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

# VOLUME II – TECHNICAL REPORT

**Annual Report to the**
**Texas Commission on Environmental Quality**
**September 2002 – August 2003**

Jeff Haberl, Ph.D., P.E.
Charles Culp, Ph.D., P.E.
Bahman Yazdani, P.E.
Tom Fitzpatrick
John Bryant, Ph.D., P.E.
Dan Turner, Ph.D., P.E.

Energy Systems Laboratory
Texas A&M University System

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**ENERGY SYSTEMS LABORATORY**

Texas Engineering Experiment Station
Texas A&M University System

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Texas Engineering Experiment Station
Texas A&M University System

**3581 TAMU**
**College Station, Texas 77843-3581**

December 19, 2003

Chairman Kathleen Hartnett White
Texas Council on Environmental Quality
P. O. Box 13087
Austin, TX 78711-3087

Dear Chairman White:

The Energy Systems Laboratory (ESL) at the Texas Engineering Experiment Station of the Texas A&M University System is pleased to provide its second 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) (2) (a) & (b), Vernon Supp. 2002 (Senate Bill 5, 77R as amended 78 R & 78S).

The ESL is required to annually report the energy savings from local municipality and county enforcement of the Texas Building Energy Performance Standards created by SB 5, as amended, and report the relative impact of proposed local energy code amendments in the 41 Texas non-attainment and affected counties as part of the Texas Emissions Reduction Plan (TERP).

Please contact me at (979) 862-8480 should you or any of the TCEQ staff have any questions concerning this report or any of the work presently being done to determine emissions reductions from energy efficiency and renewable energy measures as a result of the TERP.

Sincerely,

Dan Turner

W. Dan Turner, P.E.
Director

Enclosure

cc: Commissioner R. B. "Ralph" Marquez
Commissioner Larry R. Soward

Disclaimer

# VOLUME II – TECHNICAL REPORT

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

## 1 Executive Summary

The Texas Emissions Reduction Plan (TERP), established by the 77th Texas Legislature with the enactment of Senate Bill 5 (SB 5), states that energy efficiency and renewable energy (EE/RE) measures are needed to meet the minimum federal air quality standards. The 78th Legislature further enhanced the use of EE/RE programs for meeting TERP goals by requiring the Texas Council on Environmental Quality (TCEQ) to promote the use of energy efficiency as a way of meeting the federal air quality standards and to develop a methodology for computing emissions reduction for the SIP from energy efficiency.

Energy Savings and Resultant NOx Emissions From Energy Code Compliance. To achieve energy savings in new construction, SB 5 mandates statewide adoption of the International Residential Code (IRC) and the International Energy Conservation Code (IECC) for residential, commercial and industrial buildings. The Energy Systems Laboratory (Laboratory) at the Texas Engineering Experiment Station of the Texas A&M University System is responsible for determining the energy savings from energy code adoption and to report annually to the TCEQ.

Using data available from the TCEQ, the EPA, and others and new procedures developed by the Laboratory, the annual energy savings calculated in 2003 from energy-code compliant new residential construction in non-attainment and affected counties were 252,238 megawatt hours of electricity and 887,564 million Btus of natural gas. The resultant annual $NO_x$ reductions were 473 tons. On a peak summer day in 2003, the $NO_x$ emissions were 2.44 tons.

Impact of Local Energy Code Changes. SB 5 also requires the Laboratory to assist municipalities and counties to determine the energy savings of proposed local code amendments relative to the Texas Building Energy Performance Standards (TBEPS) and to report its findings annually to the TCEQ. The Laboratory reviewed proposed code amendments from the City of Houston and the North Central Texas Council of Governments (NCTCOG). The proposed changes by the NCTCOG were found to be substantially equivalent to the TBEPS. The analysis of the extensive changes proposed by the City of Houston had not been completed by the time of this report.

Laboratory SB 5 Related Activities and Technology Development in Support of TERP. The report also provides a summary of the Laboratory-related TERP activities; outlines for critical review, the methodologies under development for calculating energy savings and emissions reduction from energy efficiency; and provides valuable insights into the effectiveness of additional EE/RE measures, technologies, and energy reduction strategies for existing buildings currently not covered by the TERP.

*The Energy Systems Laboratory provides the second 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) (2) (a) & (b) (Vernon Supp. 2002).*

*If any questions arise, please contact us by phone at 979-458-0675, or by email at SB5info@esl.tamu.edu.*

ACKNOWLEDGEMENTS

This project would not have been possible without the support that was provided by the Texas State Legislature, under Senate Bill 5. The authors are also grateful for the timely input provided by the following individuals, and agencies: The Senate Bill 5 Stakeholders, who provided helpful insight into construction practices, air-conditioning equipment, and window performance information. Mr. Joe Huang and Dr. Fred Winklemann at LBNL, who provided helpful advice on the many DOE-2 questions, Mr. Jim Mullen, Lennox International, and Mr. Dick Cawley, Trane Corporation, for help with the Air Conditioner calculations. Mr. Art Diem, USEPA for providing the eGRID database. Mr. Thomas Smith, Texas Public Citizen, for frequent discussions about strategies for emissions reductions. Mr. Steve Anderson, TCEQ, for providing helpful insight about improvement to the Emissions Reduction Calculator.

Numerous individuals at the Laboratory also contributed significantly to this report, including: Mr. Don Gilman, Ms. Vivian Yu, Mr. Malcolm Verdict, Mr. Piljae Im, Mr. Seongchan Kim, Ms. Chayapa Chaoncharoensuk, Ms. Jaya Mukhopadhyay, and Mr. Soolyeon Cho.

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# 2 Overview

The Energy Systems Laboratory (Laboratory) is pleased to provide our second annual report, Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan to the Texas Council on Environmental Quality (TCEQ) in fulfillment of its responsibilities under Texas Health and Safety Code Ann. § 388.003, (e) (a) (b) (Vernon Supp. 2002). This annual report:

- Provides an estimate of the energy savings and $NO_x$ reductions from energy code compliance in new residential construction in 38 counties,
- Describes the technology developed to enable the TCEQ to substantiate energy and emissions reduction credits from EE/RE to the Environmental Protection Agency (EPA), and
- Provides valuable insights into the effectiveness of additional energy efficiency and renewable energy measures in existing buildings and industrial facilities.

## 2.1 Legislative Background

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

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

To achieve the clean air and emissions reduction goals of the TERP, SB 5 created a number of energy efficiency and renewable energy programs for credit in the EPA mandated State Implementation Plan (SIP):

- Mandates statewide adoption of Texas Building Energy Performance Standards (TBEPS) as the building energy code for all Texas municipalities and counties,
- Provides that a municipality or county may request the Laboratory to determine the energy impact of proposed energy code changes,
- Provides for an annual evaluation by the Public Utility Commission of Texas, in cooperation with the Laboratory, of the emissions reduction of energy demand, peak electric loads and the associated air contaminants from utility-sponsored programs established under SB 5 and utility-sponsored programs established under the electric utility restructuring act (Section 39.905 Utilities Code),
- Establishes a 5 percent per year electricity reduction goal each year for political subdivisions in non-attainment and affected counties from 2002 through 2007, and
- Requires the Laboratory to report to the 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 unamended code.

The 78th Legislature, through HB 1365 and HB 3235, amended SB 5 to enhance its effectiveness by adding additional energy efficiency initiatives, including:

- Requires the TCEQ to conduct outreach to non-attainment and affected counties on the benefits of implementing energy efficiency measures as a way to meet the air quality goals under the federal Clean Air Act,
- Requires the TCEQ develop a methodology for computing emissions reduction from energy efficiency initiatives,
- Authorizes 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 percent or more to enhance local government's ability to meet minimum air quality standards,

- Authorizes municipalities 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 EPA's Energy Star residential rating program, and
- Requires the Laboratory to develop and administer a statewide training program for municipal building inspectors seeking to become code-certified inspectors for enforcement of TBEPS.

## 2.2 Laboratory Funding for the TERP

The primary funding mechanism for the TERP from registration fees for out-of-state vehicles was declared unconstitutional, greatly reducing implementation funds available to the Laboratory and all other parties. As a consequence, the Laboratory received less than 21 percent ($181,855 in FY 2002 and $372,226 in FY 2003) of the appropriated amount. Despite this major shortfall in funding, the Laboratory was able to make significant progress on most of its duties under SB 5. Using competitively awarded federal grants, the Laboratory was able to provide the needed statewide training for the new mandatory energy codes and provide technical assistance to cities and counties in helping them implement adoption of the legislated energy efficiency codes.

## 2.3 Progress In FY 2003

Since September 2002, the Energy Systems Laboratory has accomplished the following activities in fulfillment of its requirements under SB 5:

- Estimated energy and resultant $NO_x$ reductions from implementation of the Texas Building Energy Performance Standards (IECC/IRC codes) to new residential construction,
- Developed a prototype, web-based "Emissions Reduction Calculator" for determining emissions reduction from energy efficiency improvements in residential construction,
- Enhanced the Laboratory's IECC/IRC Code-Traceable Test Suite for determining emissions reduction due to code and above-code programs,
- Developed and tested key procedures for validating simulations of building energy performance,
- Provided over 50 IECC/IRC energy code training sessions throughout the State of Texas,
- Maintained and updated the Laboratory's Senate Bill 5 web site.
- Maintained a builder's residential energy code Self-Certification Form (Ver.1.3) for use by outside municipalities,
- Resolved several major issues for manufacturers and builders regarding new insulation requirements to all parties agreement,
- Responded to hundreds of phone and email inquiries on code implementation and verification issues, and,
- Completed an evaluation of proposed energy code changes requested by the North Central Texas Council of Governments (NCTCOG) and partially completed an evaluation of proposed energy code amendments requested by the City of Houston.

These activities were designed to enhance the impact of EE/RE measures contained in SB 5 and assist the TCEQ, local governments, and the building industry with effective implementation and reporting.

## 2.4 Energy and NOx Emissions Reduction From New Residential Construction

Energy savings from energy code-compliant new residential construction in 2003 were 252,238 MWh/year of electricity and 887,564 MBtu/year of natural gas in the 38 original, non-attainment and affected counties. The resultant *annual* $NO_x$ reductions were calculated to be 473 tons $NO_x$/year which include:

- 340 tons $NO_x$/year (72.0%) from single-family residential (236,965 MWh/year saved),
- 22 tons $NO_x$/year (4.7%) from multi-family residential (15,272 MWh/year saved), and

- 110 tons $NO_x$/year (23.3%) from natural gas savings from single-family and multi-family residential (887,564 MBtu/year saved).

On a *peak summer day*, the NOx reductions in 2003 are calculated to be 2.44 tons of $NO_x$/day, which represents:

- 2.13 tons NOx/day (87.3%) from single-family residential (1,452 MWh/day saved),
- 0.11 tons $NO^x$/day (4.5%) from multi-family residential (73.73 MWh/day saved), and
- 0.20 tons $NO_x$/day (8.2%) from natural gas savings from single-family and multi-family residential (1,595 MBtu/day saved).

The comparative magnitude of the annual and peak-day $NO_x$ reductions from natural gas compared to the savings from electricity vary significantly. This is because the annualized savings include heating period $NO_x$ reductions, and the peak-day (i.e., cooling) natural gas savings include only those savings associated with the elimination of pilot lights. Details of the analysis are reported in this report.

## 2.5 Review Of Proposed Local Energy Code Changes

The TERP requires that all local energy code amendments not result in less stringent energy efficiency requirements in non-attainment and affected counties than the unamended IECC/IRC and that the Laboratory may determine, upon request, if the proposed code changes are substantially equal to or less stringent than the code. The Laboratory reviewed proposed local amendments in 2002-2003 for the North Central Texas Council of Governments (NCTCOG) and the City of Houston.

The Laboratory determined that the proposed NCTCOG window glazing shading requirements were substantially equal to the IECC/IRC. The Laboratory was informed that local builders rarely use this exception; and that this region leads the State in the use of high-performance, low-emissivity (low-e) glass for new residential construction.

The Laboratory conducted an extensive review of proposed energy code changes for the City of Houston that were driven primarily by the local concern over mold and mildew formation in Houston’s hot and humid climate. Several proposed changes were withdrawn by the City of Houston, which were substantially less stringent than the IECC/IRC requirements. Several alternative changes were reviewed and the initial determination is that, as a whole, the proposed changes are substantially equivalent. Final determination is pending the receipt of the revised amendment request.

## 2.6 Technology For Calculating And Verifying Emissions Reduction From Energy Used In Buildings

The Laboratory has developed a prototype Emissions Reduction Calculator and the underlying technology for determining emissions from power plants that deliver the electricity to the residence. The Emissions Reduction Calculator is intended to be used to obtain SIP credits from energy efficiency programs in the TERP. The TCEQ and the EPA are currently reviewing the Laboratory’s proposed technology and procedures for estimating NOx emissions from energy efficiency for inclusion in the SIP. This proposed new technology addresses two major challenges:

- How to quantify and validate the persistence of energy savings from energy efficiency and renewable energy measures.
- How to transform electricity reductions into spatially (location) and temporally (time-of-day) distributed emissions reduction from electric utility power plants.

