visualization of simulation results for building designers. The interface consists of the following two major features: (1) pre-processing BIM models to add required thermal parameters into BIM and generate the building topology and (2) translating BIM to Modelica-based building energy modelling automatically and running the thermal simulation. The visualization component presents the simulation results in BIM for designers to understand the relationship between design decisions and the building performance. For the framework implementation, we have created a ModelicaBIM library and utilized the Modelica Buildings library developed by the Lawrence Berkeley National Laboratory. We conducted a case study to demonstrate and validate the framework simulation results.

Link: <http://www.tandfonline.com/doi/full/10.1080/19401493.2014.993709>

- Kim, A.; Haberl, J.S.; Anderson, S., 2015. "Comparison between Current Industry Methods and an Energy Simulation Model for Quantifying Energy Service Projects." *J. Archit. Eng.*, 10.1061/(ASCE)AE.1943-5568.0000192, 04015016.

Different techniques and guidelines are available to select and quantify the savings from energy service projects. In this article, a comparison is presented between the engineering algorithms supported by energy service performance contract technical reference manuals and an as-built, calibrated whole-building energy simulation model. A lighting energy retrofit measure was selected to demonstrate the methodologies. The results show that the industry methods of quantifying the total savings for the lighting energy retrofit measure underreported the savings as compared with the as-built, calibrated whole-building energy simulation model. In particular, the breakdown of savings (e.g., electricity savings, adjustments to energy savings, and demand savings) was inconsistent between the various industry methods that are currently in use. The differences identified in this study were location specific and weather driven, and also included agreements with the local utility companies to quantify the demand savings. The study results also indicate that substituting a single measured occupancy parameter did not improve the current industry methods.

Link: <http://ascelibrary.org/doi/10.1061/%28ASCE%29AE.1943-5568.0000192>

- Kim, A.; Anderson, S.; and Haberl, J. S., 2015. "Current Industry Methods for Quantifying Energy Service Projects: Key Findings and Lessons Learned." *J. Archit. Eng.*, 10.1061/(ASCE)AE.1943-5568.0000191, 04015015.

The use of energy service performance contracts (ESPCs) has become a popular method for financing energy conservation upgrades. To date, the use of the stipulated savings approach, often expressed as tables and equations, has been a popular method for calculating energy savings in ESPCs. However, no studies to date have confirmed or denied the literature findings regarding the use and acceptance of this method in the current industry through a systematic investigation. Therefore, this research identified other practices by conducting an ethnographic study with subject-matter experts, by reviewing publicly available technical reference manuals, and by analyzing a typical utility assessment report from a recent ESPC. In particular, the methods for quantifying lighting and lighting control measures were explored in detail. The findings indicate that the current industry relies on a stipulated savings method as a foundation for determining the baseline and postretrofit savings. In addition, the current industry relies on experienced engineers and their valuable tactical and institutional knowledge to build upon the stipulated equations and tailor them to individual projects.

Link: <http://ascelibrary.org/doi/10.1061/%28ASCE%29AE.1943-5568.0000191>

#### 6.4.6.2.2 Papers to be published in 2016

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

- Oh, S.; Haberl, J.S., 2016. “Origins of analysis methods used to design high-performance commercial buildings: Whole-building energy simulation.” Science and Technology for the Built Environment (formerly HVAC&R Research),
- Oh, S.; Haberl, J.S., 2016. “Origins of analysis methods used to design high-performance commercial buildings: Solar energy analysis.” Science and Technology for the Built Environment (formerly HVAC&R Research),
- Oh, S.; Haberl, J.S., 2016. “Origins of analysis methods used to design high-performance commercial buildings: Daylighting Simulation.” Science and Technology for the Built Environment (formerly HVAC&R Research),

#### 6.5 Solar Test Bench

#### 6.6 Solar Test Bench

This section introduces the activities that were carried out to STB during the calendar year of 2015, and the activities summary is listed as follow:

- Regular maintenance
- Weekly report.

#### 6.6.1 Solar Test Bench Setup

The whole STB setup comprises the sensors indicated in **Error! Reference source not found.**, which includes the sensor name, make, model and serial number along with the multiplier, offset and unit.

Table 33. List of the sensors updated to the end of 2015

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

## 6.6.2 2015 STB Activities

### 6.6.2.1 Regular Maintenance

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

### 6.6.2.2 Weekly Report

The data logger downloaded data have been checked every week, and the STB data was compared with NOAA data in STB weekly report.

## 6.6.3 Future work Plan

### 6.6.3.1 Camera Installation

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

### 6.6.3.2 Wire Protection in Mechanical Room

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

#### 6.6.4 Acknowledgements

This task could not be completed without the help of many students/staffs among another Mr. Sukjoon Oh, Mr. Minjae Shin, Ms. Chunliu Mao, Mr. Yifu Sun, Dr. Sunglok Do, from ESL, TAMU.



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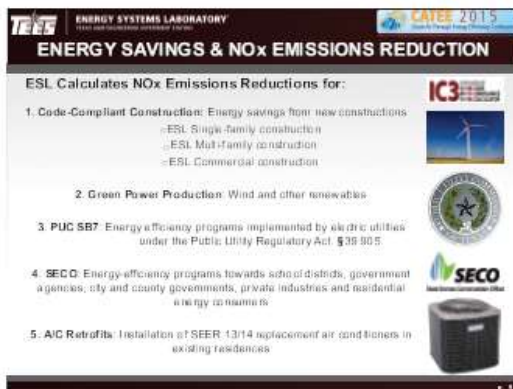
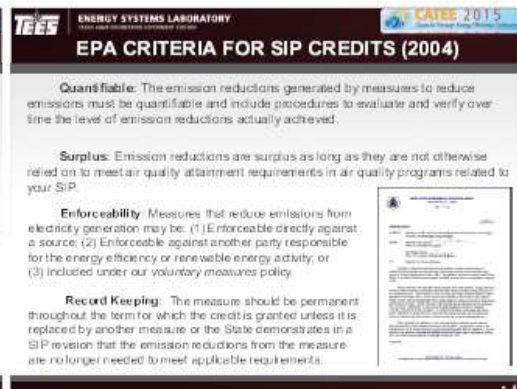
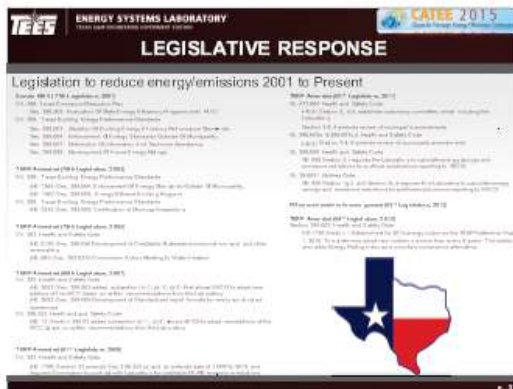
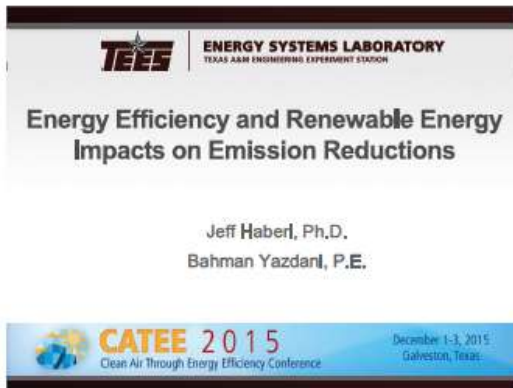
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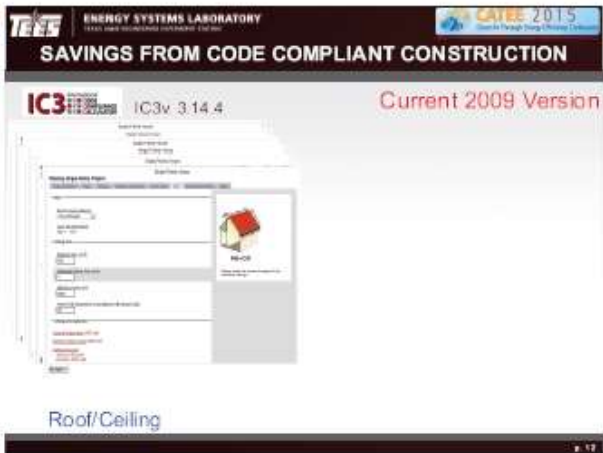
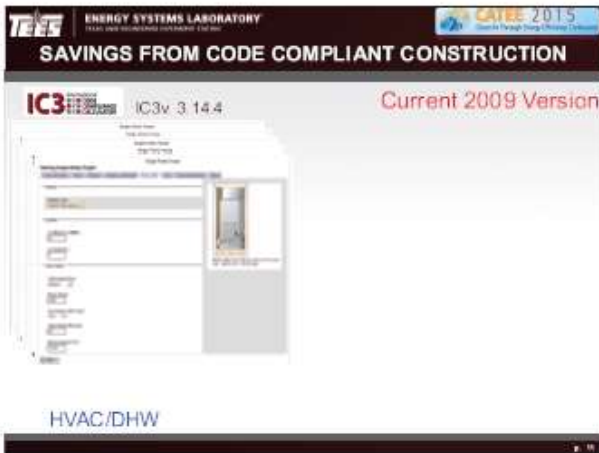
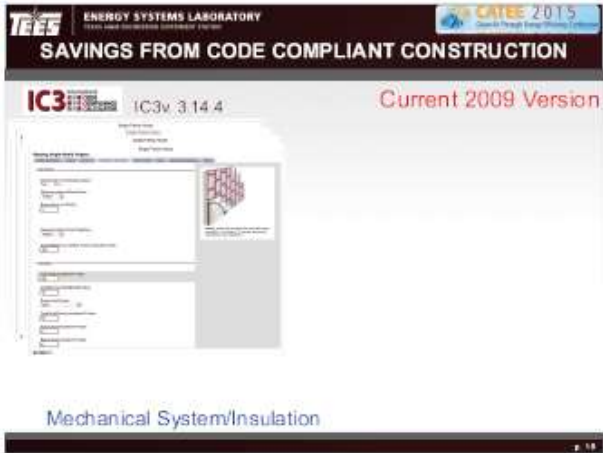
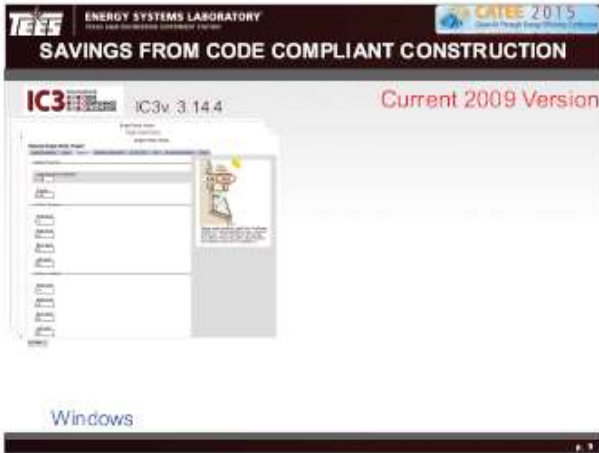
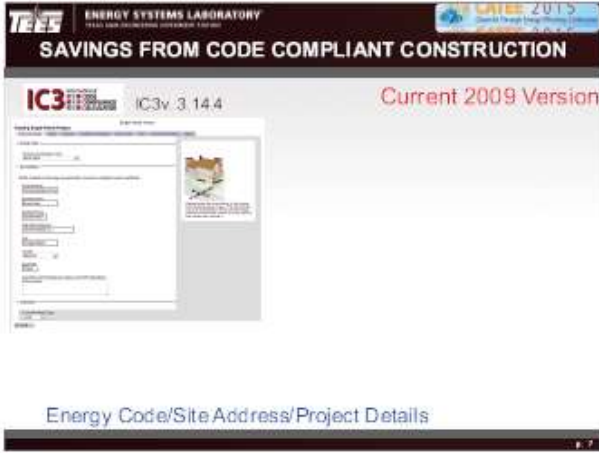


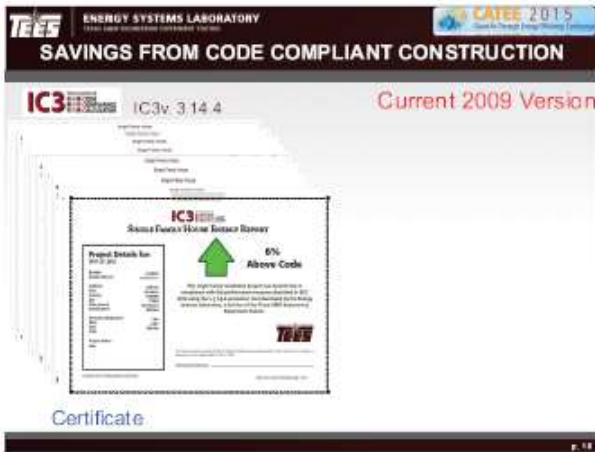
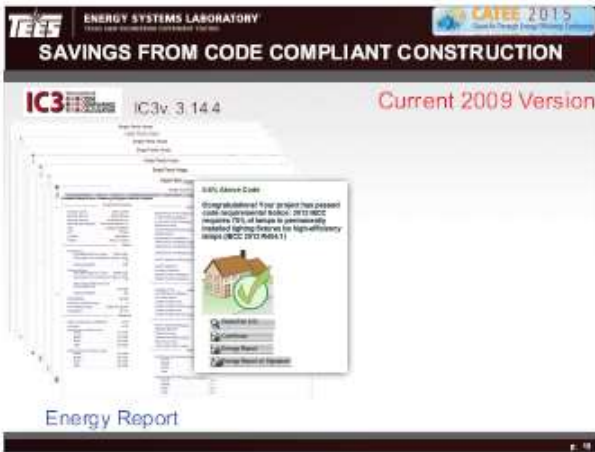
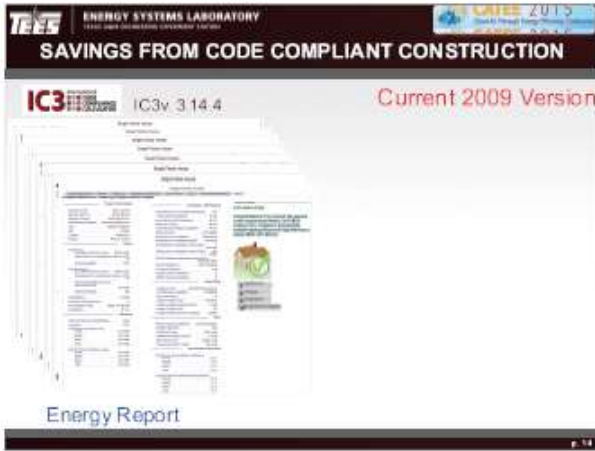
Appendix: Presentations to Various Entities at Conferences and Workshops in 2015

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 Emissions Reductions,” CATEE conference Galveston, TX Dec 2015, presented by Jeff Haberl.