The Laboratory’s Emissions Reduction Calculator uses the EPA’s eGRID database to identify where air emissions are produced. A complete description of the technology and procedures for calculation emissions reduction is contained in this report. The Laboratory requests continued input and critical analysis by affected parties and federal and state regulatory agencies on this approach to help ensure accuracy and ease of use.

## 2.7 Procedures For Calculating Energy And Emissions Reduction

The Laboratory has developed and documented methodologies to calculate the electricity and natural gas savings from the implementation of the IECC/IRC to new residential and commercial buildings. These methodologies are composed of procedures that calculate and verify savings using several different sources of information, including:

- The calculation of electricity savings and peak-day electric demand reductions from the implementation of the IECC/IRC in new residences, ASHRAE 90.1-1999 in commercial buildings, and ASHRAE 90.1-2001 in Texas State Agencies in non-attainment and affected counties as compared against 1999 building characteristics using code-traceable, hourly, building energy simulation.
- The cross-check of electricity savings using a utility bill analysis method.
- The cross-check of pre-code and post-code construction data using on-site visits.

The Laboratory has worked closely with the TCEQ and EPA to develop procedures for calculating $NO_x$ reductions from electricity savings using the EPA's Emissions and Generation Resource Integrated Database (eGRID). This procedure calculates annual and peak-day, county-wide $NO_x$ reductions from electricity savings from Energy Efficiency and Renewable Energy projects implemented in each Power Control Area (PCA) in the ERCOT region.

## 2.8 Evaluation Of Additional Technologies For Reducing Energy Use In Existing Buildings

Evaluation of additional technologies for further reducing energy use in existing buildings and community-based energy efficiency programs are covered in this report, including:

- Existing building envelope upgrades and building tune-ups (Continuous Commissioning®, building design, windows and insulation, and effective building operations.
- Use of electronic ballasts and lamps (both compact florescent lights and florescent fixture lamps).
- Use of high efficiency air-conditioners and heat pumps.
- Use of efficient supply air duct distribution systems.
- Use of renewables, including wind, solar thermal and solar photovoltaic
- Use of HVAC equipment and domestic water heaters that function without pilot lights.

## 2.9 Recommendations For Enhancing EE / RE Emissions Impacts In The TERP

Emissions reduction from energy savings in existing buildings and small industrial facilities will have a significant benefit for obtaining compliance with the EPA minimum Clean Air requirements. SB 5 contains requirements for new construction that is often the easiest to implement but does not provide for the reduction of energy use in existing buildings other than political subdivisions in non-attainment and affected counties.

The Laboratory recommends that the TCEQ evaluate the potential for additional cost-effective options for increasing emissions reduction from energy efficiency initiatives not covered by SB 5. Since new buildings only add about 2% to the existing building inventory, existing structures far surpass the annual energy use of new construction by a factor of approximately 98 to 2. Therefore, on a peak summer day 2.44 tons/day $NO_x$ reductions from new residential construction could grow to about 120 tons/day if existing buildings were brought into code compliance. If 10% of the existing buildings could be brought into code compliance, it would result in about 12 tons/day $NO_x$ emissions reduction. Three promising areas for investigation include:

1. Existing Commercial Buildings – It is estimated that commercial office space accounts for over 2.1 billion square feet in Texas. If all buildings over 50,000 square feet of air-conditioned space could be motivated to be tuned-up (i.e., commissioned), significant energy reduction potential exists in

the range of 10 – 40 percent. The Laboratory has proven that commercial and institutional building tune-ups are highly cost-effective with paybacks averaging 2 years or less.

2. Increased Use of High-efficient technologies – See discussion above. The federal government has made substantial progress promoting the use of energy efficient technologies through its Energy Star labeling. The TCEQ should investigate ways to increase the use of high-efficient technologies through such actions as recognition, local government purchasing requirements, and utility incentives to consumers, for example.

3. Reducing Federal Facility Energy Use – The federal government is the single largest building owner in Texas with over 206 million square feet, surpassing state-owned space by a substantial amount. Electricity use and emissions from these facilities have a substantial impact on local emissions inventories. For example, the federal government has approximately 46 million square feet of conditioned space in the San Antonio non-attainment counties. Since all federal agencies are required by statute and Presidential Executive Order to reduce energy use, a number of energy improvements and the purchase of electricity from renewable energy occurs every year in Texas. Therefore, it is recommend that the TCEQ solicit the help of the federal government by capturing and reporting the savings from their EE/RE projects.

## 2.10 Planned Focus For 2004

In FY2004, the Energy Systems Laboratory will continue its cooperative efforts with the TCEQ, TPUC, GLO, SECO, EPA and others to ensure EE/RE measures remain a cost-effective solution to clean air, and continue to support the energy efficiency and renewable energy goals of the TERP. The Laboratory team will:

- Continue development of well-documented, standardized methods for calculating and reporting $NO_x$ reductions, including adjustments to electricity savings needed for use of the EPA's eGRID program, from the TCEQ, TPUC, GLO and SECO initiatives.
- Continue to identify maximum, cost-effective $NO_x$ emissions reduction in existing residential, commercial and industrial buildings for possible integration into the Laboratory's Emissions Reduction Calculator.
- Assist the TCEQ to obtain EPA approval for SIP credits from energy efficiency and renewable energy in each of the non-attainment and affected counties 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/EPA approved technology.
- Develop "below today's cost" methods and techniques to implement above code energy efficiency in low-priced and moderately-priced residential housing.
- Continue the development and documentation of the Laboratory's web-based Emissions Reduction Calculator tool by including commercial buildings, municipal facility, and renewable energy calculations.

# 3 INTRODUCTION

## 3.1 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. Sixteen were designated by the EPA as non-attainment areas, twenty-two others were designated by Senate Bill 5 as affected areas. These areas are shown on the map in Figure 1, as non-attainment (dark-shaded), and affected (shaded). The sixteen counties designated as non-attainment counties included: Brazoria, Chambers, Collin, Dallas, Denton, El Paso, Fort Bend, Hardin, Harris, Jefferson, Galveston, Liberty, Montgomery, Orange, Tarrant, and Waller counties. The twenty-two counties designated as affected counties included: Bastrop, Bexar, Caldwell, Comal, Ellis, Gregg, Guadalupe, Harrison, Hays, Johnson, Kaufman, Nueces, Parker, Rockwall, Rusk, San Patricio, Smith, Travis, Upshur, Victoria, Williamson, and Wilson County. In 2003, three additional counties were classified as affected counties, including: Henderson, Hood and Hunt counties, bringing the total to forty-one counties (sixteen non-attainment and twenty-five affected counties). Analyses reported in this document, however, were conducted over the past year and focused on the original 38 counties.

These counties represent several geographic areas of the state, which have been assigned to different climate zones by the 2000 IECC[1] as shown in Figure 2, based primarily on Heating Degree Days (HDD). These include, climate zone 5 or 6 (i.e., 2,000 to 2,999 $HDD_{65}$) for the Dallas-Ft. Worth and El Paso areas, and climate zones 3 and 4 (i.e., 1,000 to 1,999 $HDD_{65}$) for the Houston-Galveston-Beaumont-Port Author-Brazoria area. Also shown on Figure 2 are the locations of the various weather data sources, including the seventeen Typical Meteorological Year (TMY2) (NREL 1995), and four Weather Year for Energy Calculations (WYEC2) (Stoffel 1995) weather stations, as well as the forty-nine National Weather Service weather stations, (NWS) (NOAA 1993).

The forty-one counties represent some of the most populated counties in the state, and contained 14.1 million residents in 1999, which represents 70.5% of the state's 20.0 million total population (U.S. Census 1999). As shown in Figure 3, the three largest counties, by population (i.e., Harris, Dallas, and Tarrant), are non-attainment counties. The fourth county, Bexar County, is classified as an affected county. These four counties contain 8.0 million residents, or 40.0% of the state's total population. In the rankings of the remaining counties it is clear that the most populous counties also represent the majority of the non-attainment regions.

In Figure 4 the total housing units trends in the forty-one non-attainment and affected counties is shown to closely follow the county populations, with Harris, Dallas, Tarrant, and Bexar counties containing 3.2 million housing units, or 40.0% of the state's total 8.0 million households (U.S. Census 1999). However, in Figure 5 the 1999 residential building permit activity differs from the population and total housing unit trends, with the most activity occurring in Harris county (25,862 units), followed by significantly less construction in the five counties in the 10,000 to 15,000 unit range, including Dallas, Travis, Bexar, Collin and Tarrant counties. These six counties represented 88,833 housing starts, or 71% of the total 125,464 residential building permits in the 41 counties classified as non-attainment or affected.

Also of interest in Figure 5 is the significant number of new multi-family units in the counties with the largest number of building permits. In the six largest counties (i.e., Harris, Dallas, Travis, Bexar, Collin and Tarrant) there were 34,038 new multi-family units, or 38% of the 88,833 housing starts in these counties. The map in Figure 6 shows these fast growing areas to be primarily in four metropolitan areas: the Houston area containing the fastest growing county (Harris county), the Dallas-Ft.Worth area containing three of the

[1] 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.

six counties (Dallas, Collin, Tarrant), Travis county in the Austin metropolitan area, and Bexar county in the San Antonio area.

| County | Population | Housing Unit | Permits (Single) | Permits(Multi) | Total Permits |
|---|---|---|---|---|---|
| Harris | 3,250,404 | 1,273,565 | 16,055 | 9,807 | 25,862 |
| Dallas | 2,062,100 | 840,374 | 8,392 | 6,545 | 14,937 |
| Tarrant | 1,382,442 | 554,145 | 8,785 | 1,969 | 10,754 |
| Bexar | 1,372,867 | 512,381 | 7,117 | 5,007 | 12,124 |
| Travis | 727,022 | 321,612 | 6,742 | 6,314 | 13,056 |
| El Paso | 701,908 | 221,244 | 3,472 | 724 | 4,196 |
| Collin | 456,612 | 184,781 | 7,704 | 4,396 | 12,100 |
| Denton | 404,074 | 162,280 | 5,222 | 1,511 | 6,733 |
| Fort Bend | 353,697 | 114,678 | 1,148 | 12 | 1,160 |
| Nueces | 315,469 | 122,102 | 694 | 308 | 1,002 |
| Montgomery | 287,644 | 108,573 | 4,493 | 426 | 4,919 |
| Galveston | 248,469 | 108,802 | 1,627 | 480 | 2,107 |
| Jefferson | 241,332 | 101,465 | 581 | 54 | 635 |
| Williamson | 240,892 | 84,634 | 3,984 | 1,621 | 5,605 |
| Brazoria | 234,303 | 88,543 | 1,717 | 266 | 1,983 |
| Smith | 169,693 | 71,158 | 440 | 90 | 530 |
| Johnson | 122,594 | 45,604 | 514 | 358 | 872 |
| Gregg | 113,155 | 46,189 | 194 | 144 | 338 |
| Ellis | 107,580 | 38,095 | 481 | 8 | 489 |
| Hays | 92,755 | 33,919 | 754 | 256 | 1,010 |
| Parker | 85,427 | 33,802 | 242 | 52 | 294 |
| Orange | 85,240 | 34,607 | 218 | 3 | 221 |
| Guadalupe | 82,808 | 33,112 | 628 | 0 | 628 |
| Victoria | 82,087 | 32,778 | 196 | 2 | 198 |
| Comal | 76,770 | 31,586 | 926 | 20 | 946 |
| Hunt | 75806 | 32423 | 97 | 32 | 129 |
| Henderson | 72080 | 35820 | 139 | 18 | 157 |
| San Patricio | 71,636 | 24,369 | 248 | 0 | 248 |
| Kaufman | 68,065 | 25,803 | 178 | 184 | 362 |
| Liberty | 67,161 | 26,146 | 310 | 52 | 362 |
| Harrison | 59,797 | 26,243 | 22 | 42 | 64 |
| Bastrop | 52,561 | 22,106 | 143 | 2 | 145 |
| Hardin | 49,684 | 19,815 | 33 | 2 | 35 |
| Rusk | 45,819 | 19,854 | 18 | 0 | 18 |
| Hood | 39969 | 19072 | 64 | 14 | 78 |
| Rockwall | 39,489 | 14,396 | 761 | 22 | 783 |
| Upshur | 36,541 | 14,917 | 14 | 0 | 14 |
| Caldwell | 32,820 | 11,844 | 81 | 0 | 81 |
| Wilson | 32,504 | 12,099 | 7 | 0 | 7 |
| Waller | 28,070 | 11,668 | 29 | 40 | 69 |
| Chambers | 23,993 | 10,027 | 213 | 0 | 213 |
| TOTAL | 14,093,339 | 5,526,631 | 84,683 | 40,781 | 125,464 |

Table 1: 1999 Texas County Population for Non-attainment (grey) and Affected Counties.

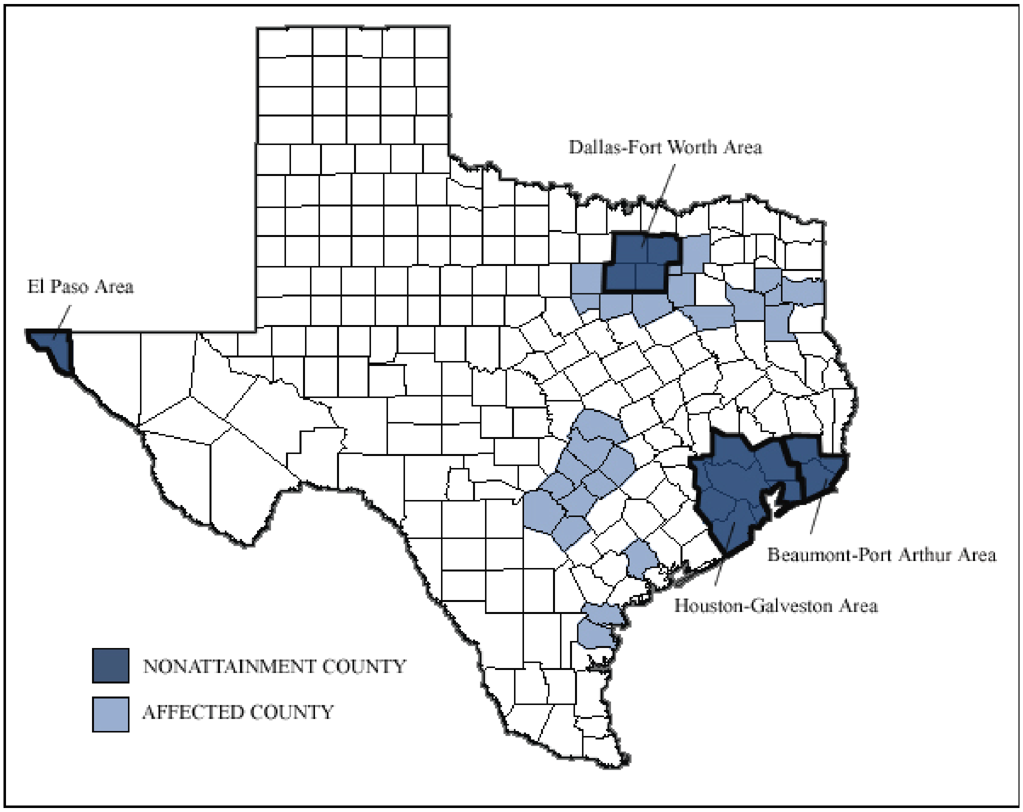



Figure 1: EPA Non-attainment (dark shade) and affected counties (light shade).

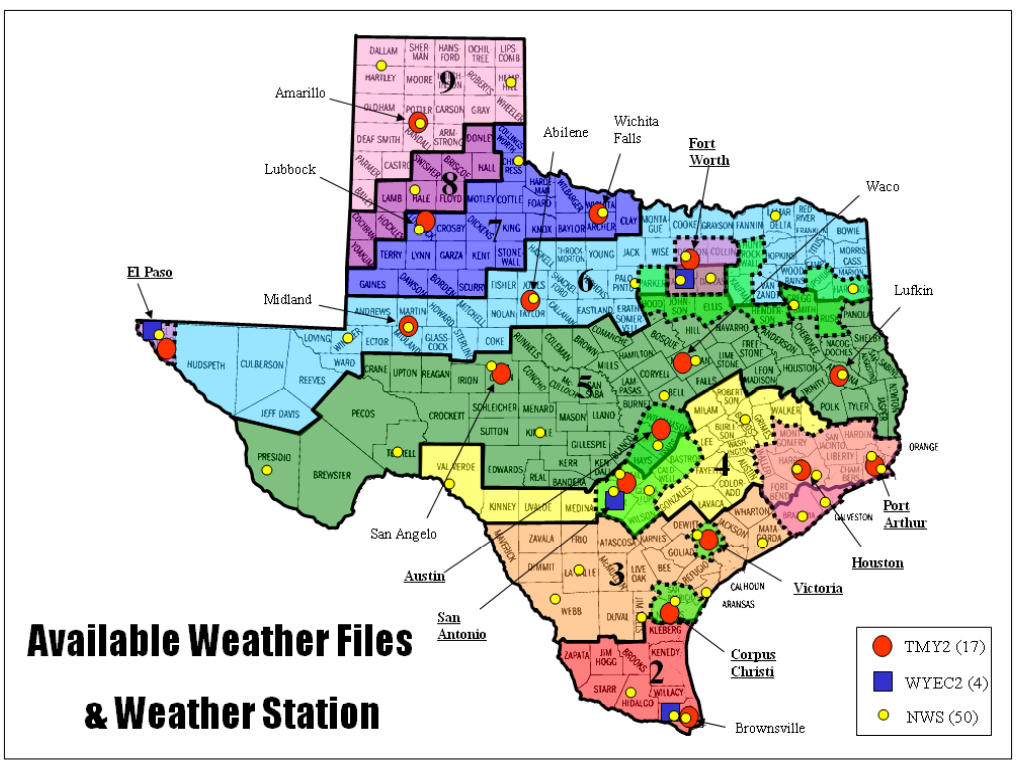



Figure 2: Available NWS, TMY2 and WYEC2 weather files compared to IECC / IRC weather zones for Texas.

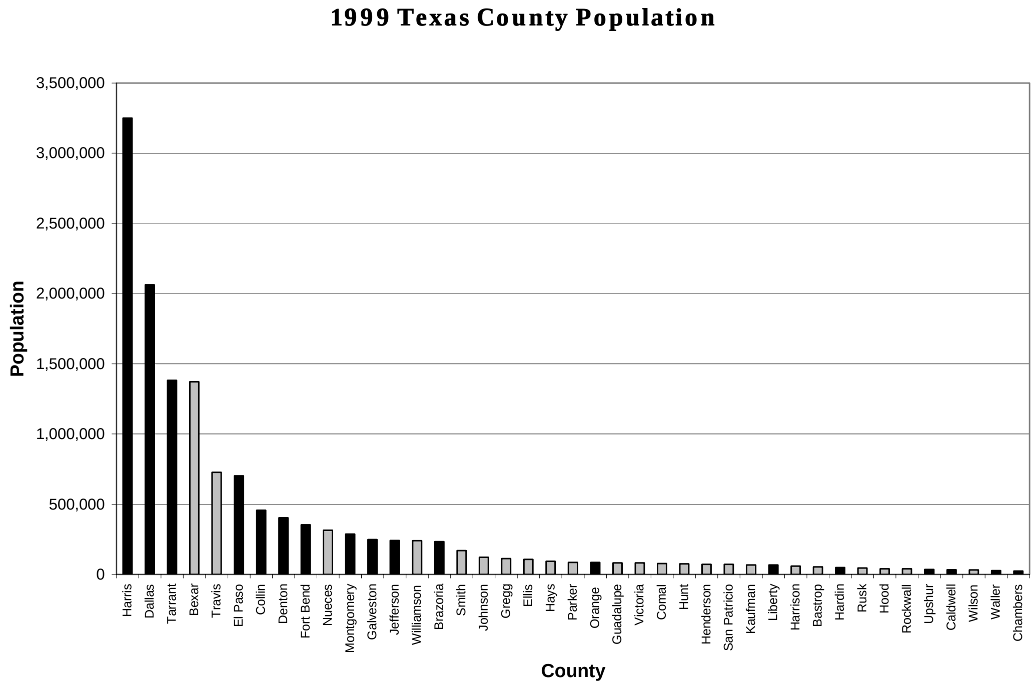



Figure 3: 1999 Texas county population for non-attainment (dark shade) and affected (light shade) counties (Source: U.S. Census).

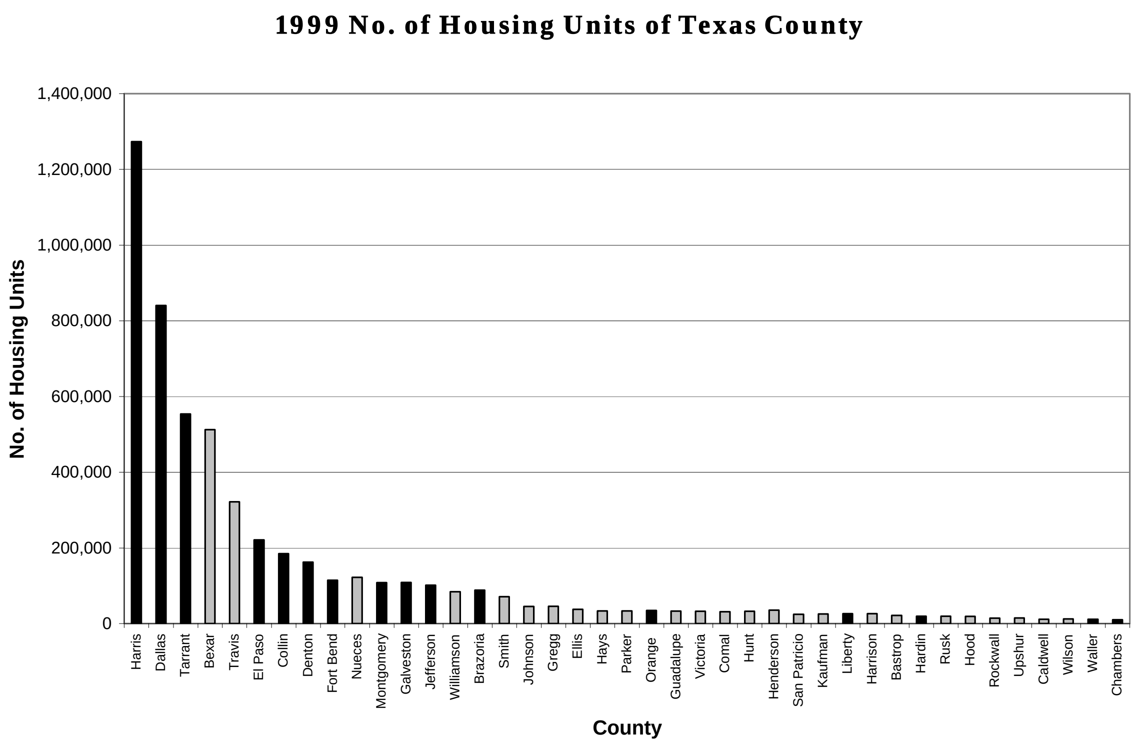



Figure 4: 1999 Housing units by county (Source: RECenter 2002).

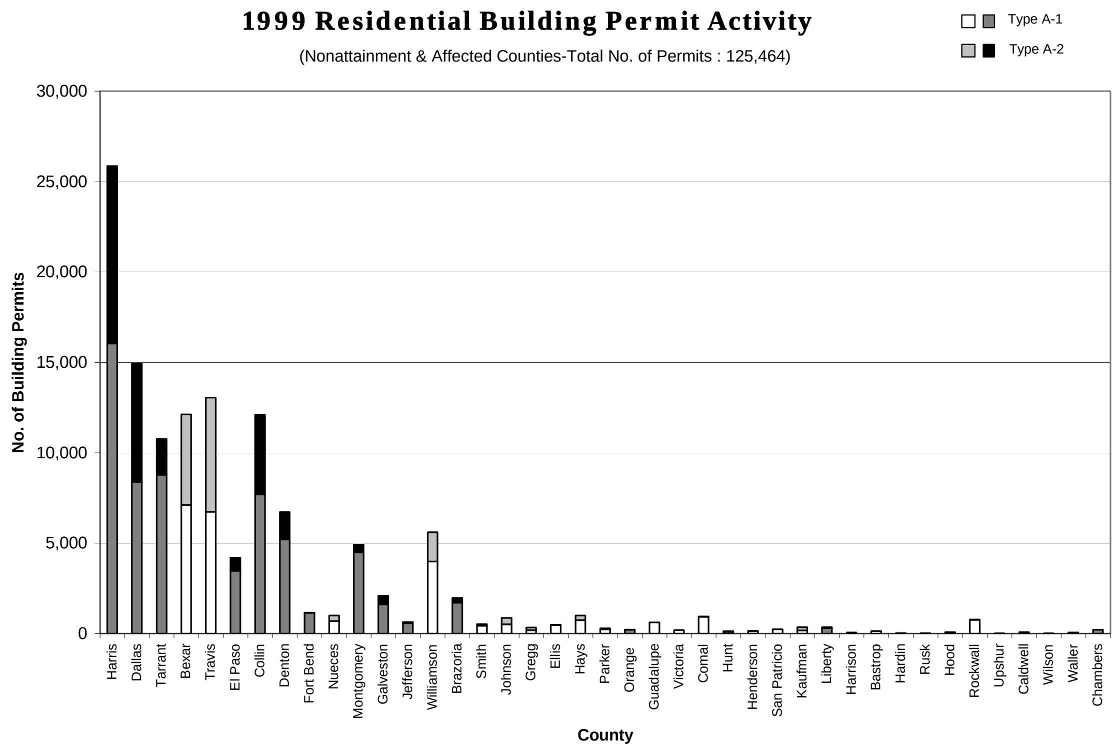



Figure 5: 1999 Residential building permits by county (Source: Real Estate Center, TAMU).