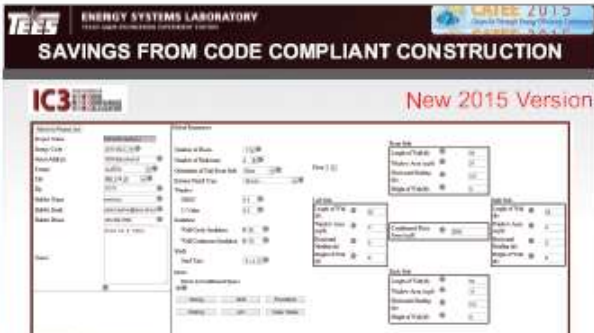








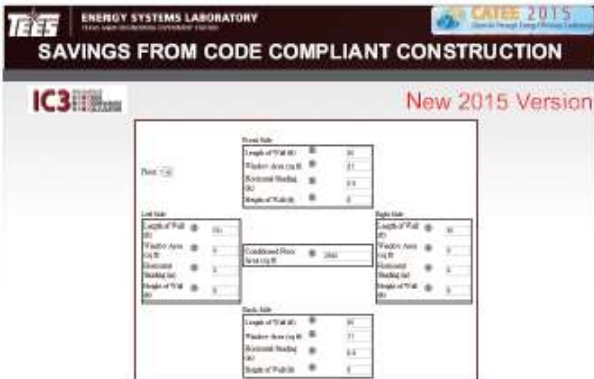
Login Screen



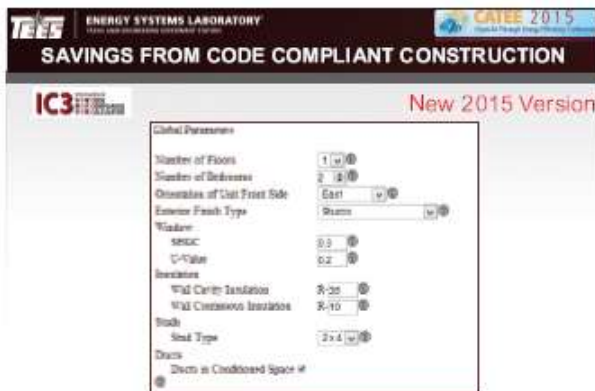
Main Page



Energy Code/Site Address/Project Details



Floors/BedRooms/Foundation



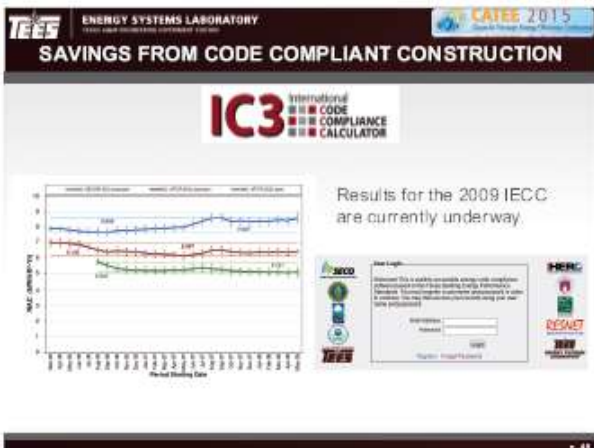
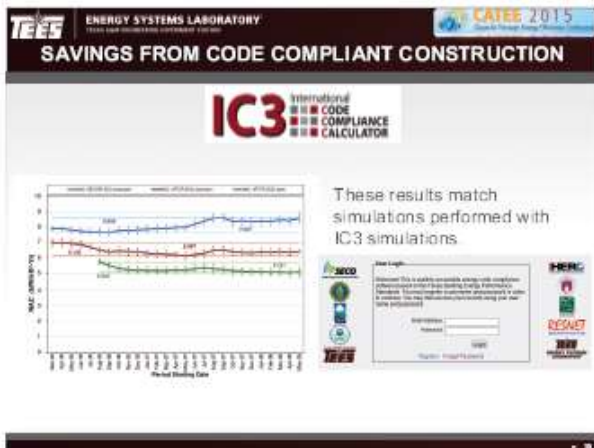
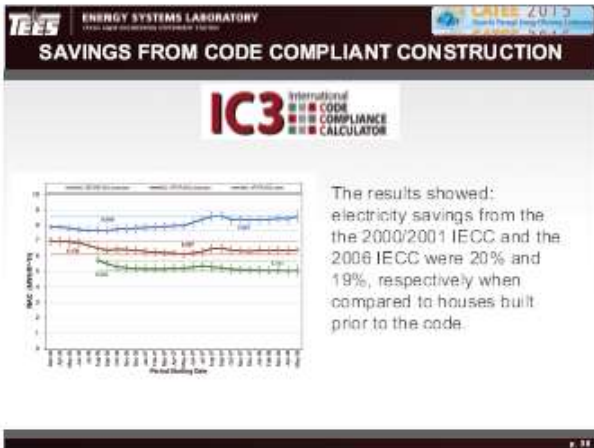
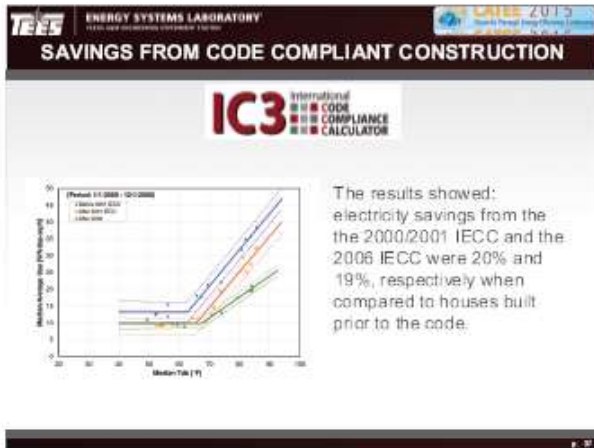
Global Parameters











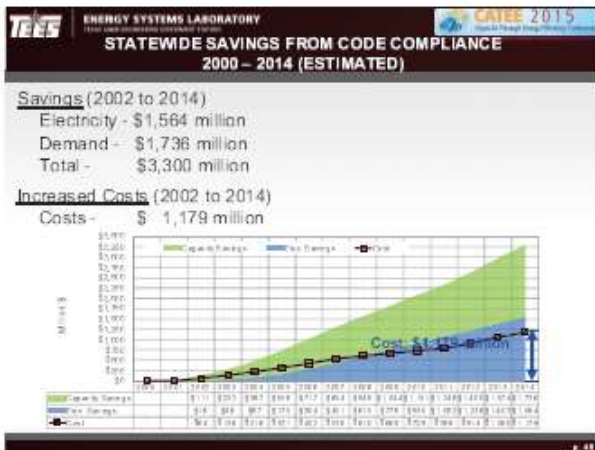
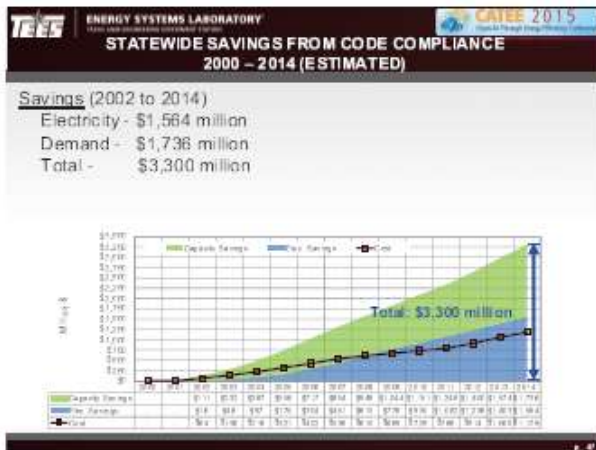
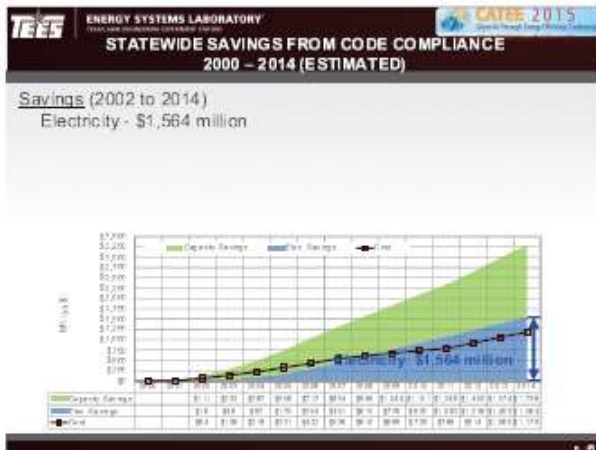
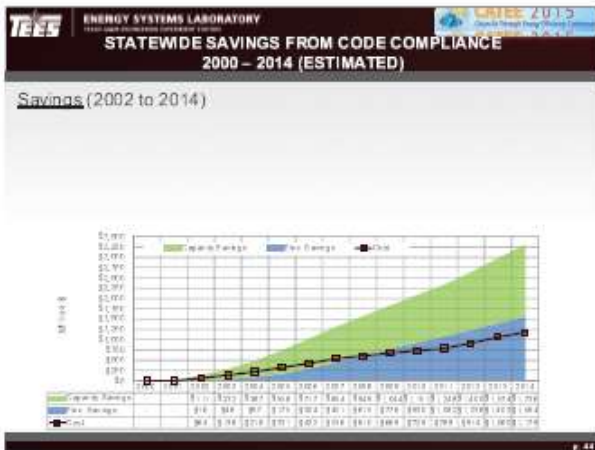
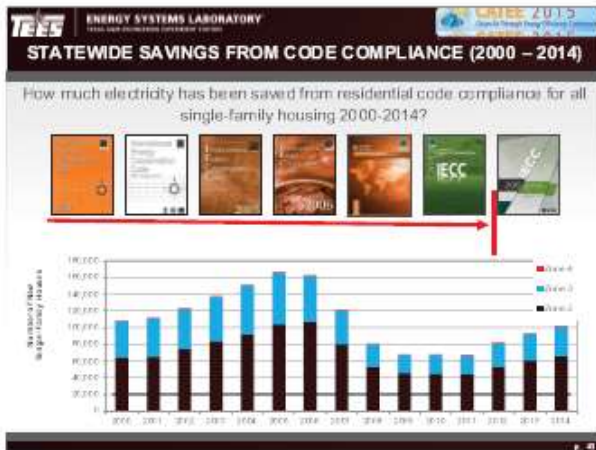
**New API for IC3**

IC3 Web: <http://ic3.2015.tamu.edu>

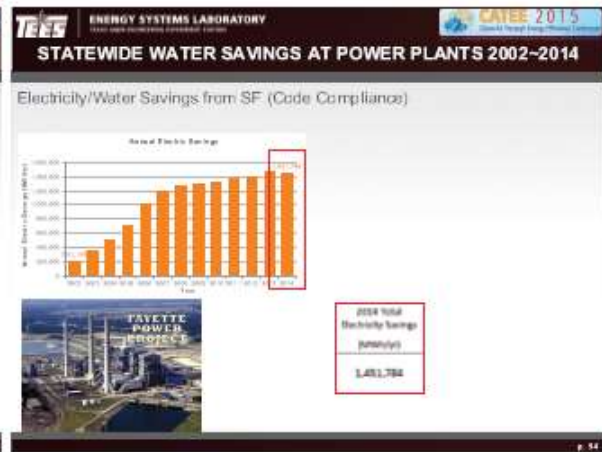
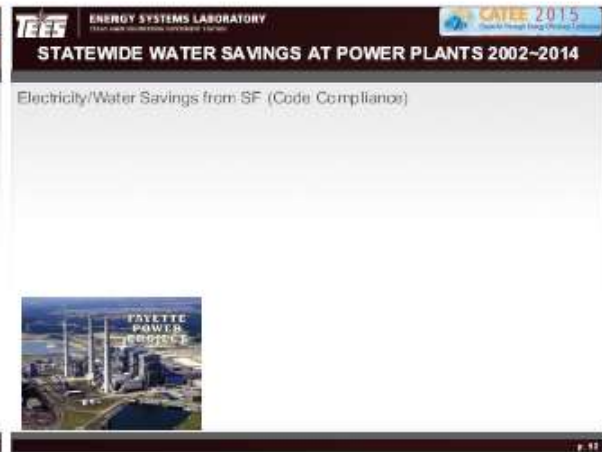
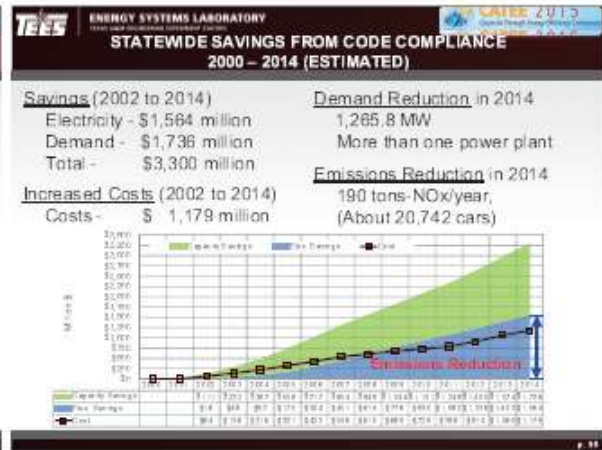
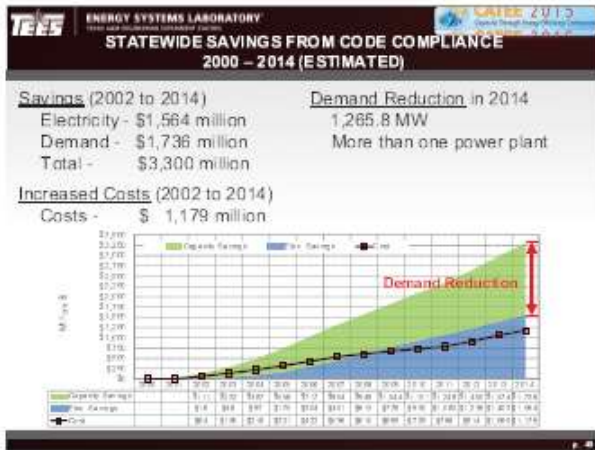
**Benefits from API:**