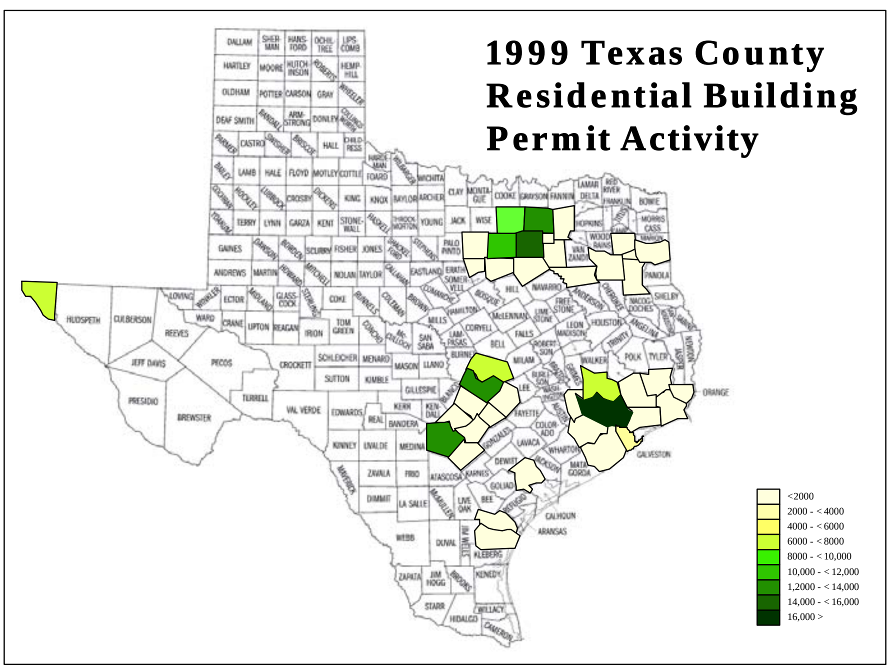



Figure 6: Map of 1999 residential building permits by county (Source: Real Estate Center, TAMU) .

### 3.2 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.

These responsibilities were updated in 2003 with House Bill 1365, including modifications to:

- Sec. 388.004. Enforcement Of Energy Standards Outside Of Municipality.
- Sec. 388.009. Energy-Efficient Building Program.

These responsibilities were updated in 2003 with House Bill 3235, including modifications to:

- Sec. 388.009.Certification of Municipal Building Inspectors.

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

#### 3.2.1 (SB5) Section 386.205 - Evaluation Of State Energy Efficiency Programs (w/PUC).

The Laboratory is instructed to assist the Texas Public Utilities Commission (PUC) 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).

#### 3.2.2 (SB5) Sec. 388.003. Adoption Of Building Energy Efficiency Performance Standards.

Senate Bill 5 adopts the energy efficiency chapter of the 2000 International Residential Code (IRC 2000) as an energy code for single-family residential construction, and the 2000 International Energy Conservation Code 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.

Senate Bill 5 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 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.

#### 3.2.3 (SB5) Sec. 388.004. Enforcement Of Energy Standards Outside Of Municipality.

For construction outside of the local jurisdiction of a municipality, Senate Bill 5 provides for a building to comply if:

a) a building certified by a national, state, or local accredited energy efficiency program shall be considered in compliance;

b) 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

c) 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.

3.2.4 (SB5) 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. Senate Bill 5 authorizes the Laboratory to develop simplified materials to be designed for projects in which a design professional is not involved. It also a 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.

3.2.5 (SB5) Sec. 388.008. Development Of Home Energy Ratings.

Senate Bill 5 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. Senate Bill 5 requires the Laboratory to establish a public information program to inform homeowners, sellers, buyers, and others regarding home energy ratings.

3.2.6 (HB 1365) Sec. 388.004. Enforcement Of Energy Standards Outside Of Municipality.

In 2003, House Bill 1365 modified Section 388.004 of Senate Bill 5 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 1st, 2001, but not later than August 31st, 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 Senate Bill 5 website.

3.2.7 (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 percent 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.

3.2.8 (HB 3235) Sec. 388.009. Certification of Municipal Inspectors.

Also in 2003, House Bill 3235 modified the TERP to add the following 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 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.

# 4 PROGRESS: SEPTEMBER 2002 TO AUGUST 2003

## 4.1 (SB5) Section 386.205 - Evaluation Of State Energy Efficiency Programs (w/PUC).

### 4.1.1 Held Preliminary Meetings with PUC to Discuss Procedures for Evaluating State Energy Efficiency Programs

The Laboratory has had several meetings with the Texas Public Utilities Commission (PUC) to discuss the development of a framework for reporting emissions reduction from the State Energy Efficiency Programs administered by the PUC. The State Energy Efficiency Programs administered by the PUC include programs under Senate Bill 7 (i.e., Section 39.905 Utilities Code) and Senate Bill 5.

In October 2002 the Laboratory filed comments with the PUC regarding how the reporting of savings from SB5 and SB7 could be more accurately reported using the planned eGRID database, as indicated in the memo in the appendix to this report. Several conference calls were then held with the PUC and their contractor that developed the deemed tables to work through the details of how this change in reporting could be carried out.

## 4.2 Sec. 388.003. Adoption Of Building Energy Efficiency Performance Standards.

### 4.2.1 Created Senate Bill 5 Stakeholders Group

In 2002 the Laboratory created a Senate Bill 5 Stakeholders Group consisting of manufacturers, public interest groups, builders, utilities, and Federal, State and Local government agencies. These Stakeholders meetings provided the Laboratory with valuable input on how to best proceed with difficult issues that had to be addressed in the first year of Senate Bill 5.

Communication with the Senate Bill 5 Stakeholders continued during the period September 2002 to August 2003, including: communication of upcoming workshops, responding to specific concerns about how codes will impact product performance, etc.

### 4.2.2 Builder’s Guide (Version 1.04) Published

In 2002 the Laboratory produced a simplified Builder’s Guide that provides builders with three prescriptive paths for each climate zone in Texas. The Builder’s Guide helps simplify the implementation of the IECC / IRC. This guide is maintained on the Laboratory’s web site for downloading as a PDF file (i.e., eslsb5.tamu.edu). Laminated, color copies of the Builder’s Guide are distributed to builders to code officials upon request, and to those who attend the Laboratory’s workshops. An example copy of the Builder’s Guide is provided in the Appendix, Figure 64 and Figure 65.

### 4.2.3 Review of Local Amendments

Two sets of local amendments were reviewed in 2003, a portion of NCTCOG amendments which could not be simulated at the time of initial conditional approval, and City of Houston amendments initially submitted in July , 2002.

#### 4.2.3.1 North Central Texas Central Council of Governments (NCTCOG)

The regional amendments to IECC / IRC by NCTCOG included an exception to the .4 SHGC requirement in Sec. 502.1.5 for north-facing or appropriately shaded south-facing exposures. Simulations indicated that an un-shaded northern exposure with insulated clear glass would result in slightly more total annual energy than an exposure with low-SHGC performance glass. A properly shaded southern exposure with insulated clear glass would result in slightly less total annual energy than a similar exposure with low-SHGC performance glass. On balance, the net difference is negligible and the exception remains acceptable for this region, in terms of substantial code equivalence. It is noted however, that low-SHGC, low-emissivity glazings, in all exposures, do have net benefits during the summer ozone season. It is further noted that this region has led the window market transformation to high-performance, low-SHGC glazings and the exception does not appear to be widely used in any case.

#### 4.2.3.2 City of Houston

Amendments proposed by the City of Houston underwent a lengthy series of reviews, dialog with City representatives, revisions and further review and simulation. Any proposed amendments which would have reduced stringency were subsequently revised or withdrawn by the City. Amendments which enhance stringency were also proposed. These appear to have limited impact and the current determination for Houston was also of "substantial equivalence." A complete, final set of amendments is being developed by the City for review, but all prior issues have been resolved.

### 4.2.4 Requested by EPA to Approve Energy Star as Above Code for Texas

As part of the request by the NCTCOG, the Laboratory was requested to approve the Energy Star program as an alternative compliance path. A similar request was also made by the City of Houston. The Laboratory reviewed the Energy Star program, including the computer simulation code used by the EPA[2]. The initial review precluded a blanket approval of the Energy Star program. The Laboratory reviewed selected Building Option Packages (BOPs) for Houston and Dallas. As part of this review the Laboratory had extensive discussions with the EPA, ICF, the International Code Council (ICC), the United States Department of Energy (USDOE), Pacific Northwest National Lab (PNNL), the National Renewable Energy Laboratory (NREL) and the Lawrence Berkeley National Laboratory (LBNL) to determine how a code-traceable simulation could be developed and reviewed by experts at the USDOE's National Labs. Following the discussions the Laboratory then developed a code-traceable DOE-2 input file for a single-family single residence that represented the average housing type in Texas, and tested the Energy Star BOPs for Houston and Dallas.

The tests showed that selected Energy Star BOPs that were submitted to the Laboratory meet or exceed the prescriptive energy requirement of the 2000 IECC / IRC, after revisions were made[3]. A copy of the Laboratory's letter regarding the use of Energy Star is provided in the Appendix, along with a list of the Energy Star BOPs that passed the test.

### 4.2.5 Requested to Approve REMRate and EnergyGauge USA as Alternative Compliance Path.

As part of the request by the NCTCOG, the Laboratory was requested to approve the REMRate and EnergyGauge USA software as an alternative compliance paths. A similar request was also made by the City of Houston. The Laboratory has developed a HERs Standardized Report that will facilitate the use of transfer files from the REMRate and EnergyGauge-USA programs for this purpose. A copy of this report is included in the appendix.

### 4.2.6 Estimated NOx Reduction Potential From Implementation of the IECC / IRC to New Residences

The Laboratory developed estimates of potential NOx reductions from the implementation of the IECC / IRC to new single-family residences for calendar year 2002, which were published in the Laboratory's

[2] This computer analysis for the Energy Star program is based on DOE-2.1e, ver. 121 simulations, which are performed by ICF Consulting, Washington, D.C., under contract to the U.S.E.P.A.
[3] These revisions include: mandating SHGC < 0.40 for HDD < 3,500, double pane windows, referencing window area to wall area, and revising the footnotes on the BOPs to comply with the IECC/IRC.

Annual report to the TNRCC[4]. These estimates were based on the IECC-traceable DOE-2 simulation of an average-sized house as defined by the NAHB for 1999. It was anticipated that the implementation of the IECC / IRC would save between 1.7 and 2.5 tons-NOx/day. Additional information about these preliminary calculations can be found the 2002 report, which is available on the Laboratory's web page.

This analysis was updated in 2003 to include the newly published housing permits for 2002 and 2003. The analysis was also substantially modified to include a new methodology for using the EPA's eGRID program, which is based on extensive discussions with EPA. Additional information can be found in Section 8 of this report.

#### 4.2.7 Development of an Analysis Plan to Report Energy Reductions and Link to Emissions Reduction

In 2002 the Laboratory initiated the development of an analysis plan to report the energy reductions from the implementation of the IECC / IRC to the TCEQ. This analysis plan consists of several tasks. The first procedure required annual, countywide kWh reductions and peak kW reductions from the implementation of the IECC / IRC to new construction. Results from the application of the first procedure were submitted in the Laboratory's 2002 Annual Report, and are updated in this report. The second procedure requires data and calculations from several state agencies, university labs and private entities, which is still undergoing discussion and review by the participating agencies. Additional information about both procedures are provided in the sections that follow in this report.

### 4.3 Sec. 388.004. Enforcement Of Energy Standards Outside Of Municipality.

#### 4.3.1 Self-Certification Form (Version 1.04) Published

The Laboratory maintains a self-certification form for code compliance for residential buildings in unincorporated areas that is available for downloading as a PDF file at the Laboratory's web site (i.e., eslsb5.tamu.edu). An example of the self-certification form is provided in the Appendix, Figure 66 and Figure 67. This two-page form provides a simplified checklist for a builder to use to self-certify that they are compliant with the IECC / IRC.

### 4.4 Sec. 388.007. Distribution Of Information And Technical Assistance.

#### 4.4.1 Laboratory's Senate Bill 5 Web Site Operational "eslsb5.tamu.edu"

Since the Fall of 2001 the Laboratory has maintained a Senate Bill 5 web page (i.e., eslsb5.tamu.edu), where information is provided to builders, code officials, the design community and homeowners about Senate Bill 5, including:

- A summary of Senate Bill 5,
- Information about the Laboratory's Senate Bill 5 training programs,
- Copies of the Builder's Guide (B&W or color PDF),
- The Builder's self-certification form,
- The Laboratory's letter regarding the R8 flexible duct issue,
- A copy of the Laboratory's 2003 ICEBO paper that describes the prototype Emissions Reduction Calculator, and information from the 2002 Annual Report,
- A copy of the Laboratory's 2002 Annual Report,
- The Laboratory's standardized HERs Reporting Form,
- Information about the Laboratory's analysis of Energy Star BOPs for Houston and NCTCOG,
- Related links (TCEQ, PUC, DOE, SECO, EPA, NCTCOG, AACOG),
- Information about the Laboratory's communications to the Texas Legislature.

[4] Haberl, J., Culp, C., Yazdani, B., Fitzpatrick, T., and Turner, D. 2002. "Texas Senate Bill 5 Legislation for Reducing Pollution in Non-attainment and Affected Areas: Annual Report", submitted to the Texas Natural Resources Conservation Commission, Energy Systems Laboratory Report ESL-TR-02/07-01, Texas A&M University, 116 pages, (Revised: September).

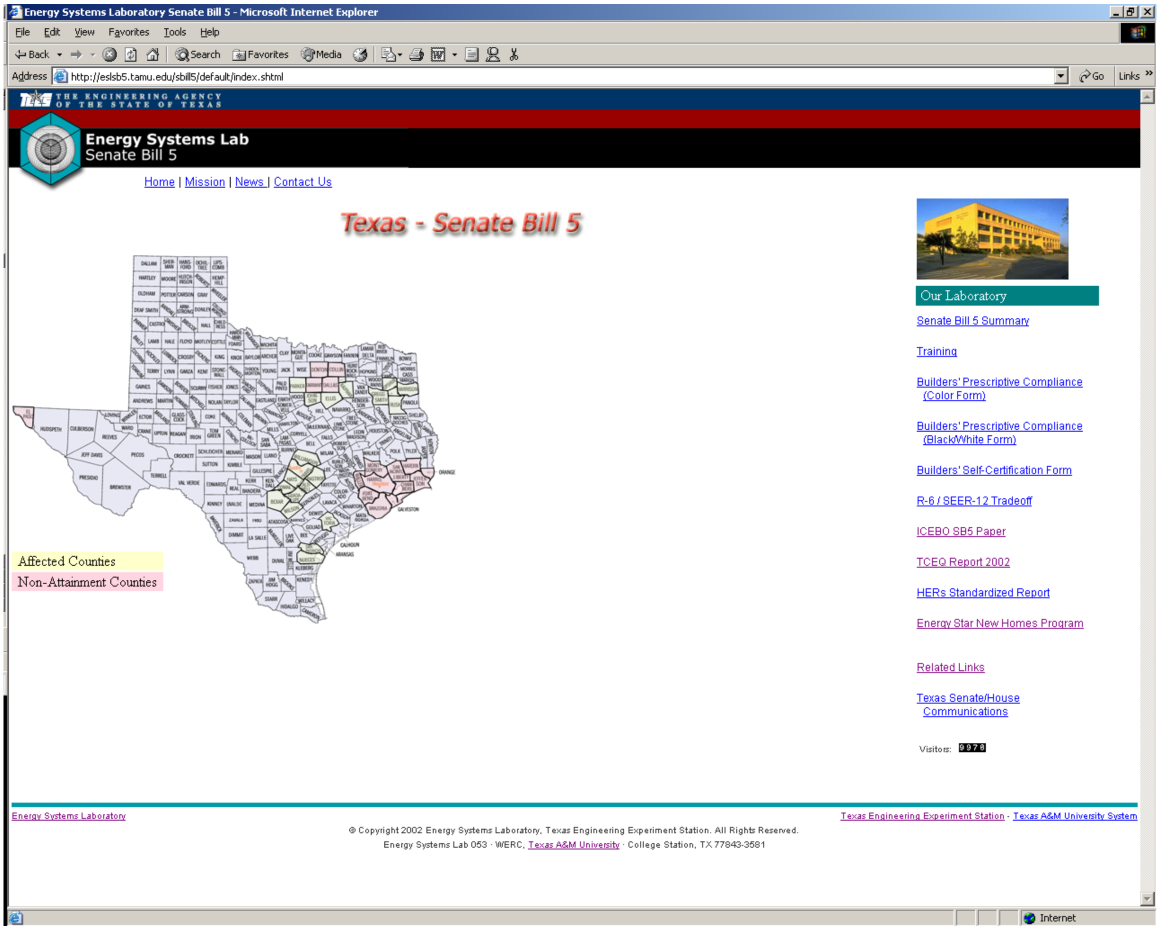



Figure 7: Laboratory's Senate Bill 5 web page for providing information about implementing the IECC / IRC.

### 4.4.2 Web Site for the Emissions Reduction Calculator Developed.

#### 4.4.2.1 Prototype Emissions Reduction Calculator (Beta 1.0, "eslsb5ec.tamu.edu").

In the fall of 2002 a prototype Texas Emissions Reduction Calculator was created to demonstrate the concept of an accurate, easy-to-use, web-based tool for calculating the emission reduction credits attributable to a single-family residence that is designed and built to meet or exceed the specifications of the 2000 International Energy Conservation Code (2000 IECC), as amended by the 2001 Supplement. In the summer and fall of 2003, the TCEQ and the Laboratory negotiated a contract for further development of the calculator, with support from the EPA. This contract was signed by both parties in November 2003.

The prototype calculator was configured initially for the Houston area and utilizes the June, 2002, NOx, SO2, and CO2 emissions rates published by the United States Environmental Protection Agency (EPA) for the electric utility provider indicated for the chosen county. The Texas Emissions Reduction Calculator uses the Energy Systems Laboratory's Code Traceable Test Suite to create an IECC code-compliant, DOE-2 hourly, base-case simulation for a house that has the same location, azimuth, conditioned area and window-to-wall area as the house under consideration. Energy efficiency improvements can then be entered on the "House Details" screen for a target house. The calculator then determines the annual emissions resulting from the code-compliant, base-case house and compares these emissions to the target house.

Figure 8 shows the opening page of the Emissions Reduction Calculator that includes information about what the calculator is intended to be and a step-by-step procedure for using the calculator. Figure 9 shows the Main Entry page of the calculator, which allows the user general information about the house including: the address, city and ZIP code for the house, the affected or non-attainment county the house is located in, the nearest city for weather information, the direction the front of the house is facing, and the depth and width of the house.

Figure 10 shows the calculator's House Details page, which includes additional information that the use can enter, including: the window area, window U-factor, solar heat gain coefficient, the house's floor type, information about the house's floor information, solar energy contributions (a place holder for future functions), the R-value of the wall insulation, R-value of the attic insulation, duct location, type of water heater, heating system type, efficiency of the heating system, cooling system type, efficiency of the cooling system, and cost information for electricity and natural gas.

Figure 11 shows the display that the calculator presents to the user while it performs the DOE-2 simulations to determine the code compliance and emissions reduction. In this display the calculator indicates which of the two simulations the calculator is performing, first, the calculator simulates the base case house (i.e., the code compliant house) that has same description as the user's house, only with code-compliant features (e.g., R-value, SHGC, etc.). Once this simulation is finished the calculator simulates the Customer's house, and then posts the results on the Annual Emissions screen, as shown in Figure 12. In Figure 12 the results are shown for a code compliant house (i.e., there is no difference between the customer's house and the base case house). These results include information about the total energy use, electricity use and natural gas use, with each of the categories including cost, energy, NOx, SO2, and CO2 values.

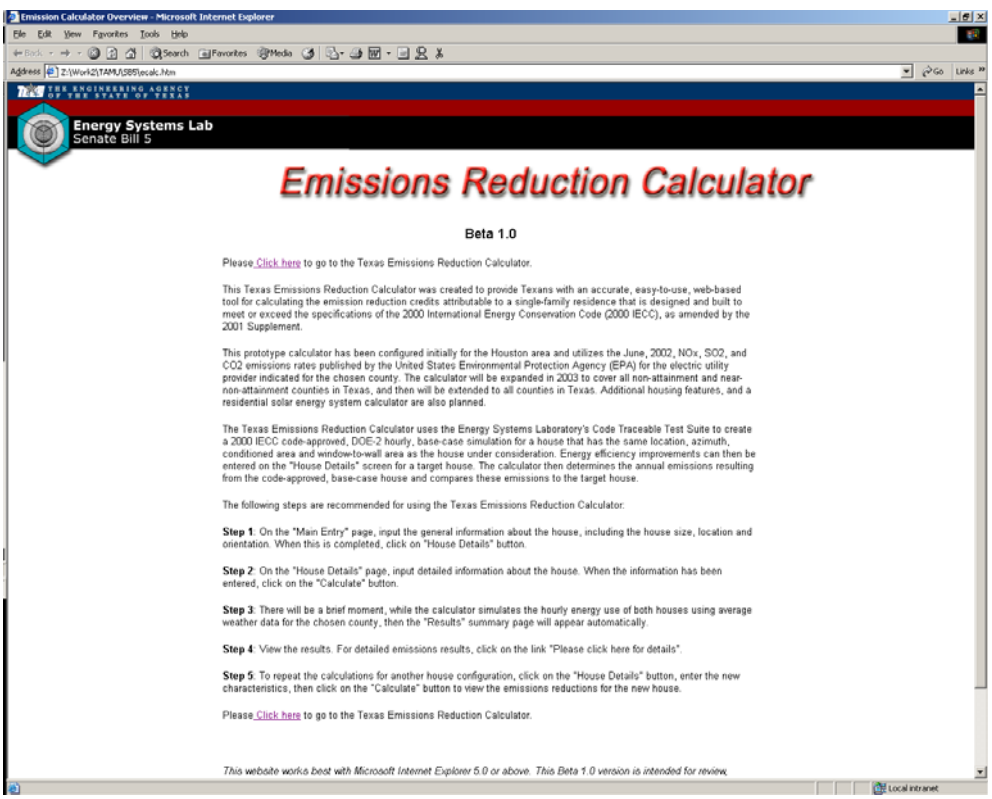



Figure 8: The Emissions Reduction Calculator: Entering Page.

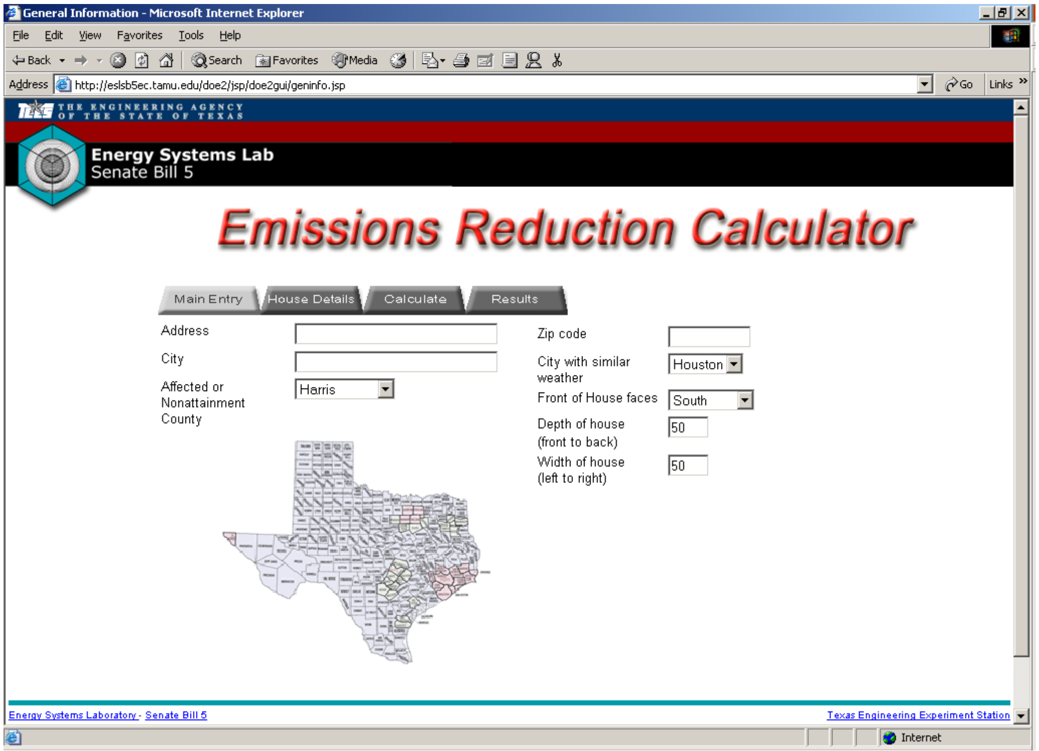



Figure 9: The Emissions Reduction Calculator: Main Page.