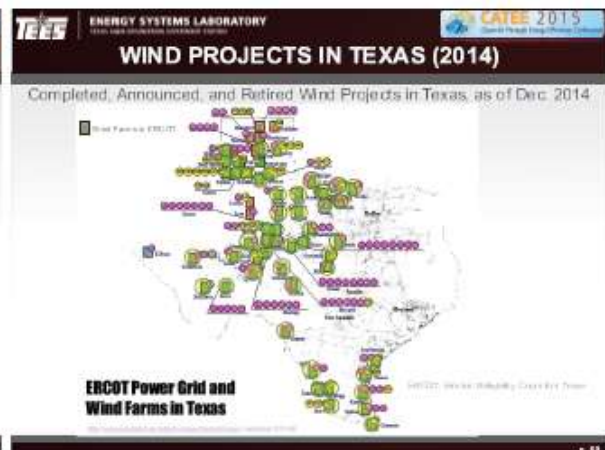
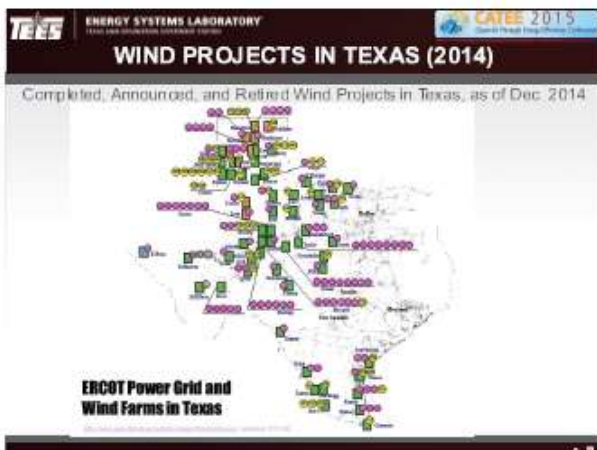
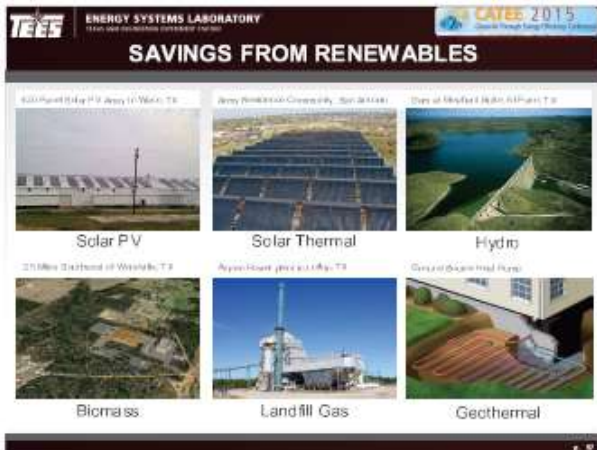
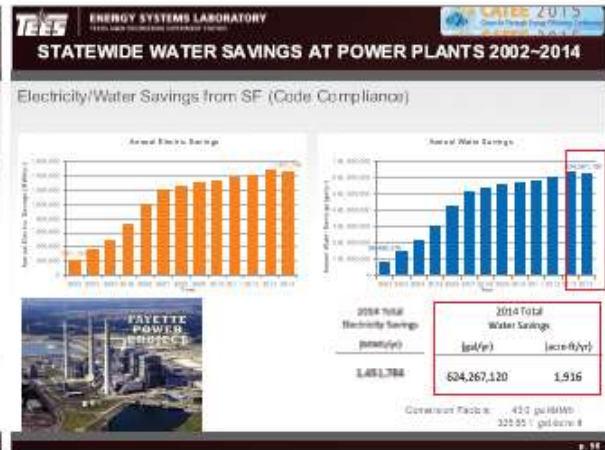
- Single screen allowing access to the same DOE-2 model used by the IC3 webpage
- Tablet/iPad/Phone friendly
- XML input/output
- Easily integrated into existing *third party software*



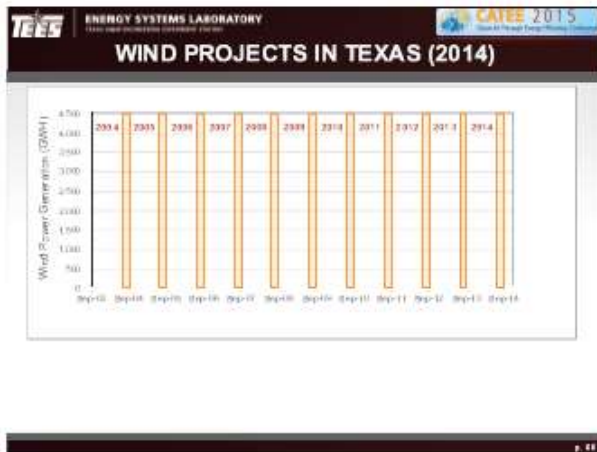
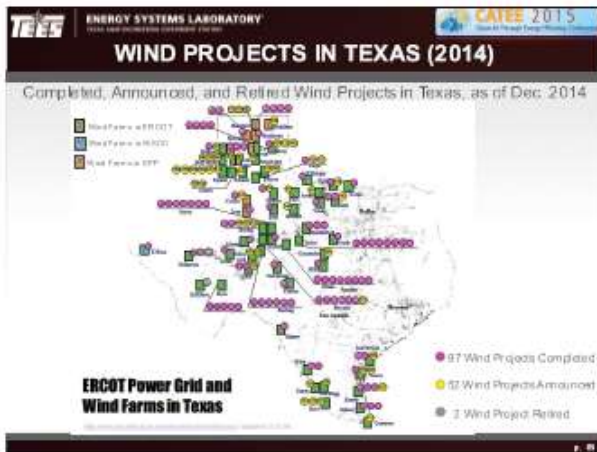
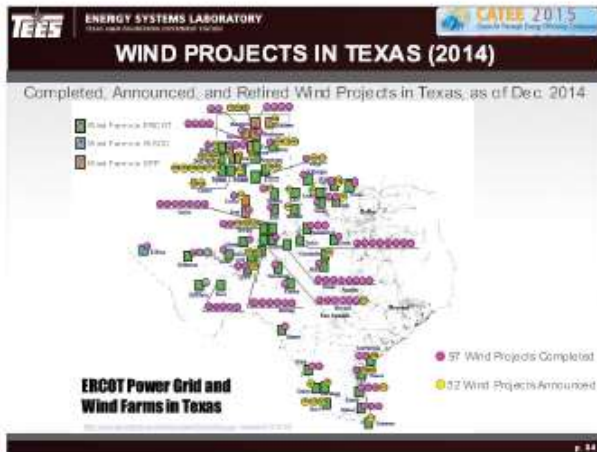
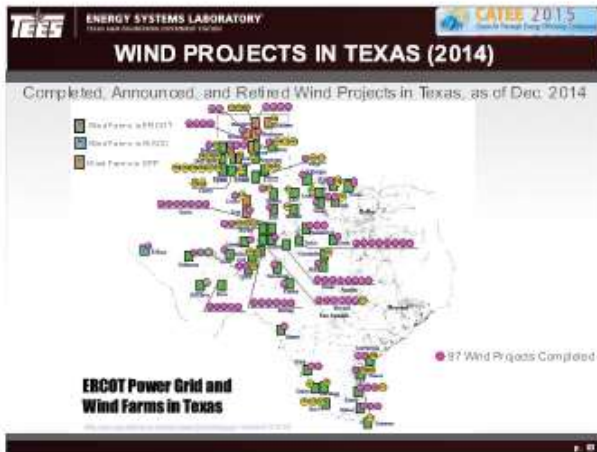
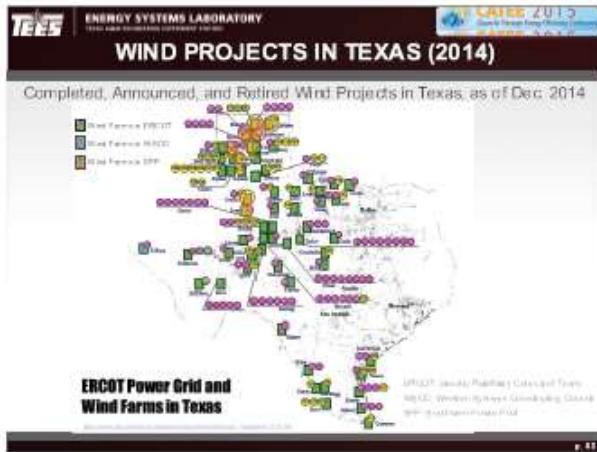
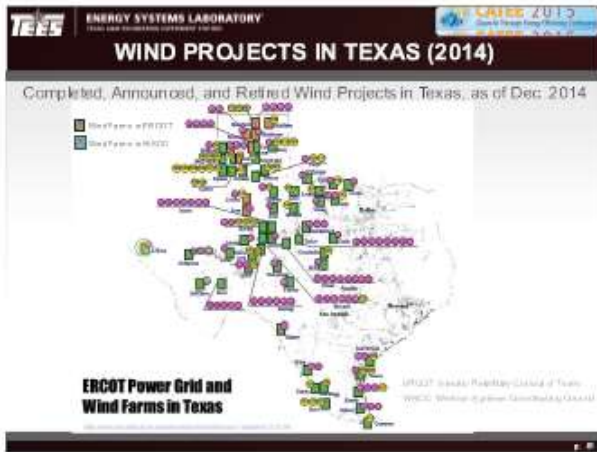


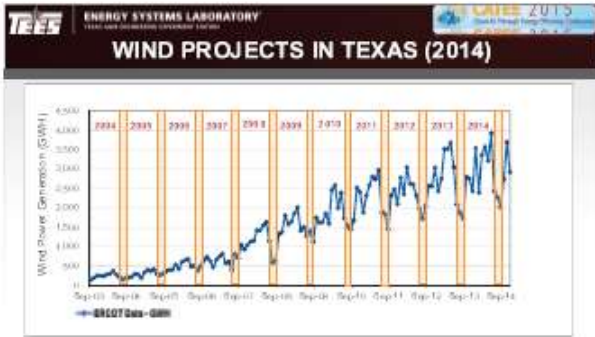




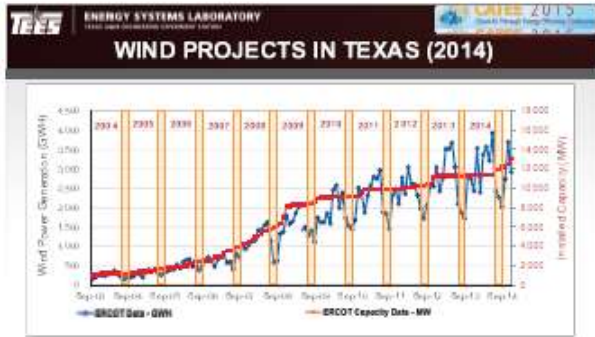




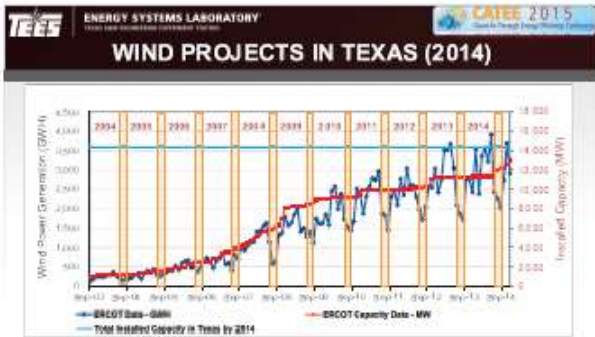




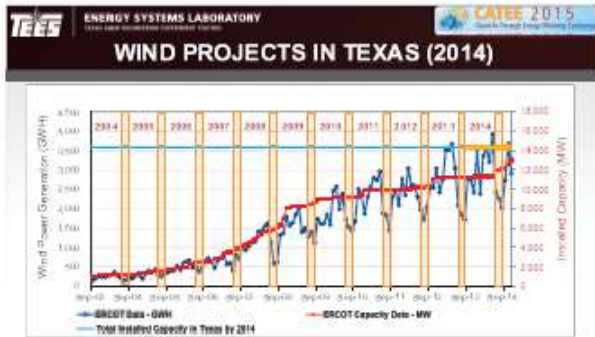
Substantial increases in measured electricity from wind energy



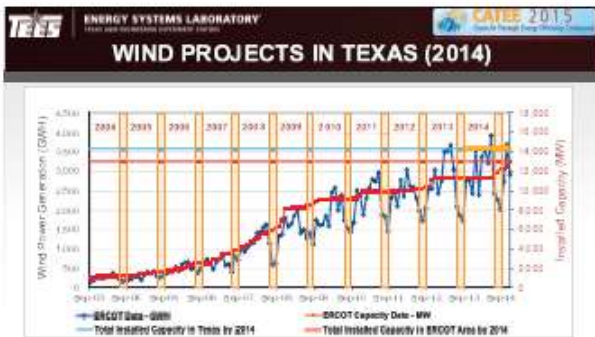
Substantial increases in measured electricity from wind energy



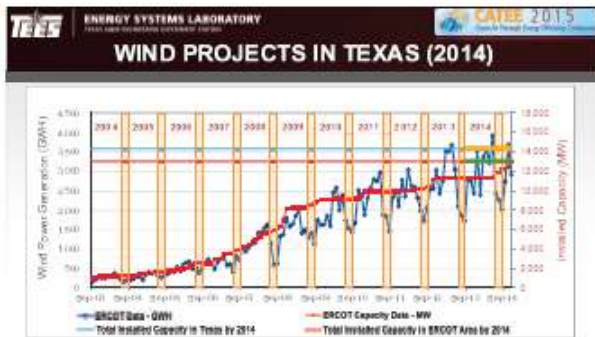
Substantial increases in measured electricity from wind energy



Substantial increases in measured electricity from wind energy  
Total capacity: 14,327 MW in Texas