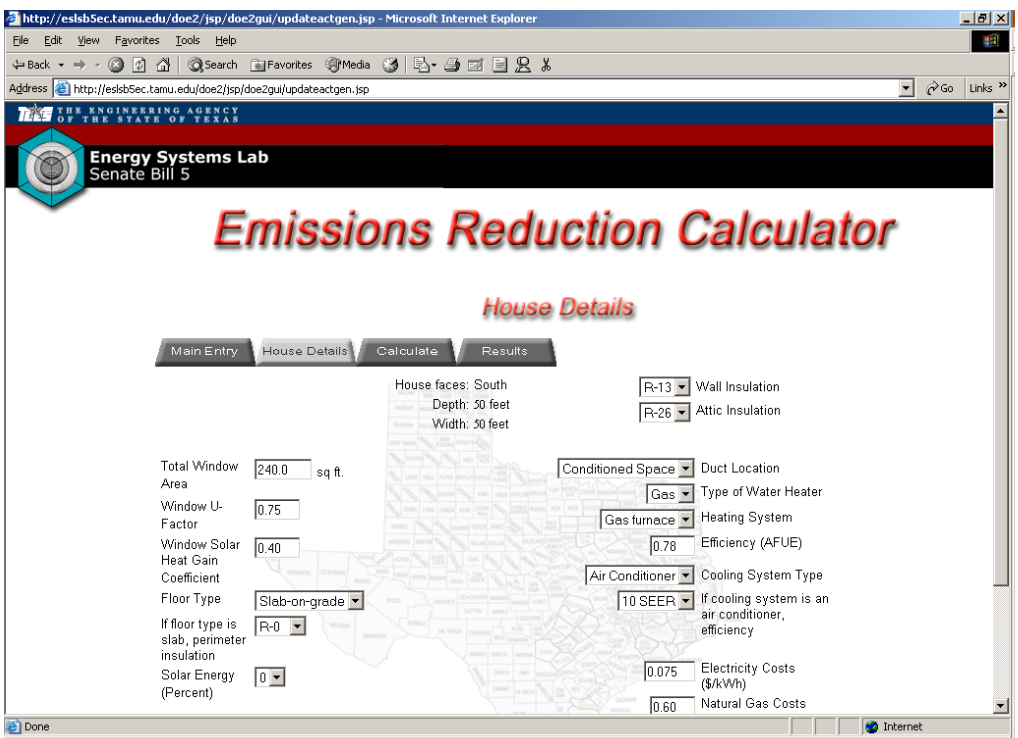



Figure 10: The Emissions Reduction Calculator: House Details Page.

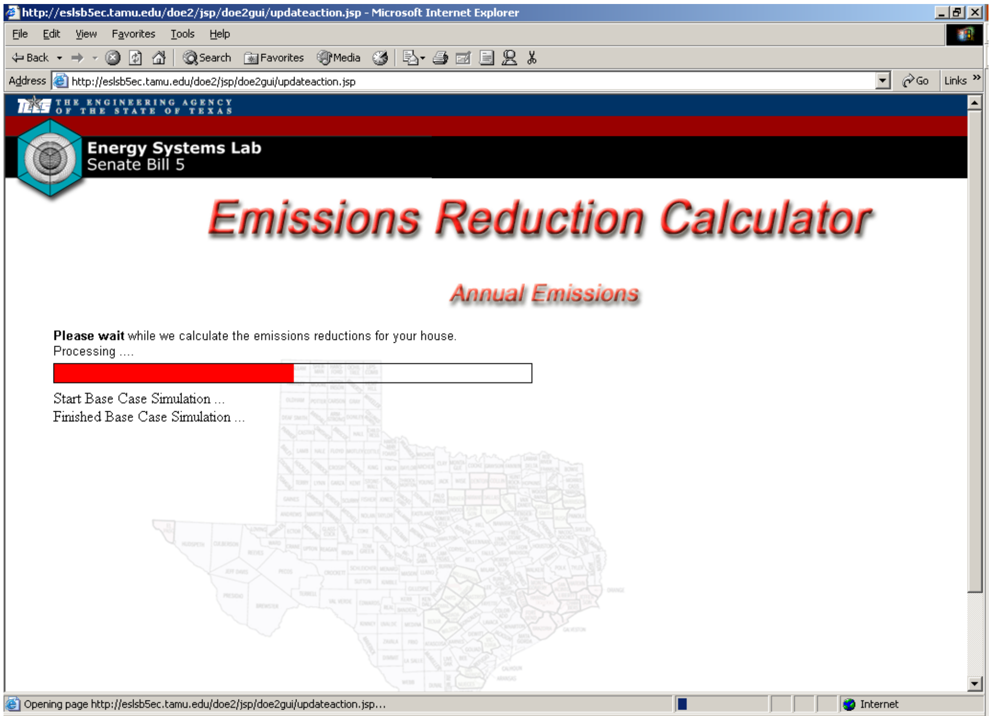



Figure 11: The Emissions Reduction Calculator: Simulating the Energy Savings.

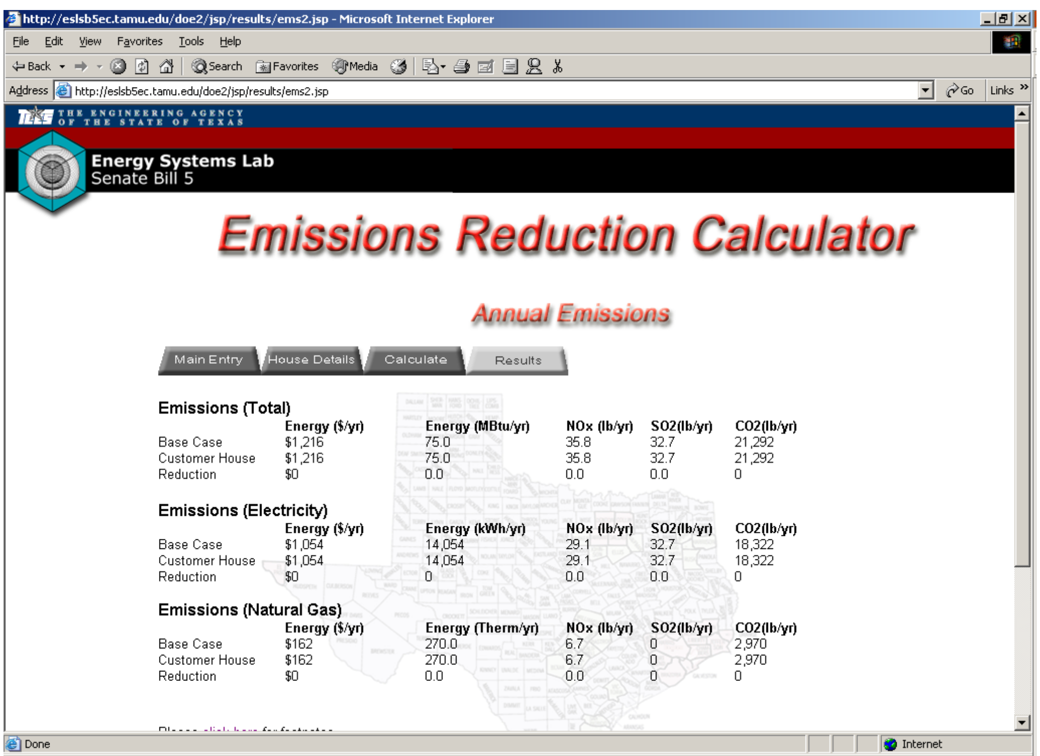



Figure 12: The Emissions Reduction Calculator: Results Page.

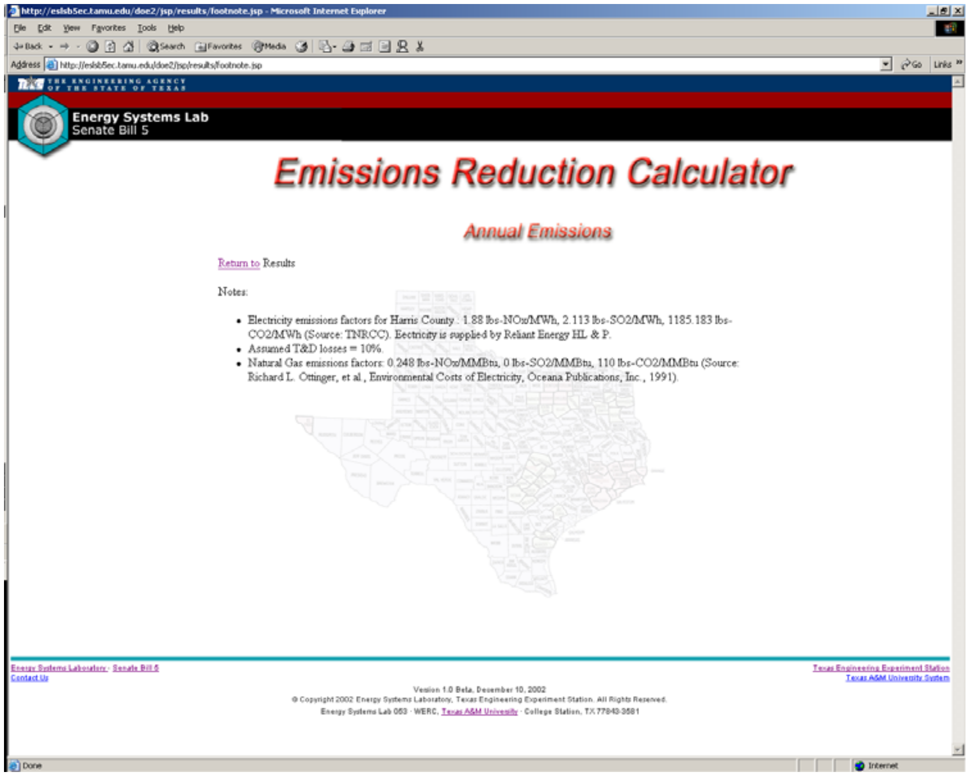



Figure 13: The Emissions Reduction Calculator: Results Page Footnote.

Should the user be interested in finding out more information about how the calculations were performed, they can click on the "footnotes" link, and the information shown in Figure 13 appears, which contains the name of the county and the EPA emissions factors for the county (i.e., Harris county, with EPA emissions data for Reliant Electric), information about the transmission and distribution losses, and the emissions factors for natural gas.

#### 4.4.2.2 Enhancements to the Emissions Reduction Calculator.

In the spring of 2003 the Laboratory formed a partnership with the Texas Commission for Environmental Quality (TCEQ), and the USEPA, to enhance the Emissions Reduction Calculator. The Laboratory will work closely with the TCEQ, using funding provided by the USEPA, to enhance the calculator to include the following new features:

- Expand the calculator to be fully-functional for all (41) affected and non-attainment counties,
- Expand the calculator to include: single-family residential (1 or 2 story), multi-family, commercial, individual renewable energy systems, and community-based energy efficiency and renewable energy projects.

Additional enhancements are planned for the 2004/2005 fiscal years.

#### 4.4.2.3 Developed new Emissions Calculation Procedures Using eGRID Matrix

In 2002 the Laboratory calculated emissions reduction from the implementation of the IECC / IRC to new construction of single-family homes. This calculation relied on the NOx/MWh values that were published by the TCEQ[5], which used the emissions factors published by the EPA in their eGRID database[6]. These

[5] The lbs-NOx/MWh are those published in the TNRCC's June 5, 2002, Houston/Galveston Attainment Demonstration and Post-1999 Rate-of-Progress SIP, Appendix A: Description of the Methodology for Determining Credit for Energy Efficiency, Table 3, (TNRCC 2002).

[6] E-GRID, Ver. 2, is the EPA's Emissions and Generation Resource Integrated Database (Version 2). This publicly available database can be found at www.epa.gov/airmarkets/egrid/.

values were published in a tabular format similar to that shown in Table 2, which represented the total NOx/MWh generated by the utility supplier in all the utility plants that served the customer. In the 2002 analysis the Laboratory used the utility map provided by ERCOT to assign the utility provider for a given county, which is shown in Figure 14. This analysis showed that the proper use of the eGRID NOx/MWh values combined with simulated peak-day electricity savings increased the reported NOx savings by 2:1 when compared to the NOx savings calculated with average annual values.

In 2003, after discussions with the EPA and the TCEQ, the Laboratory developed a more robust method for assigning utility suppliers and then, using eGRID, assigning the electricity production to a utility supplier and its power plant, across counties. This procedure is illustrated with the information provided in Table 3 through Table 5, and Figure 16 through Figure.

In Table 3 the NOx production for each power plant is provided from the eGRID database[7], for ten electric utility suppliers (i.e., AEP, Austin Energy, Brownsville Public Utility, LCRA, Reliant, San Antonio Public Service, South Texas Coop, TMPP, TNMP, and TXU). This new matrix was utilized to assign the power plant used by the utility provider, once the utility provider had been chosen for a given county. In 2003, the previous procedure, which had assigned a utility provider according to the information provided in Figure 14 was replaced with the utility providers shown in Table 4 and Table 5, which were obtained from the Texas Public Utility Commission in November 2002[8].

Figure 16 through Figure 19 present the results of the application of the eGRID database to the 2002 electricity from the implementation of the IECC / IRC to single-family residential construction[9]. In Figure 16 and Figure 17 the magnitude and geographical distribution of the peak-day electricity savings from the implementation of the IECC / IRC is shown for the new housing permits reported in 2002. In Figure 18 and Figure 19 the magnitude and distribution of the NOx reduction from the electric power plants is shown, as reported with the November 2002 eGRID database. A comparison of Figure 16 and Figure 17 against Figure 18 and Figure 19 clearly shows the value of the proper use of the eGRID matrix in its ability to more accurately calculate the magnitude and geographic distribution of the NOx savings from new single-family homes, which are constructed to the new IECC / IRC standard. Therefore, the NOx emissions reduction in this year's report include the simulated peak-day electricity savings and the November 2002 eGRID matrix to calculate the magnitude and geographical distribution of the NOx emissions reduction.

| Electric Utility | NOx Emissions (lbs/MWh) |
|---|---|
| American Electric Power – West | 2.90 |
| Austin Energy | 2.56 |
| Brownsville Public Utility | 2.24 |
| Lower Colorado River Authority | 3.16 |
| Reliant Energy | 2.50 |
| San Antonio Public Service | 2.65 |
| South Texas Electric Cooperative | 3.28 |
| Texas Municipal Power Pool | 3.22 |
| Texas-New Mexico Power Co. | 1.59 |
| TXU | 3.66 |
| ERCOT Average | 2.69 |
| | |

Table 2: EPA eGRID total emissions factors for selected utilities.