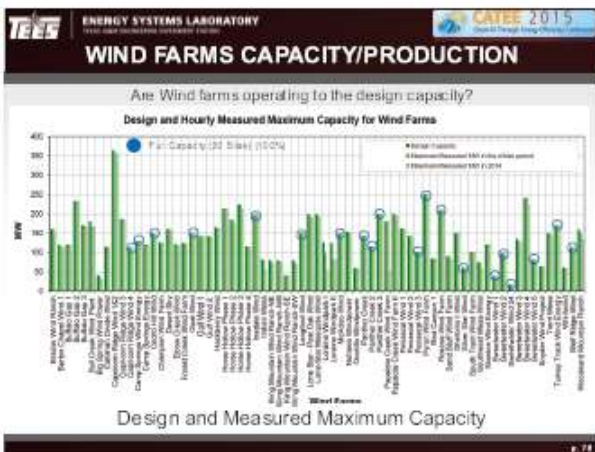
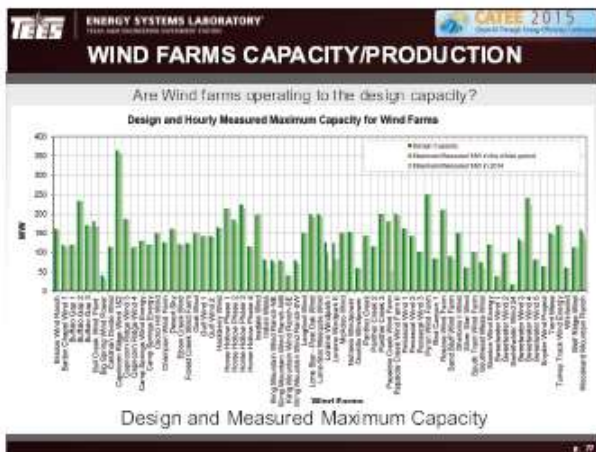
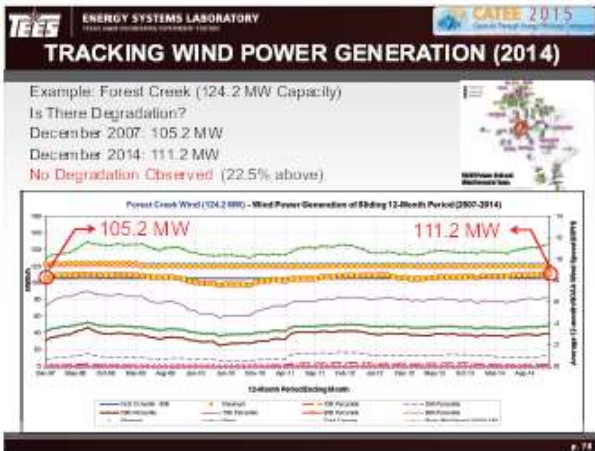
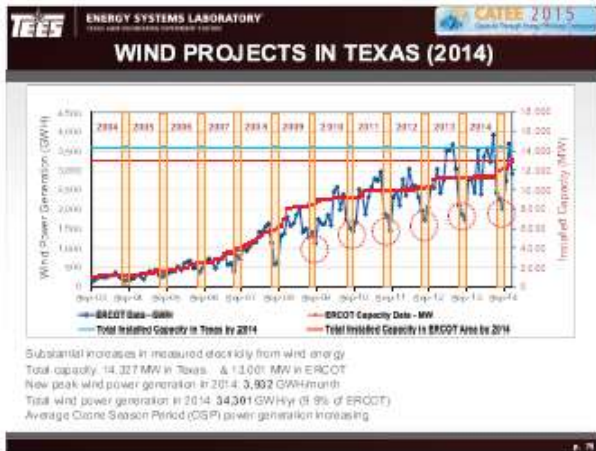
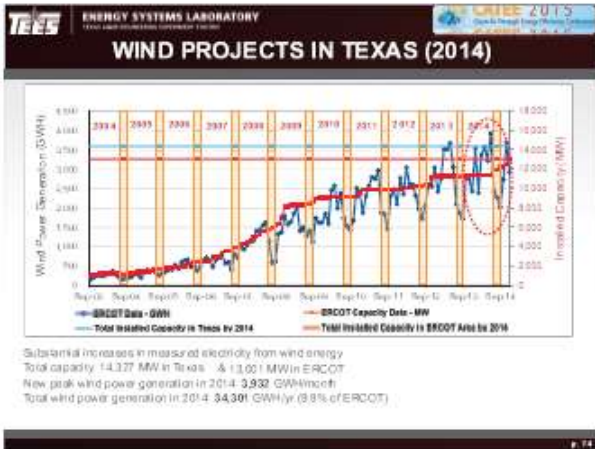
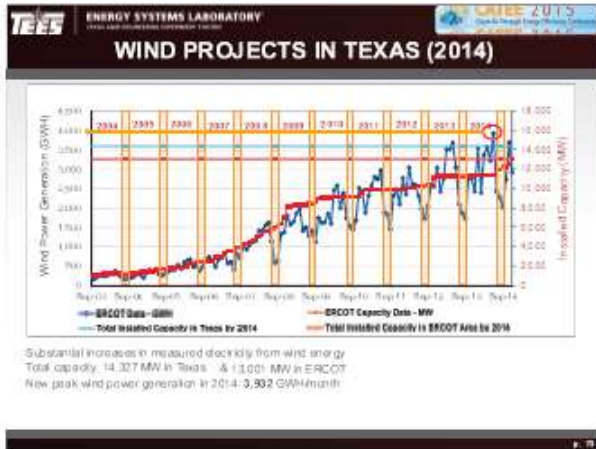


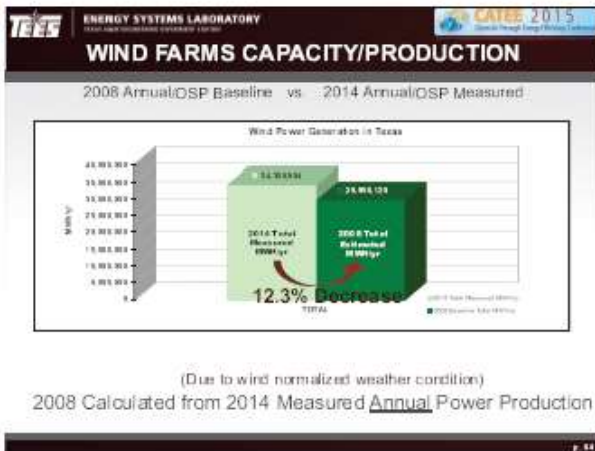
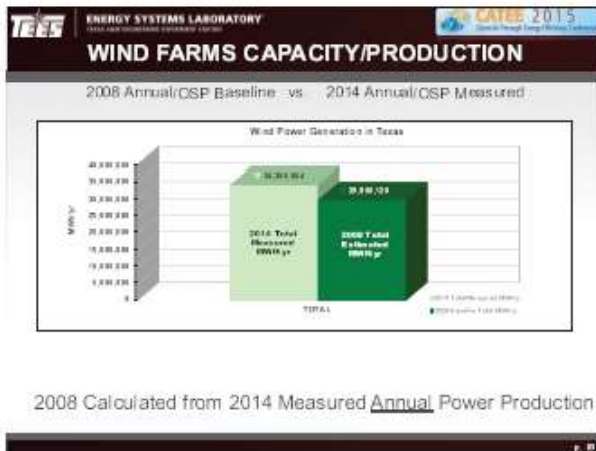
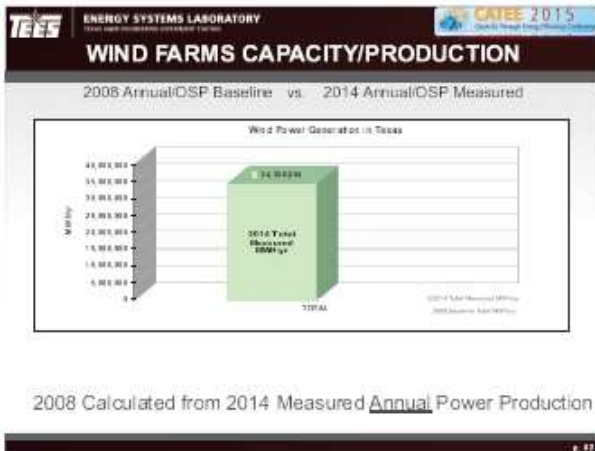
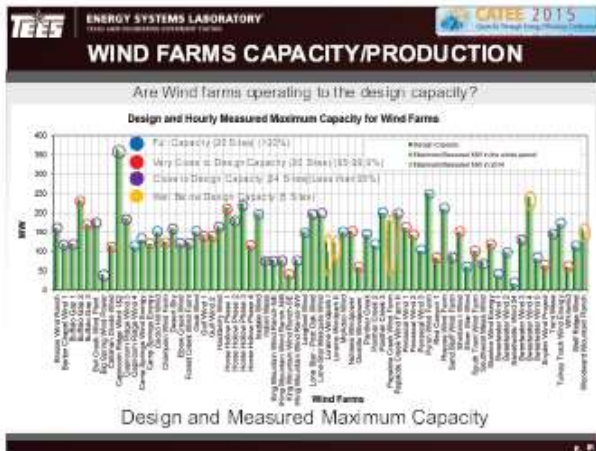
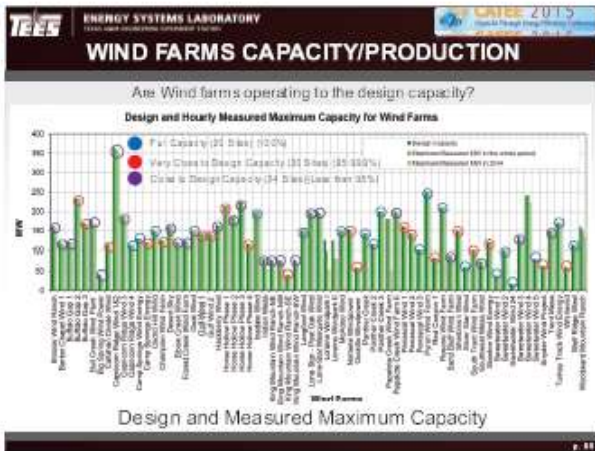
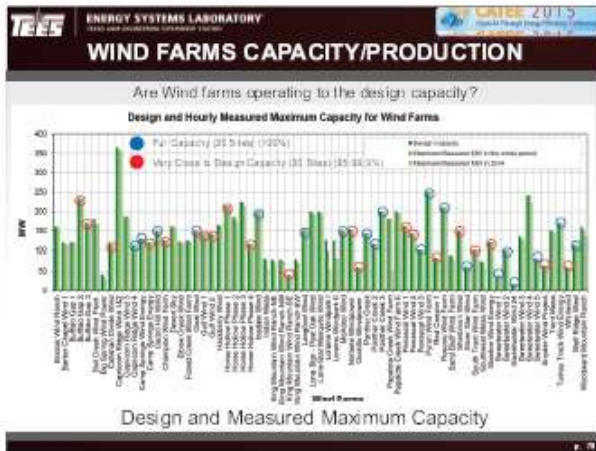
Substantial increases in measured electricity from wind energy  
Total capacity: 14,327 MW in Texas



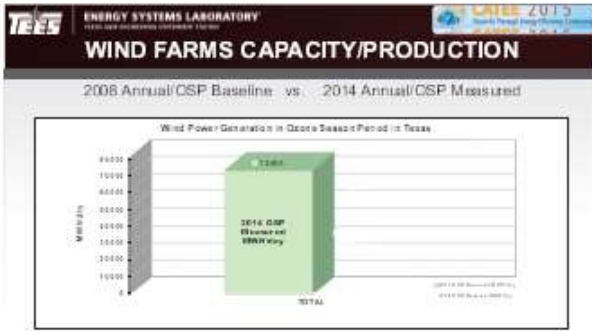
Substantial increases in measured electricity from wind energy  
Total capacity: 14,327 MW in Texas & 13,001 MW in ERCOT



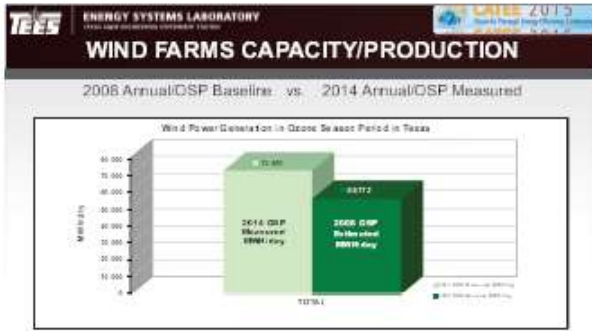




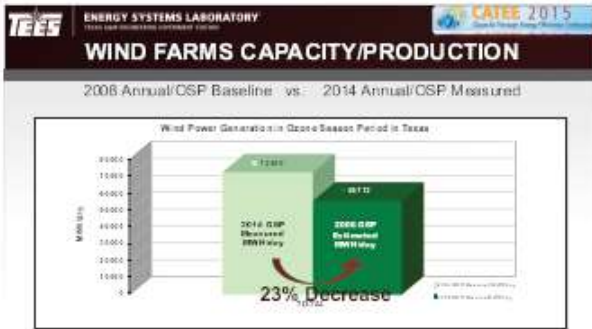




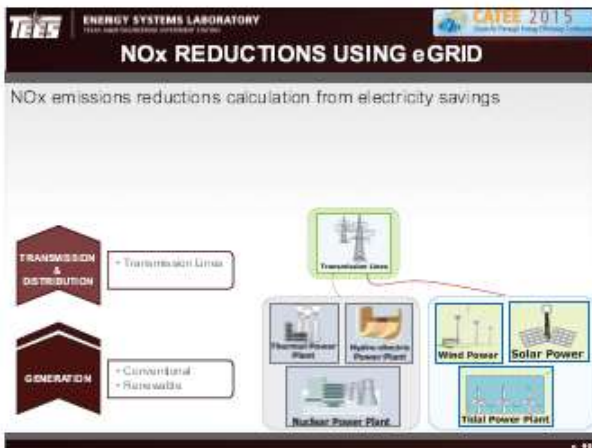
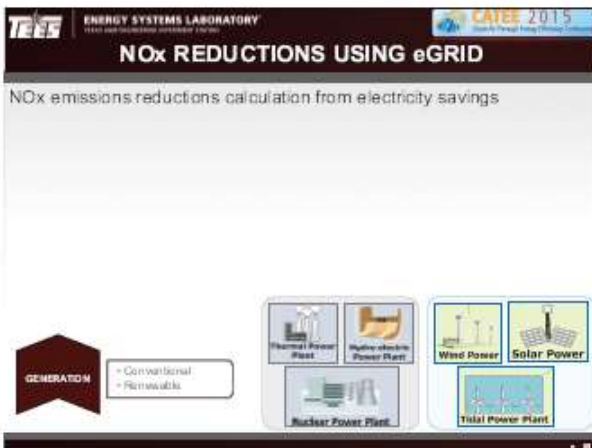
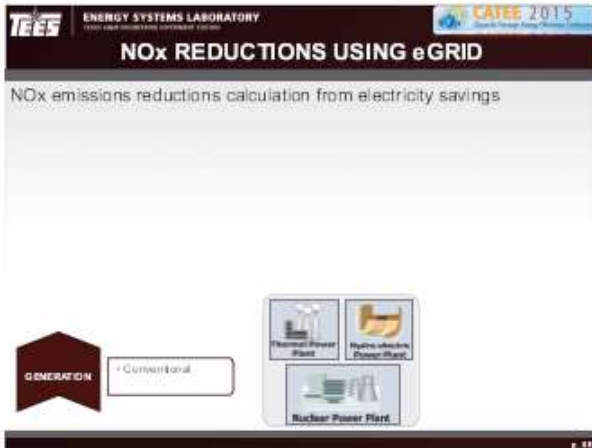
2008 Calculated from 2014 Measured O&P Power Production