[7] The information in this table is from the November 2002 edition of the E-GRID database, provided by Art Diem at the USEPA.
[8] For the purposes of the 2003 report, the first provider in each county was assumed to be the utility provider for the entire county.
[9] Additional information can be found in the report: Haberl, J., Im, P., Culp, C., Yazdani, B., Fitzpatrick, T., Verdict, M., Turner. 2003. Procedure to Calculate NOx Reductions Using the Emissions and Generation Resource Integrated Database (E-GRID) Spreadsheet, Energy Systems Laboratory Report No. ESL-TR-03/05-xx, (May).

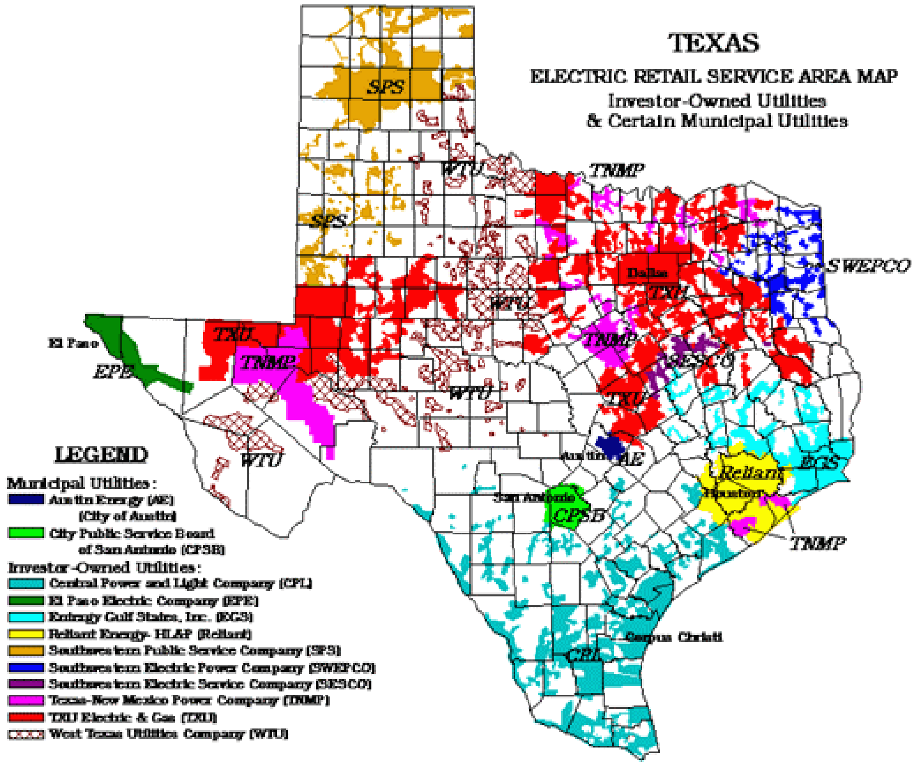



Figure 14: Texas electric retail service map (Source: ERCOT 2002).

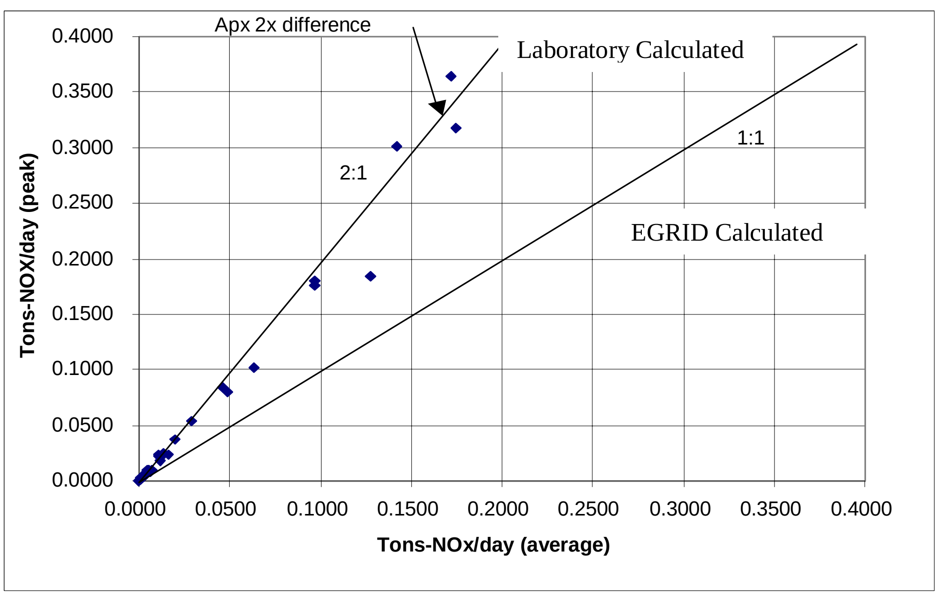



Figure 15: Comparison of Peak Day Versus Average Daily NOx Reductions From Electricity Savings for the 38 Non-attainment and Affected Counties.

| | | County-wide NOx Reductions in pounds per MWh for EE/RE implemented in each listed PCA | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cnty_FIP | County | American Electric Power - West (ERCOT)/PCA | Austin Energy/PCA | Brownsville Public Utils Board/PCA | Lower Colorado River Authority/PCA | Reliant Energy HL&P/PCA | San Antonio Public Service Bd/PCA | South Texas Electric Coop Inc/PCA | Texas Municipal Power Pool/PCA | Texas-New Mexico Power Co/PCA | TXU Electric/PCA |
| 48021 | **BASTROP** | 0.01 | 0.20 | | 0.34 | | 0.01 | | | | |
| 48029 | **BEXAR** | 0.06 | 0.09 | 0.04 | 0.16 | | 2.00 | 0.08 | 0.01 | | |
| 48039 | **BRAZORIA** | 0.01 | 0.01 | | | 0.05 | 0.01 | | | | |
| 48041 | **BRAZOS** | | 0.01 | | 0.01 | | | 0.03 | 0.11 | | 0.01 |
| 48057 | **CALHOUN** | 0.19 | | 0.14 | 0.01 | | | 0.04 | 0.01 | | 0.01 |
| 48061 | **CAMERON** | 0.14 | | 0.20 | | | | 0.03 | | | 0.01 |
| 48071 | **CHAMBERS** | 0.05 | 0.06 | 0.03 | 0.02 | 0.35 | 0.08 | 0.03 | 0.02 | 0.02 | 0.03 |
| 48073 | **CHEROKEE** | 0.01 | 0.01 | 0.01 | 0.02 | | | 0.02 | 0.06 | 0.02 | 0.10 |
| 48081 | **COKE** | 0.03 | | 0.02 | | | | 0.01 | | | |
| 48083 | **COLEMAN** | 0.02 | | 0.01 | | | | | | | |
| 48085 | **COLLIN** | 0.01 | 0.01 | | 0.02 | 0.01 | | 0.05 | 0.19 | | 0.02 |
| 48105 | **CROCKETT** | 0.14 | | 0.11 | | | | 0.03 | | | 0.01 |
| 48113 | **DALLAS** | 0.06 | 0.06 | 0.04 | 0.09 | 0.03 | 0.01 | 0.09 | 0.30 | 0.09 | 0.51 |
| 48121 | **DENTON** | | 0.01 | | 0.01 | | | 0.04 | 0.15 | | 0.01 |
| 48147 | **FANNIN** | 0.02 | 0.02 | 0.01 | 0.03 | 0.01 | | 0.03 | 0.09 | 0.03 | 0.17 |
| 48149 | **FAYETTE** | 0.02 | 0.86 | 0.02 | 1.51 | 0.01 | 0.04 | 0.01 | 0.02 | | 0.02 |
| 48157 | **FORT BEND** | 0.13 | 0.17 | 0.10 | 0.06 | 1.01 | 0.23 | 0.09 | 0.06 | 0.07 | 0.10 |
| 48161 | **FREESTONE** | 0.02 | 0.02 | 0.02 | 0.04 | 0.01 | | 0.03 | 0.12 | 0.04 | 0.22 |
| 48163 | **FRIO** | 0.05 | | 0.04 | 0.01 | | | 1.15 | 0.07 | | |
| 48167 | **GALVESTON** | 0.05 | 0.06 | 0.04 | 0.02 | 0.39 | 0.09 | 0.04 | 0.03 | 0.42 | 0.04 |
| 48185 | **GRIMES** | 0.01 | 0.01 | | 0.02 | 0.01 | | 0.06 | 0.23 | | 0.01 |
| 48197 | **HARDEMAN** | 0.01 | | 0.01 | | | | | | | |
| 48201 | **HARRIS** | 0.05 | 0.07 | 0.04 | 0.02 | 0.41 | 0.09 | 0.04 | 0.02 | 0.03 | 0.04 |
| 48207 | **HASKELL** | 0.16 | | 0.12 | 0.01 | | | 0.03 | 0.01 | | 0.01 |
| 48213 | **HENDERSON** | | | | 0.01 | | | | 0.02 | 0.01 | 0.03 |
| 48215 | **HIDALGO** | 0.13 | | 0.10 | | | | 0.03 | | | |
| 48221 | **HOOD** | 0.02 | 0.02 | 0.02 | 0.04 | 0.01 | | 0.03 | 0.12 | 0.04 | 0.22 |
| 48251 | **JOHNSON** | | | | | | | | 0.01 | | |
| 48253 | **JONES** | 0.14 | | 0.11 | | | | 0.03 | | | 0.01 |
| 48277 | **LAMAR** | | | | | | | | | | 0.01 |
| 48293 | **LIMESTONE** | 0.01 | 0.01 | | | 0.05 | 0.01 | | | | |
| 48299 | **LLANO** | | 0.12 | | 0.21 | | 0.01 | | | | |
| 48309 | **MCLENNAN** | 0.04 | 0.04 | 0.03 | 0.07 | 0.02 | 0.01 | 0.06 | 0.22 | 0.07 | 0.40 |
| 48335 | **MITCHELL** | 0.04 | 0.04 | 0.03 | 0.07 | 0.02 | 0.01 | 0.06 | 0.21 | 0.07 | 0.39 |
| 48353 | **NOLAN** | | | | | | | | | | 0.01 |
| 48355 | **NUECES** | 0.74 | 0.01 | 0.55 | 0.02 | 0.01 | 0.01 | 0.15 | 0.02 | 0.01 | 0.03 |
| 48363 | **PALO PINTO** | 0.01 | 0.02 | 0.01 | 0.03 | 0.01 | | 0.09 | 0.36 | | 0.02 |
| 48367 | **PARKER** | | | | | | | 0.01 | 0.03 | | |
| 48387 | **RED RIVER** | | | | | | | | 0.01 | | 0.02 |
| 48395 | **ROBERTSON** | | | | | 0.01 | | | | 0.40 | 0.01 |
| 48401 | **RUSK** | 0.01 | 0.01 | 0.01 | 0.01 | | | 0.01 | 0.04 | 0.01 | 0.07 |
| 48439 | **TARRANT** | 0.04 | 0.04 | 0.03 | 0.06 | 0.02 | 0.01 | 0.05 | 0.18 | 0.06 | 0.33 |
| 48441 | **TAYLOR** | 0.01 | | | | | | | | | |
| 48449 | **TITUS** | 0.01 | 0.01 | 0.01 | 0.02 | | | 0.02 | 0.05 | 0.02 | 0.10 |
| 48453 | **TRAVIS** | | 0.46 | | 0.05 | | | | | | |
| 48469 | **VICTORIA** | 0.30 | 0.01 | 0.22 | 0.01 | | | 0.68 | 0.05 | | 0.01 |
| 48475 | **WARD** | 0.06 | 0.06 | 0.04 | 0.09 | 0.02 | 0.01 | 0.08 | 0.28 | 0.10 | 0.51 |
| 48479 | **WEBB** | 0.06 | | 0.05 | | | | 0.01 | | | |
| 48481 | **WHARTON** | | | | | 0.01 | | | | | |
| 48503 | **YOUNG** | 0.02 | 0.02 | 0.01 | 0.03 | 0.01 | | 0.03 | 0.09 | 0.03 | 0.16 |
| | ***TOTAL*** | ***2.90*** | ***2.56*** | ***2.24*** | ***3.16*** | ***2.50*** | ***2.65*** | ***3.28*** | ***3.22*** | ***1.59*** | ***3.66*** |