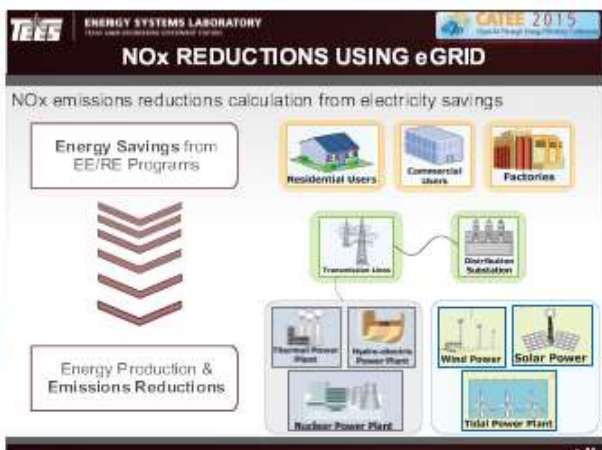
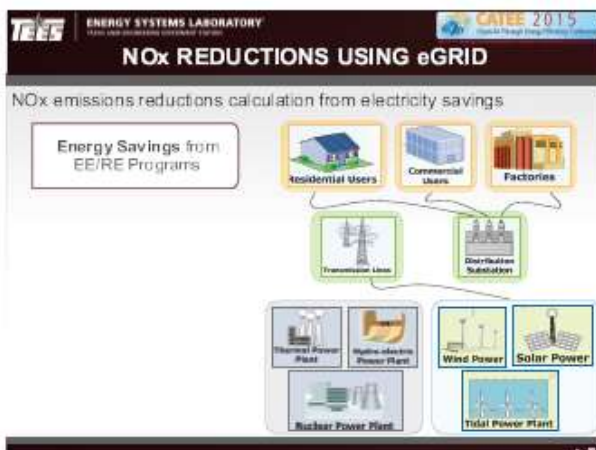
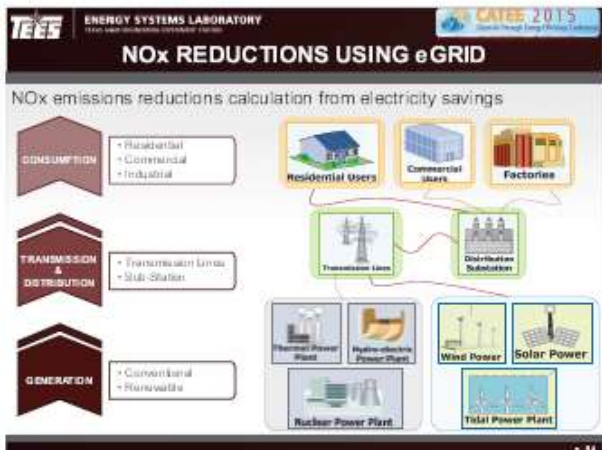
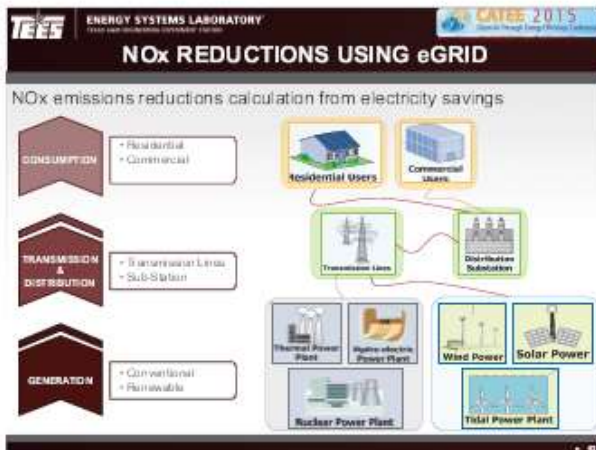
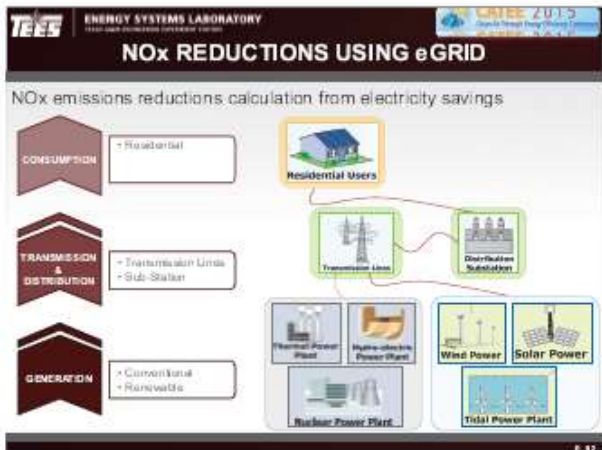
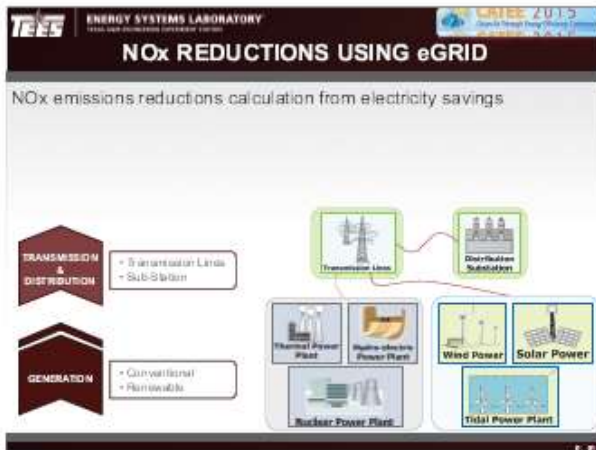


2008 Calculated from 2014 Measured O&P Power Production

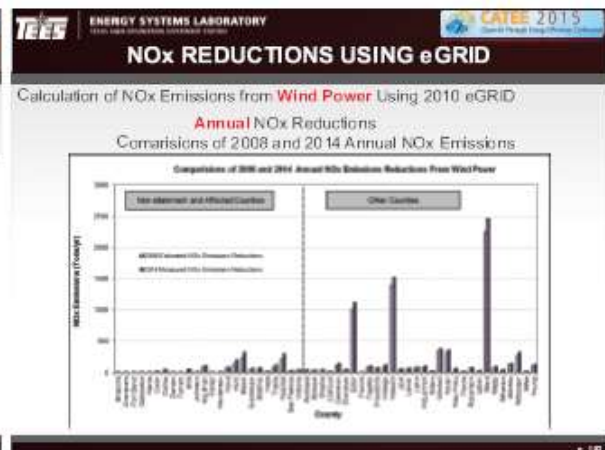
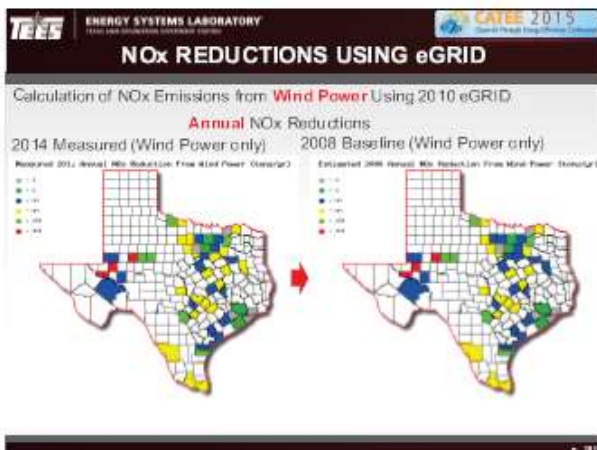
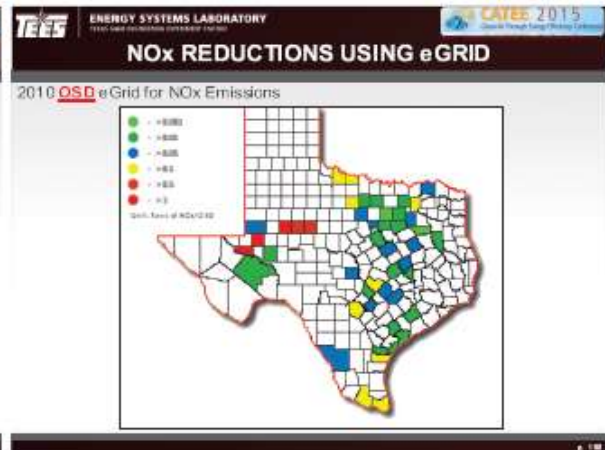
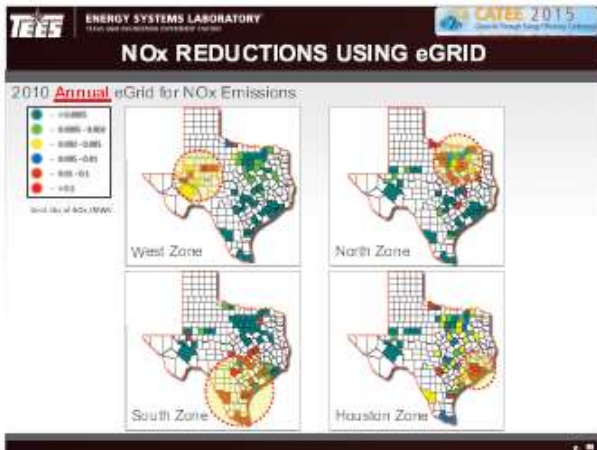
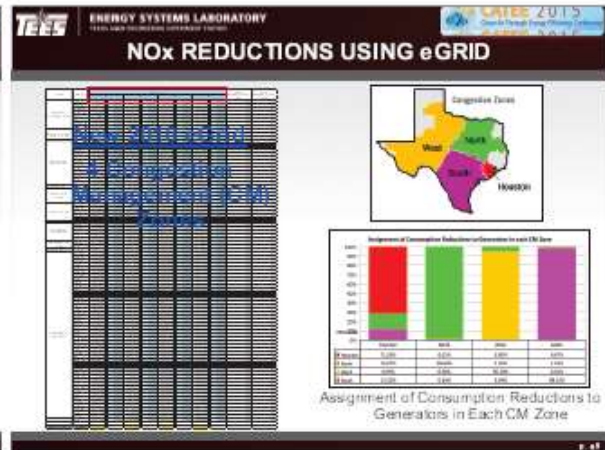
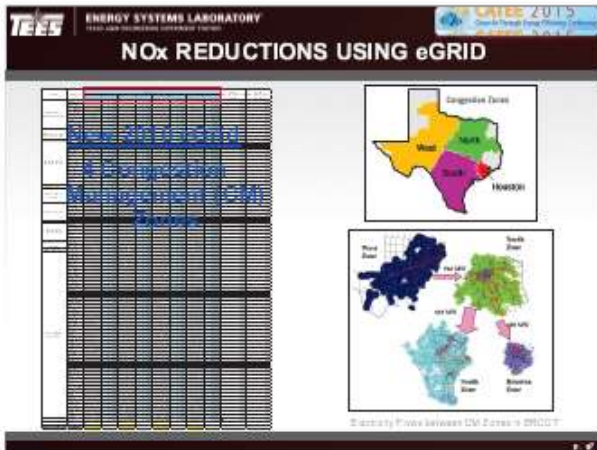


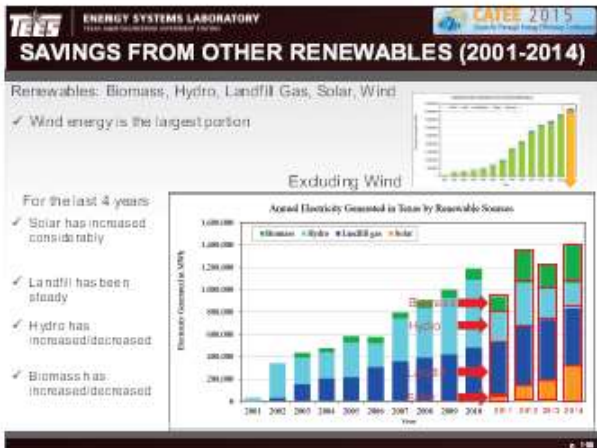
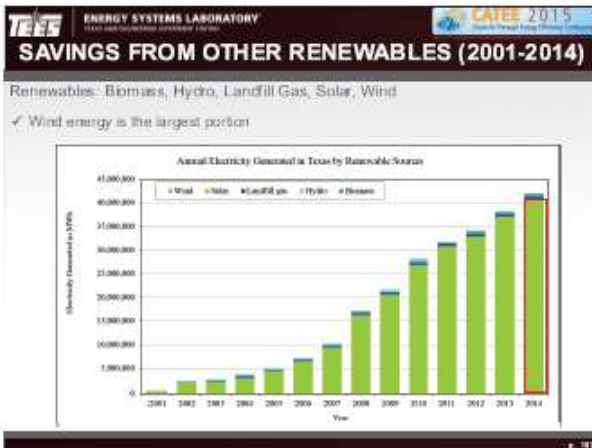
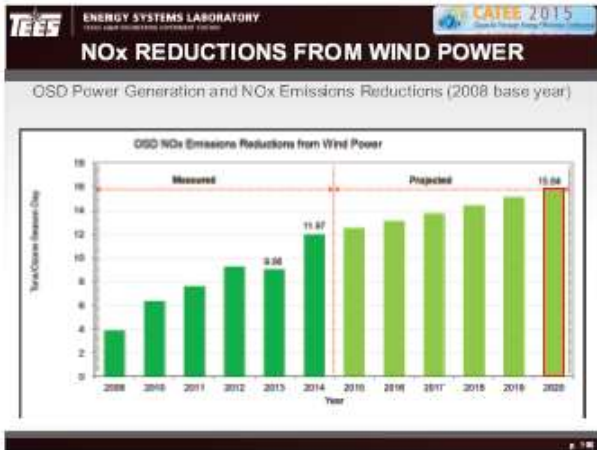
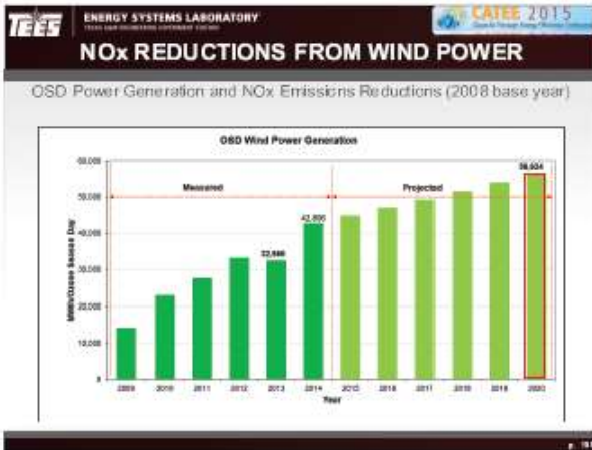
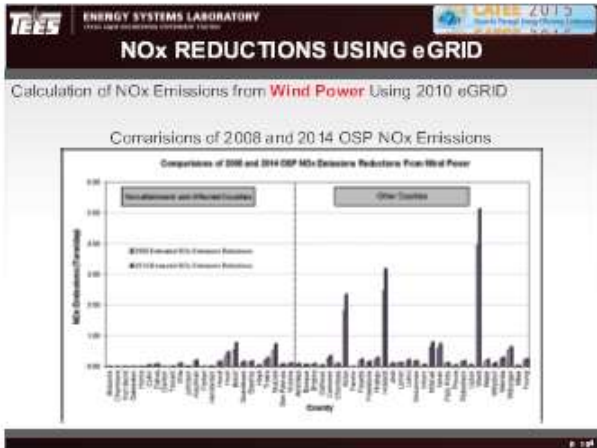
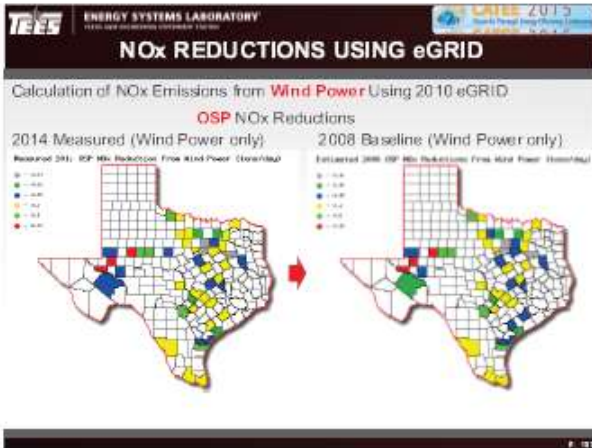
(Due to wind normalized weather condition)  
2008 Calculated from 2014 Measured O&P Power Production



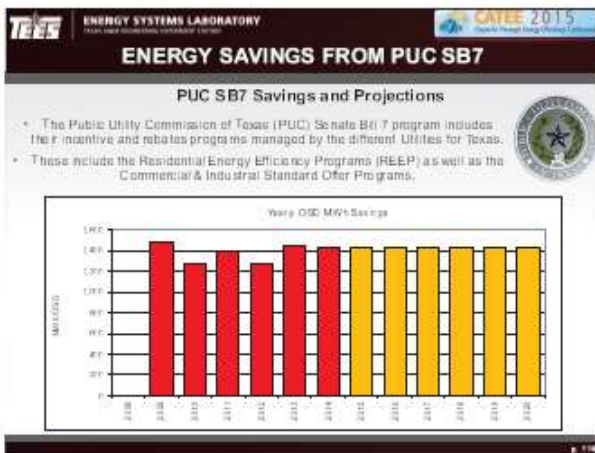
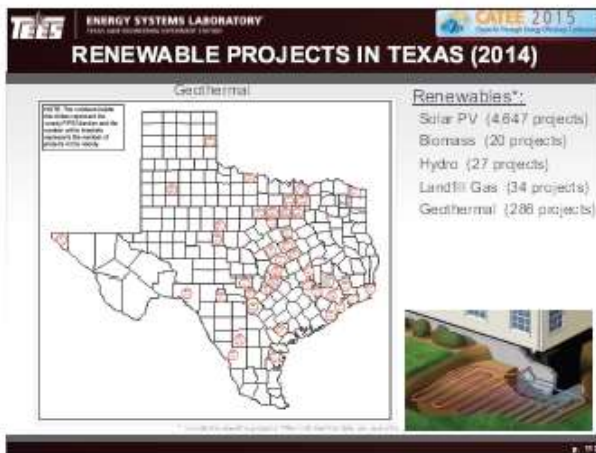
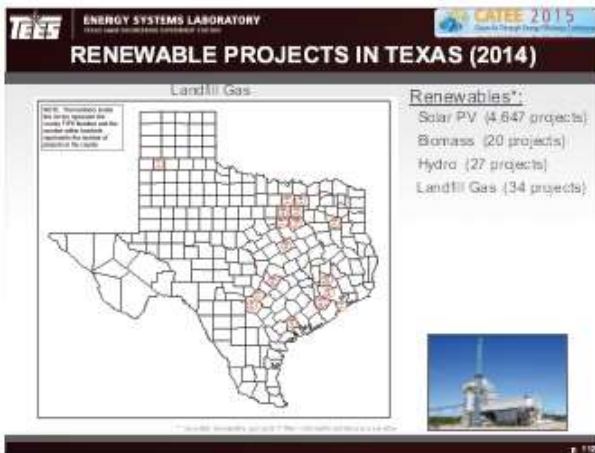
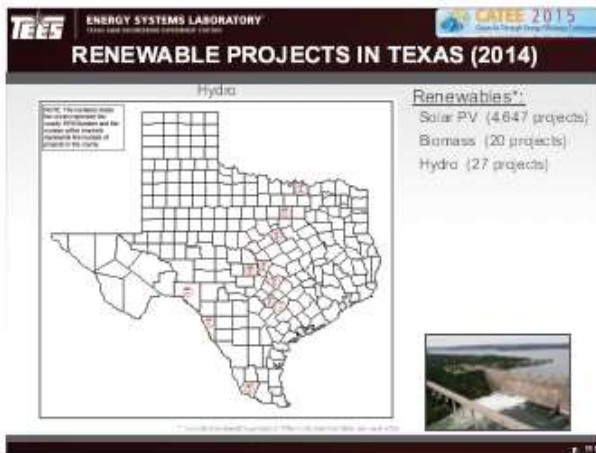
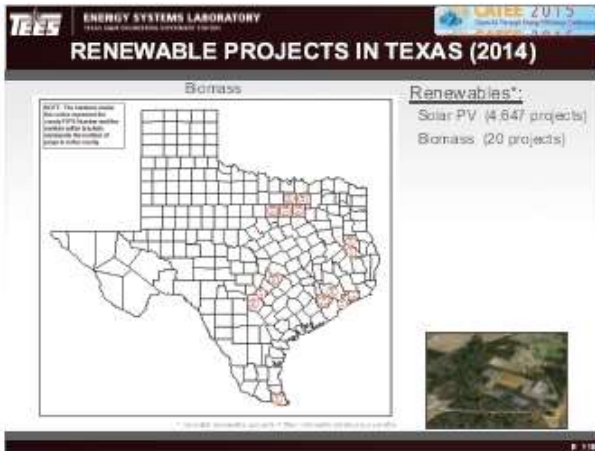
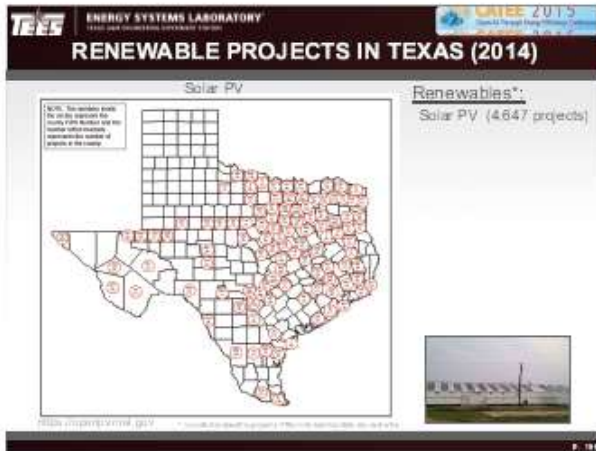


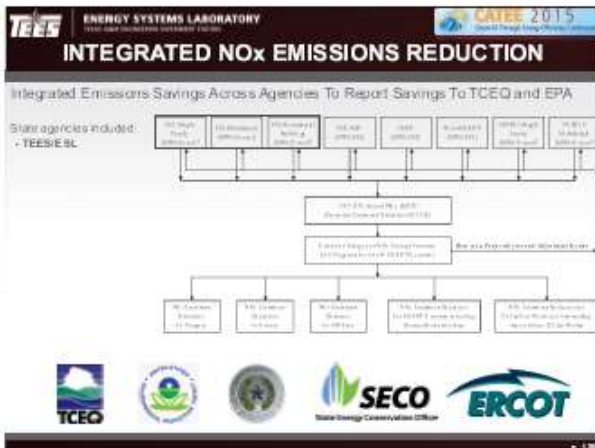
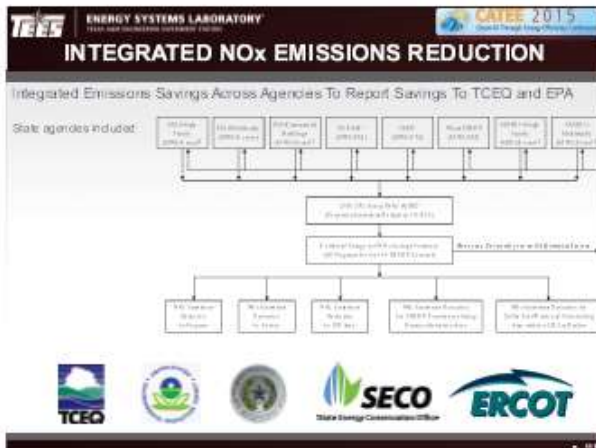
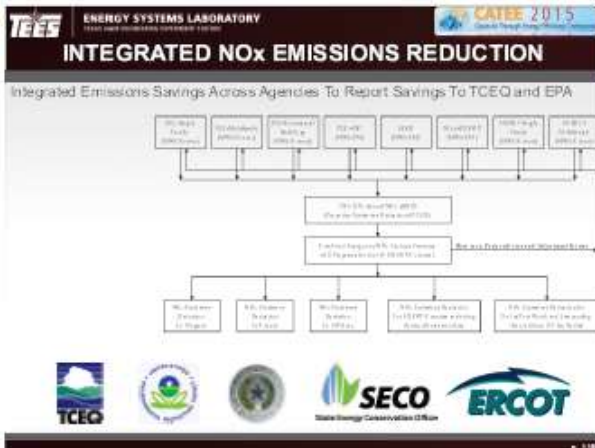
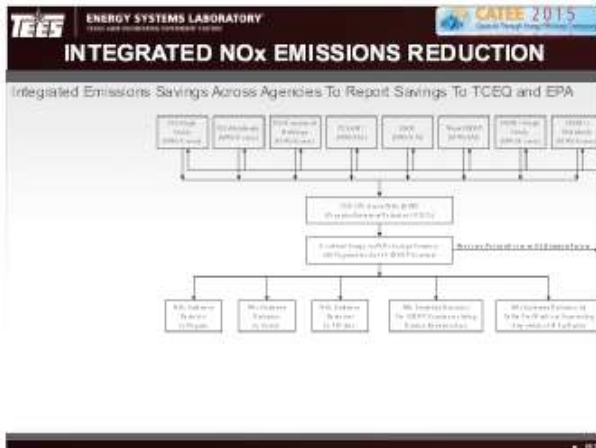
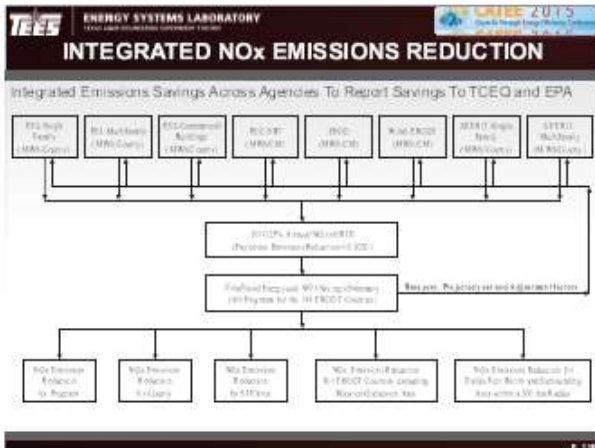
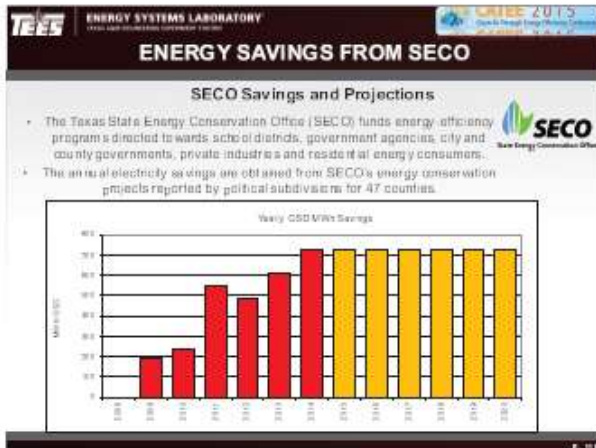


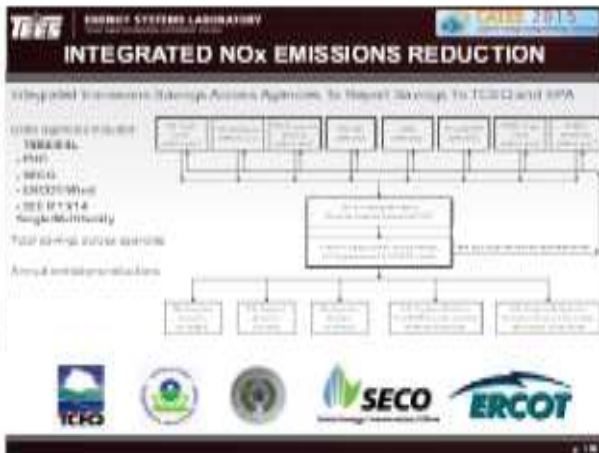
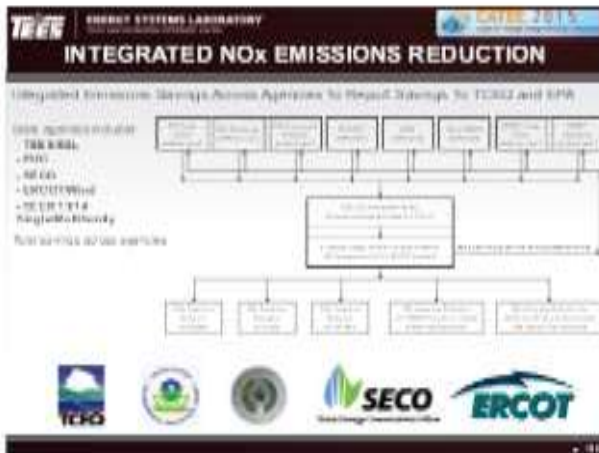
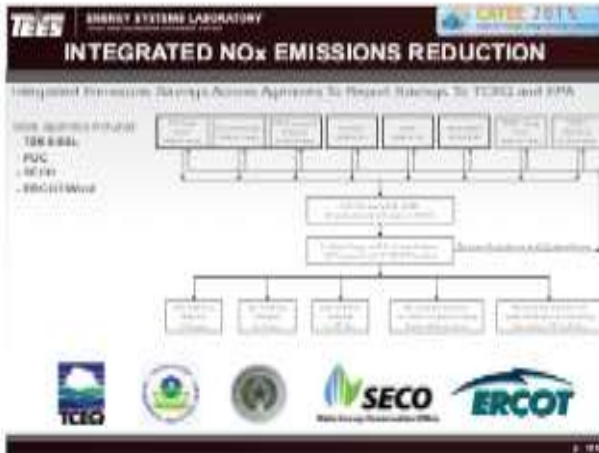
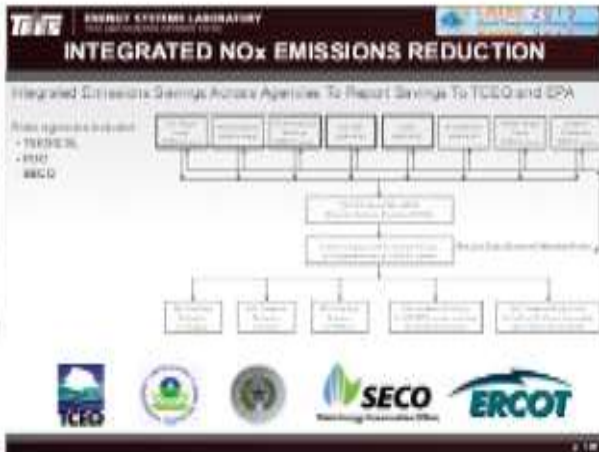
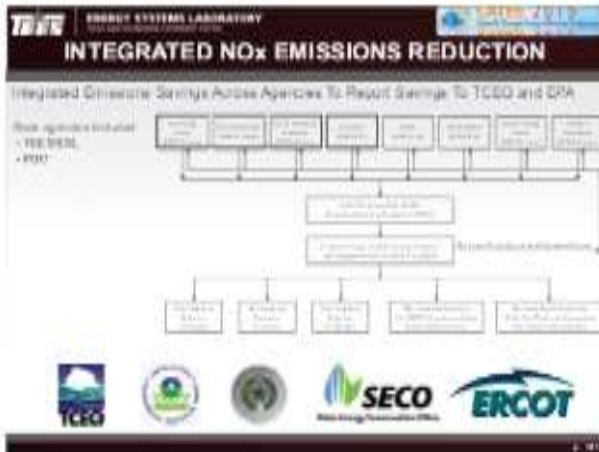




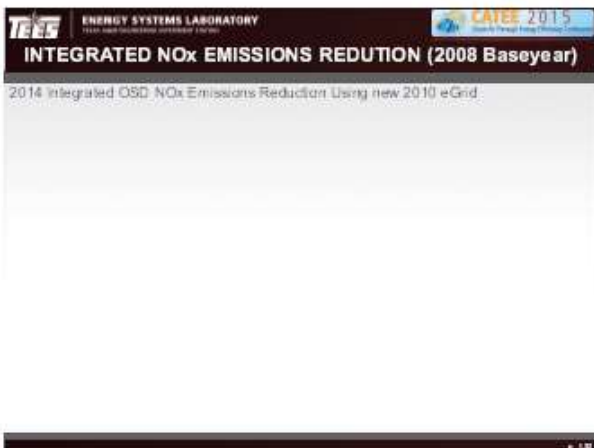
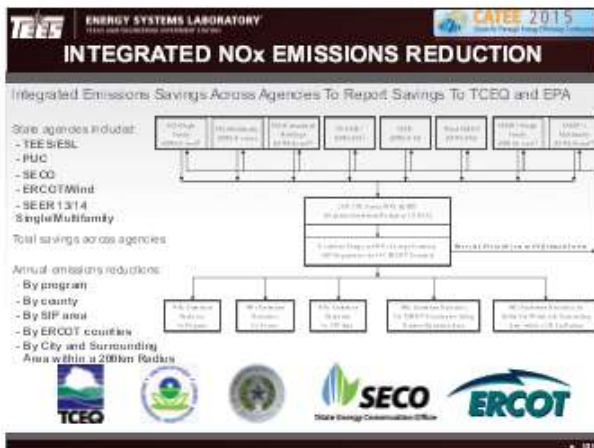
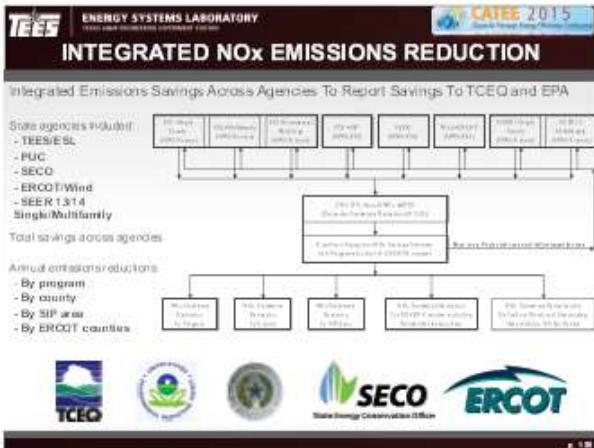
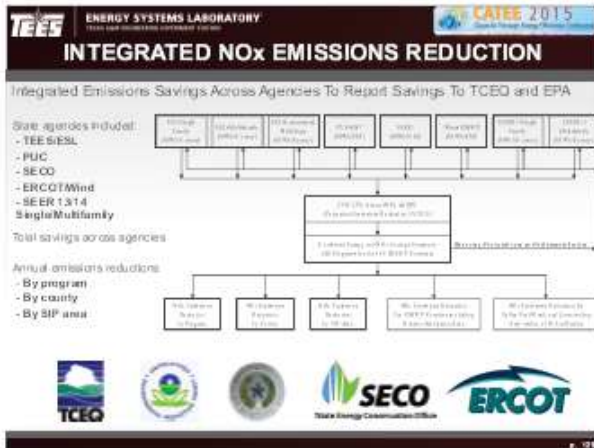
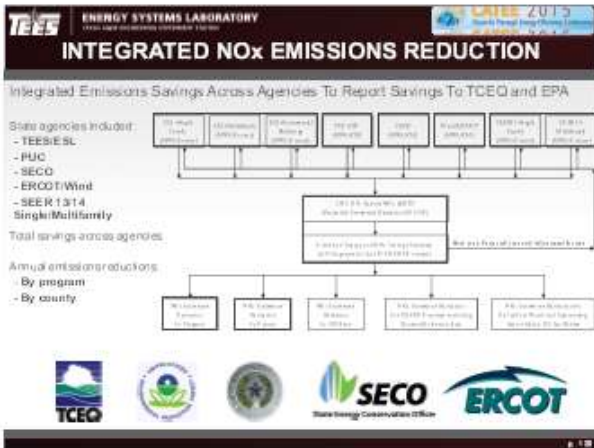
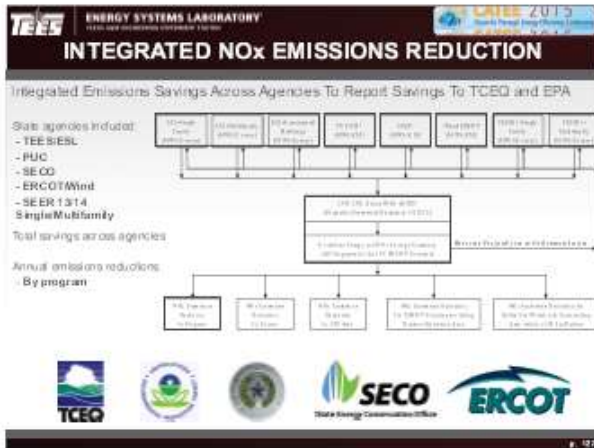


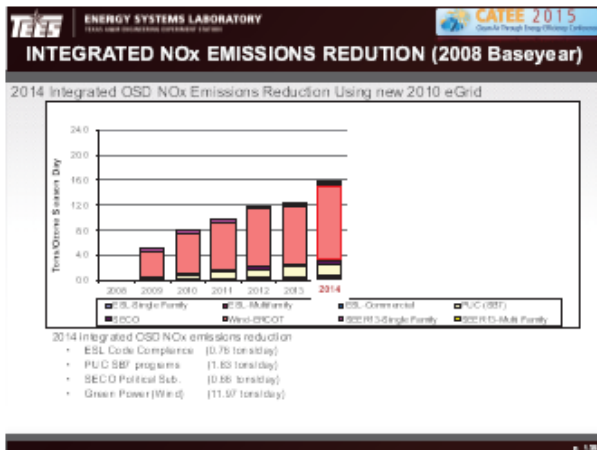
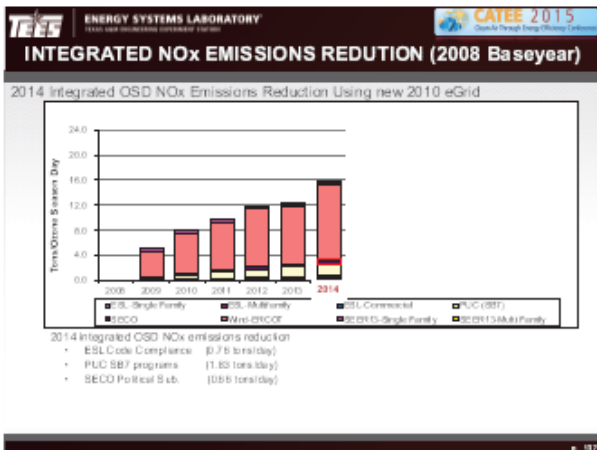
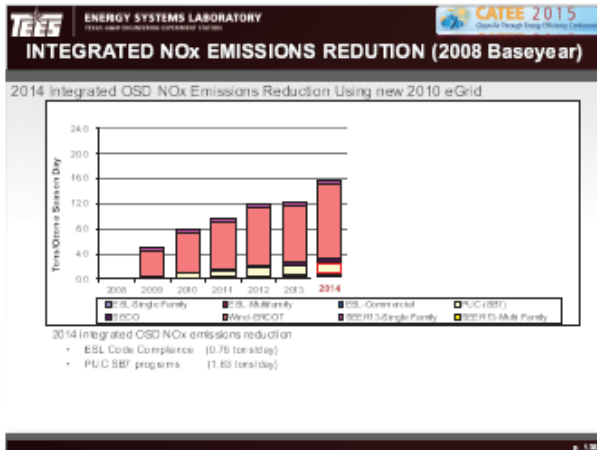
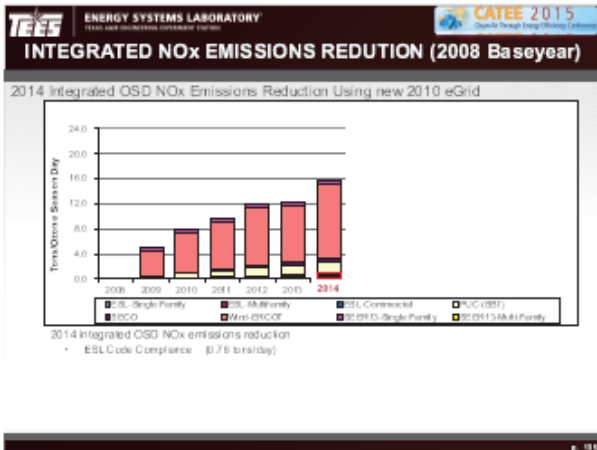
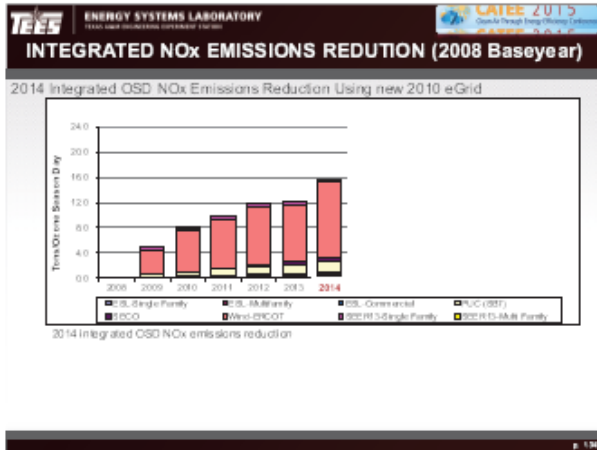
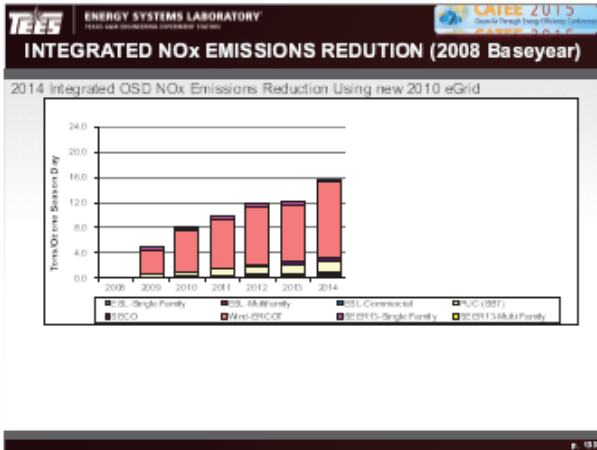


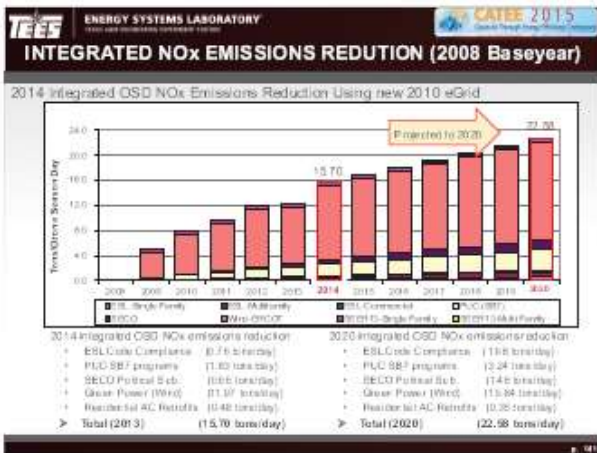
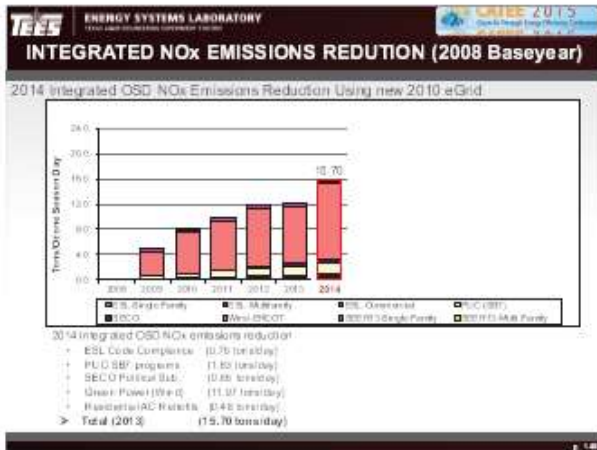
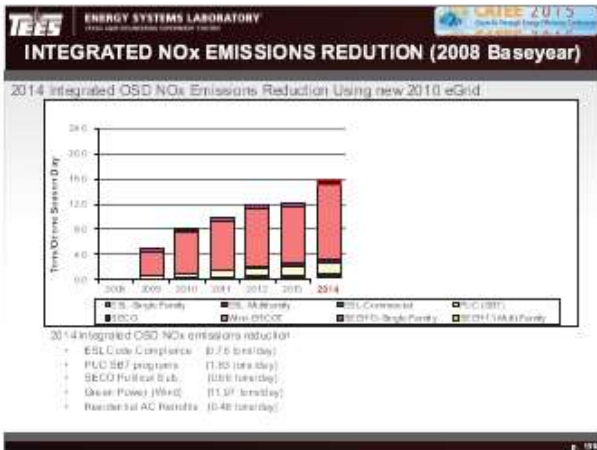












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2014 Papers:

- Validation of energy savings from the implementation of the residential building code in Texas

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2014 Papers:

- Validation of energy savings from the implementation of the commercial building code in Texas
- Developing a physical IPED Ready for building thermal energy simulation

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**2014 Reports**

- Comparing the residential provisions of the 2015 IECC with the 2012 IECC
- Baseline energy and demand capacity savings from the IECC
- Analysis of Proposed Amendments to 2015 IECC and the 2012 IECC
- Comparing the commercial provisions of the 2015 IECC with the 2012 IECC


**2014 Papers**

- Evaluation of the energy savings from the implementation of the residential building codes in Texas
- Developing a physical DSM for building thermal energy simulation
- DSM based lighting simulation and analysis
- Developing DSM in Building Energy Modeling
- Development and application of weather model based monthly building water use model

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- Development and application of weather model based monthly building water use model


**2015 Papers**

- A Framework to Investigate Direct, Indirect Physical Loads with DSM for Building Thermal Simulation

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### REPORTS AND PAPERS: TERP

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- Development and application of weather model based monthly building water use model


**2015 Papers**

- A Framework to Investigate Direct, Indirect Physical Loads with DSM for Building Thermal Simulation
- Development of Methodology to Characterize Building Energy Loads Residential Buildings

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**REPORTS AND PAPERS: TERP**

Reports: 2002 through 2013



2014 Papers:

- Comparison of the residential programs of the 2015 IECC with the 2012 IECC
- Building electrical load forecasting: a new way to work with the IECC
- Analysis of Energy Assessment (EA) for IECC and the 2015 IECC
- Comparison of the residential programs of the 2015 IECC with the 2012 IECC

2014 Papers:

- Evaluation of the energy savings from the implementation of the residential building code in Texas
- Developing a pathway to BIM for the building energy industry
- BIM based daylight simulation in residential building design
- Developing an application for the residential market by building code compliance


2015 Papers:

- A Framework to Integrate Climate Change Physical Modeling with Building Energy Modeling
- Development of Building for California Resilience in Single Family Residential Building
- Development of a new Energy and Efficiency for Commercial Building

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**ACEEE: NATIONAL RECOGNITION FOR CODE CHANGES (2015)**

As in 2014, states rose in the State Scorecard rankings. California, leading state, is also one of the most improved states this year. Maryland, Illinois, the District of Columbia, and Texas also deserve recognition for improvement over the past year. Maryland increased its commitment to energy efficiency in 2015 by establishing new, more aggressive energy savings targets for utilities. Illinois is one of the first states to adopt the newest building energy codes, and has increased the amount of energy efficiency available to utilities through procurement agreements with the Illinois Power Agency. Like Illinois, Texas has been aggressive in adopting the latest building energy codes, and has also taken notable actions to ensure code compliance across the state. The District of Columbia is among the most improved for the second year in a row, due to its progress across a number of policy areas and the ramping up of DC Sustainable Energy Utility programs.



ACEEE  
 American Council on Energy Efficiency

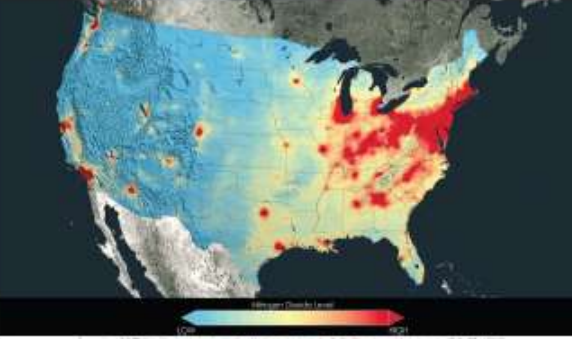
REPORTING  
 AND RECOGNITION  
 FOR CODE CHANGES

ACEEE State Scorecard: Massachusetts Topges Out California As Most Energy Efficient State, Maryland Among Most Improved

For more details, see the report at [www.aceee.org/2015-state-scorecard](http://www.aceee.org/2015-state-scorecard)

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**U.S. AIR QUALITY IMPROVEMENT FROM 2005 - 2011**



U.S. AIR QUALITY IMPROVEMENT FROM 2005 - 2011

Source: EPA, www.epa.gov/airquality/airqualityindex

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<http://esl.tamu.edu/terp>



- “2015 International Energy Conservation Code: Significant Changes” CATEE conference Galveston, TX Dec 2015, presented by Shirley Ellis.

 <p><b>2015 International Energy Conservation Code</b></p> <p>Significant Changes</p>	<p><b>Shirley Ellis</b></p> <p>Energy Codes Specialist Texas A&amp;M Engineering Experiment Station shirleyellis@tamu.edu</p> 
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 <p><b>The Role of the ESL</b></p> <ul style="list-style-type: none"> <li>• Mandated to review the latest ICC editions             <ul style="list-style-type: none"> <li>- Ensure stringency of the latest IRC and IECC compared to current adopted statewide energy codes</li> <li>- Provide SECO a written recommendation based on analysis and review of public comments</li> </ul> </li> <li>• Evaluate energy efficiency programs</li> <li>• Report emission reductions to Texas Commission for Environmental Quality (TCEQ)</li> </ul> 	 <p><b>The Role of the ESL</b></p> <ul style="list-style-type: none"> <li>• Develop home energy rating system (IC3)</li> <li>• Provide technical assistance with code implementation             <ul style="list-style-type: none"> <li>- Code implementation materials for builders, designers, engineers and architects</li> <li>- Provide local jurisdictions with technical assistance concerning implementation and enforcement</li> <li>- Develop a self certification form for builders outside of municipalities</li> </ul> </li> <li>• Evaluate proposed local amendments</li> </ul> 
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 	 <p><b>Presentation Synopsis:</b></p> <ul style="list-style-type: none"> <li>• The significant changes to the 2015 IECC</li> </ul>  
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### Chapter 1 – Scope and Administration

- New chapters on Existing Buildings
  - Relocated requirements from Chapter 1
- Information on construction documents
  - Additional details and clarification
  - Building thermal envelope depiction



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### Chapter 2 – Definitions - Commercial

- Air Curtain
- Alterations
- Approved agency
- ~~• Basement wall~~
- Boiler, modulating
- Boiler system
- Bubble point
- Circulating Hot Water System
- Climate zone
- Computer Room
- Condensing Unit
- Conditioned space
- Continuous insulation

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### Chapter 2 - Definitions

- Daylight responsive control
- Daylight zone
- Demand recirculation water system
- Fan efficiency grade
- Fan system BHP
- Fan system motor nameplate
- Fenestration
- Floor area, net
- General purpose electric motor (I)
- General purpose electric motor (II)

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### Chapter 2 - Definitions

- Greenhouse
- High speed door
- Historic building
- ~~• Insulated Sheathing Liner system~~
- Low-sloped roof
- Low-voltage dry-type distribution
- transformer
- Occupant sensor control
- Opaque door
- Powered roof/wall ventilators
- Radiant Heating system

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### Chapter 2 - Definitions

- Refrigerant dew point
- Refrigerated warehouse cooler
- Refrigerated warehouse freezer
- Refrigerated warehouse freezer
- Refrigeration system, low temperature
- Refrigeration system, medium temperature
- Registered design professional
- Repair
- Reroofing
- Roof recover
- Roof repair

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### Chapter 2 - Definitions

- Roof replacement
- Rooftop monitor
- Saturated condensing temperature
- Small electric motor
- ~~• Sunroom~~
- Time switch control
- Variable refrigerant flow system
- Walk-in cooler
- Walk-in freezer
- Wall above-grade
- Wall below-grade
- Water heater

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### 202 – General Definitions - Residential

- Alteration
- Approved Agency
- Circulating Hot Water System
- Conditioned Space
- Continuous Insulation
- Entrance Door
- ERI Reference Design
- Fenestration
- Historic Building
- Insulated Siding
- Reroofing
- Roof recover
- Roof repair
- Roof replacement
- Vertical fenestration

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### Chapter 3 Design Conditions

- Insulated Siding R-value
- Warm and Humid designation removed
  - Bandera, Dimmit, Edwards, Frio, Kinney
  - La Salle, Maverick, Medina, Real, Uvalde
  - Val Verde, Webb, Zapata, Zavala
- Tropical Zone added




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### Commercial – Building Thermal Envelope

- Equipment Building exceptions added
- Table C402.1.3 R-value method
  - Changes to "Insulation entirely above roof deck" - all Texas climate zones
  - Removed swing doors
- Table 402.1.4 U-factor method
  - Changes to "Insulation entirely above roof deck" and "Mass walls" - all climate zones
  - Added swinging doors – no changes in values

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- Cold-formed steel walls
- Component performance alternative
- Roof assembly additional exceptions
- Mass wall – added heat capacity
- Floors – insulation placement
- Radiant heating systems – insulation
- Roof solar reflectance and thermal emittance – exceptions expanded



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### Commercial – Fenestration

- Daylight responsive controls
- Added minimum skylight fenestration
  - Office, lobby, atrium, retail store, etc.
- Haze factor requirements added
- Skylight U-factor, SHGC increases
- Dynamic glazing added

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### Commercial

- Air leakage
  - Building envelope – assemblies added
  - Fenestration – exceptions added
- Rooms containing fuel-burning appliances
- Vestibules exceptions
  - Air curtains added
- Recessed lighting - clarified



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### Commercial - Mechanical

- Minimum Efficiency Requirement Tables
- Requirements for economizer fault detection and diagnostics
- Enclosed parking garage ventilation controls
- Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers

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- Economizers (Prescriptive) – changes to requirements
- Demand controls for recirculation systems
- Requirements for hot water circulation and heat trace systems and controls
- Drain Water Heat Recovery option not included in the Performance path

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- Minimum performance criteria were improved for the following applications to match ASHRAE 90.1-2013 standards:
  - AC/Heat pump
  - Energy recovery equipment
  - Kitchen exhaust flow
  - Refrigeration
  - Economizers, controls, and VAV fans
  - Heat rejection equipment
  - 1/12 - 1 hp fans
  - Multi-zone VAV systems
  - Hot water system controls
  - Exterior lighting controls
  - Lighting power densities
  - Electric transformers
  - Electrical motors
  - People movers
  - Lighting O&M manual

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### Commercial – Electrical

- Occupant sensor controls – new requirements
- Daylight-responsive controls
- Electrical motors minimum efficiency requirements
- Vertical and horizontal transportation systems and equipment

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### Commercial

- Additional Efficiency Package Options
  - Lighting separated into power density and controls
  - Dedicated outdoor air system on some HVAC
  - High-efficiency service water heating

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### Commercial

- Total Building Performance added Exceptional calculation method
  - Where the simulation program does not model a proposed design, material or device
- Service water-heating systems add to Commissioning



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### Residential

- Duct reduces insulation from R-8 to R-6 on duct less than 3 inches in diameter
- Demand recirculation systems
- Lighting equipment increased to 75%
- Establishes criteria for compliance using an ERI analysis
- Performance path now requires a second report based on as-built conditions

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### Residential

- Appendix RA - Recommended Procedure for Worst-Case Testing of Atmospheric Venting Systems Under R402.4 or R405 Conditions  $\leq 5ACH_{50}$
- Appendix RB - Solar-Ready Provisions – Detached One- and Two-Family Dwellings, Multiple Single-Family Dwellings (Townhouses)

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## Questions????

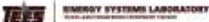
Thank you for your time and attention



- “CATEE 2015 :Energy Systems Laboratory” CATEE conference Galveston, TX Dec 2015, presented by David Claridge.

# CATEE 2015

David E. Claridge, Director  
Energy Systems Laboratory



## Energy Systems Laboratory



An applied research laboratory focused on energy efficiency

- An engineering "Teaching Hospital"
- Develops innovative technologies
- Commercializes affordable results for industry
- Funded by contracts for research and engineering services




## Architectural Engineering

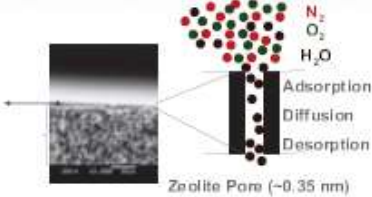


- New undergraduate and graduate degree program coming at A&M
- Will offer specialties in HVAC/Mechanical, Electrical/Lighting, and Structures
- Program Director hired: Dr. Morad Atif

## Molecular Membrane Air Conditioner (MMAC)




- Zeolite membrane permits water vapor to pass through - blocks most air passage
- Acts as a "sieve" for water vapor to dehumidify air without the energy penalty of condensation

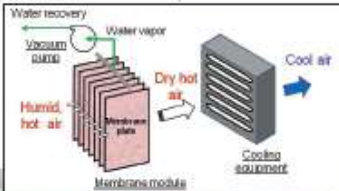
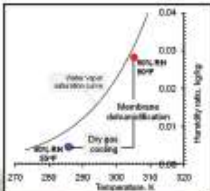


Zeolite Pore (~0.35 nm)

## MMAC Operation



- A very green process
- No refrigerants
- High Efficiency ("SEER's from 17 to 40+ in future)
- Cost effective (targeted to eventually cost less than conventional)

## Status: Bench Prototype Built




Testing Verifies It Works As Expected

<b>Future Development</b> 	<b>MMAC will</b> 
<ul style="list-style-type: none"><li>• <b>Supported by</b><ul style="list-style-type: none"><li>- DOE Advanced Research Projects Agency – Energy ARPA-E</li><li>- Department of Defense</li><li>- U.S. Navy</li></ul></li><li>• <b>Initial Customers Identified</b><ul style="list-style-type: none"><li>- U.S. Navy</li><li>- Data Center Dehumidification</li></ul></li></ul>	<ul style="list-style-type: none"><li>• <b>Fundamentally change in the way we dehumidify and cool air</b></li><li>• <b>Completely eliminate use of any refrigerants with environmental impacts</b></li><li>• <b>Be more efficient than current technology</b></li><li>• <b>Generate highly pure water</b></li><li>• <b>Ultimately cost less than current technology</b></li></ul>