Table 3: eGRID NOx emissions for Texas counties in ERCOT Power Control Area.

| County | Region Number | Region Name | Electric Utilities | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ANDERSON | 6 | East Texas Council of Governments | ONCOR | Trinity Valley EC | Houston County EC | | | | | |
| ANDREWS | 9 | Permian Basin Regional Planning Commission | ONCOR | Cap Rock EC | | | | | | |
| ANGELINA | 14 | Deep East Texas Council of Governments | ONCOR | Sam Houston EC | Houston County EC | Jasper-Newton EC | | | | |
| ARANSAS | 20 | Coastal Bend Council of Governments | CPL(AEP) | San Patricio EC | | | | | | |
| ARCHER | 3 | North Texas Regional Planning Commission | ONCOR | T-NMP | J-A-C EC | Fort Belknap EC | Tri-County EC | Southwest Rural EC | | |
| ARMSTRONG | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Greenbelt EC | Swisher EC | | | | | |
| ATASCOSA | 18 | Alamo Area Council of Governments | CPL(AEP) | CPSB | Medina EC | Karnes EC | | | | |
| AUSTIN | 16 | Houston-Galvetson Area Council | RELIANT(CENTER POINT) | Bellville | San Benard EC | Bluebonnet EC | Fayette EC | | | |
| BAILEY | 2 | South Plains Association of Governments | XCEL(SPS) | Baliey County EC | Lamb County EC | | | | | |
| BANDERA | 18 | Alamo Area Council of Governments | Bandera EC | | | | | | | |
| BASTROP | 12 | Capitol Area Planning Council | ONCOR | Smithville | Bluebonnet EC | Fayette EC | | | | |
| BAYLOR | 3 | North Texas Regional Planning Commission | ONCOR | Seymour | Tri-County EC | Southwest Rural EC | | | | |
| BEE | 20 | Coastal Bend Council of Governments | CPL(AEP) | San Patricio EC | Karnes EC | | | | | |
| BELL | 23 | Central Texas Council of Governments | ONCOR | Bartlett EC | Belfalls EC | McLennan County EC | Pedernales EC | Bartlett | | |
| BEXAR | 18 | Alamo Area Council of Governments | CPSB | Bandera EC | Karnes EC | | | | | |
| BLANCO | 12 | Capitol Area Planning Council | Pedernales EC | Central Texas EC | | | | | | |
| BORDEN | 9 | Permian Basin Regional Planning Commission | Lyntegar EC | Big Country EC | Cap Rock EC | | | | | |
| BOSQUE | 11 | Heart of Texas Council of Governments | T-NMP | United Coop Services | McLennan County EC | | | | | |
| BOWIE | 5 | Ark-Tex Council of Governments | SWEPCO(AEP) | Bowie-Cass EC | Southwest Arkansas EC | | | | | |
| BRAZORIA | 16 | Houston-Galveston Area Council | RELIANT(CENTER POINT) | T-NMP | Jackson EC | | | | | |
| BRAZOS | 13 | Brazos Valley Council of Governments | BRYAN | College Station | Mid-South EC | Navasota Valley EC | | | | |
| BREWSTER | 8 | Rio Grande Council of Governments | WTU(AEP) | Rio Grande EC | | | | | | |
| BRISCOE | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | WTU(AEP) | Lighthouse EC | Swisher EC | | | | |
| BROOKS | 20 | Coastal Bend Council of Governments | CPL(AEP) | Medina EC | Nueces EC | | | | | |
| BROWN | 7 | West Central Texas Council of Governments | ONCOR | WTU(AEP) | Cap Rock EC | Comanche EC | | | | |
| BURLESON | 13 | Brazos Valley Council of Governments | ENTERGY | BRYAN | Bartlett EC | Bluebonnet EC | | | | |
| BURNET | 12 | Capitol Area Planning Council | ONCOR | Pedernales EC | | | | | | |
| CALDWELL | 12 | Capitol Area Planning Council | CPL(AEP) | Luling | Pedernales EC | Bluebonnet EC | | | | |
| CALHOUN | 17 | Golden Crescent Regional Planning Commission | CPL(AEP) | Victoria EC | Jackson EC | | | | | |
| CALLAHAN | 7 | West Central Texas Council of Governments | WTU(AEP) | Taylor EC | Comanche EC | | | | | |
| CAMERON | 21 | Lower Rio Grande Valley Development Council | CPL(AEP) | Magic Valley EC | Brownsville | | | | | |
| CAMP | 6 | East Texas Council of Governments | SWEPCO(AEP) | Wood County EC | Upshur-Rural EC | | | | | |
| CARSON | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | | | | | | | |
| CASS | 5 | Ark-Tex Council of Governments | SWEPCO(AEP) | Upshur-Rural EC | Bowie-Cass EC | | | | | |
| CASTRO | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Deaf Smith EC | Bailey County EC | Lamb County EC | Swisher EC | | | |
| CHAMBERS | 16 | Houston-Galveston Area Council | RELIANT(CENTER POINT) | ENTERGY | | | | | | |
| CHEROKEE | 6 | East Texas Council of Governments | ONCOR | Cherokee County EC | Houston County EC | | | | | |
| CHILDRESS | 1 | Panhandle Regional Planning Commission | WTU(AEP) | Greenbelt EC | Lighthouse EC | South Plains EC | Harmon EC | | | |
| CLAY | 3 | North Texas Regional Planning Commission | ONCOR | T-NMP | J-A-C EC | Wise EC | | | | |
| COCHRAN | 2 | South Plains Association of Governments | XCEL(SPS) | Baliey County EC | Lamb County EC | Lea County Ec | | | | |
| COKE | 10 | Concho Valley Council of Governments | WTU(AEP) | Concho Valley EC | Taylor EC | | | | | |
| COLEMAN | 7 | West Central Texas Council of Governments | WTU(AEP) | Coleman | Cap Rock EC | Coleman County EC | | | | |
| COLLIN | 4 | North Central Texas Council of Governments | ONCOR | T-NMP | Farmersville | Cap Rock EC | Grayson-Collin EC | CoServ E | FEC Electric | Fannin County EC |
| COLLINGSWORTH | 1 | Panhandle Regional Planning Commission | WTU(AEP) | Greenbelt EC | | | | | | |
| COLORADO | 16 | Houston-Galveston Area Council | CPL(AEP) | Weimar | Fayette EC | Bluebonnet EC | San Benard EC | Wharton County EC | | |
| COMAL | 18 | Alamo Area Council of Governments | CPSB | New Braunfels | Pedernales EC | | | | | |
| COMANCHE | 7 | West Central Texas Council of Governments | ONCOR | T-NMP | Comanche EC | United Coop Services | | | | |
| CONCHO | 10 | Concho Valley Council of Governments | WTU(AEP) | Concho Valley EC | Cap Rock EC | Coleman County EC | Southwest Tx EC | | | |
| COOKE | 22 | Texoma Council of Governments | ONCOR | Cooke County EC | CoServ E | Wise EC | | | | |
| CORYELL | 23 | Central Texas Council of Governments | ONCOR | T-NMP | McLennan County EC | Hamilton County EC | United Coop Services | | | |
| COTTLE | 3 | North Texas Regional Planning Commission | WTU(AEP) | South Plains EC | | | | | | |
| CRANE | 9 | Permian Basin Regional Planning Commission | ONCOR | | | | | | | |
| CROCKETT | 10 | Concho Valley Council of Governments | WTU(AEP) | Rio Grande EC | Southwest Tx EC | | | | | |
| CROSBY | 2 | South Plains Association of Governments | XCEL(SPS) | Crosbyton | Lighthouse EC | South Plains EC | | | | |
| CULBERSON | 8 | Rio Grande Council of Governments | EPEC | Rio Grande EC | | | | | | |
| DALLAM | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Rita Blanca EC | | | | | | |
| DALLAS | 4 | North Central Texas Council of Governments | ONCOR | Garland | FEC Electric | HILCO EC | Trinity Valley EC | | | |
| DAWSON | 9 | Permian Basin Regional Planning Commission | ONCOR | Lyntegar EC | Cap Rock EC | | | | | |
| DEAF SMITH | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Deaf Smith EC | Farmers EC New Mexico | | | | | |
| DELTA | 5 | Ark-Tex Council of Governments | ONCOR | Lamar County EC | FEC Electric | | | | | |
| DENTON | 4 | North Central Texas Council of Governments | ONCOR | T-NMP | Denton | Sanger | Cooke County EC | CoServ E | Wise EC | Tri-County EC |
| DEWITT | 17 | Golden Crescent Regional Planning Commission | CPL(AEP) | Yoakum | Cuero | DeWitt EC | Victoria EC | South Texas EC | | |
| DICKENS | 2 | South Plains Association of Governments | WTU(AEP) | South Plains EC | Lighthouse EC | | | | | |
| DIMMIT | 24 | Middle Rio Grande Development Council | CPL(AEP) | Medina EC | Rio Grande EC | | | | | |
| DONLEY | 1 | Panhandle Regional Planning Commission | WTU(AEP) | Greenbelt EC | Lighthouse EC | | | | | |
| DUVAL | 20 | Coastal Bend Council of Governments | CPL(AEP) | Medina EC | Nueces EC | South Texas EC | | | | |
| EASTLAND | 7 | West Central Texas Council of Governments | ONCOR | WTU(AEP) | Comanche EC | United Coop Services | Taylor EC | | | |
| ECTOR | 9 | Permian Basin Regional Planning Commission | ONCOR | Goldsmith | Cap Rock EC | | | | | |
| EDWARDS | 24 | Middle Rio Grande Development Council | CPL(AEP) | Rio Grande EC | Medina EC | Pedernales EC | Southwest Tx EC | | | |
| EL PASO | 8 | Rio Grande Council of Governments | EPEC | Rio Grande EC | | | | | | |
| ELLIS | 4 | North Central Texas Council of Governments | ONCOR | Navarro County EC | HILCO EC | United Coop Services | | | | |
| ERATH | 4 | North Central Texas Council of Governments | ONCOR | T-NMP | United Coop Services | | | | | |
| FALLS | 11 | Heart of Texas Council of Governments | ONCOR | Belfalls EC | McLennan County EC | Navasota Valley EC | | | | |
| FANNIN | 22 | Texoma Council of Governments | ONCOR | T-NMP | Fannin County EC | Cap Rock EC | FEC Electric | Lamar County EC | | |
| FAYETTE | 12 | Capital Area Planning Council | La Grange | Schulenburg | Flatonia | Fayette EC | Bluebonnet EC | | | |
| FISHER | 7 | West Central Texas Council of Governments | WTU(AEP) | Big Country EC | Cap Rock EC | Taylor EC | | | | |
| FLOYD | 2 | South Plains Association of Governments | XCEL(SPS) | Floydada | Lighthouse EC | South Plains EC | | | | |
| FOARD | 3 | North Texas Regional Planning Commission | WTU(AEP) | Southwest Rural EC | South Plains EC | Tri-County EC | | | | |
| FORT BEND | 16 | Houston-Galveston Area Council | RELIANT(CENTER POINT) | | | | | | | |
| FRANKLIN | 5 | Ark-Tex Council of Governments | SWEPCO(AEP) | FEC Electric | Bowie-Cass EC | Wood County EC | | | | |
| FREESTONE | 11 | Heart of Texas Council of Governments | ONCOR | Navasota Valley EC | Navarro County EC | Houston County EC | | | | |
| FRIO | 18 | Alamo Area Council of Governments | CPL(AEP) | Medina EC | | | | | | |
| GAINES | 9 | Permian Basin Regional Planning Commission | XCEL(SPS) | Lyntegar EC | Lea County Ec | | | | | |
| GALVESTON | 16 | Houston-Galveston Area Council | RELIANT(CENTER POINT) | T-NMP | ENTERGY | | | | | |
| GARZA | 2 | South Plains Association of Governments | XCEL(SPS) | Big Country EC | Lyntegar EC | South Plains EC | | | | |
| GILLESPIE | 18 | Alamo Area Council of Governments | Fredericksburg | Pedernales EC | Central Texas EC | | | | | |
| GLASSCOCK | 9 | Permian Basin Regional Planning Commission | ONCOR | Cap Rock EC | | | | | | |
| GOLIAD | 17 | Golden Crescent Regional Planning Commission | CPL(AEP) | Karnes EC | Victoria EC | San Patricio EC | DeWitt EC | | | |
| GONZALES | 17 | Golden Crescent Regional Planning Commission | CPL(AEP) | Gonzales | Waelder | Guadalupe Valey EC | | | | |
| GRAY | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Greenbelt EC | | | | | | |
| GRAYSON | 22 | Texoma Council of Governments | ONCOR | T-NMP | Whitesboro | Grayson-Collin EC | Fannin County EC | Cooke County EC | CoServ E | |
| GREGG | 6 | East Texas Council of Governments | SWEPCO(AEP) | Rusk County EC | Upshur-Rural EC | | | | | |
| GRIMES | 13 | Brazos Valley Council of Governments | ENTERGY | Mid-South EC | San Benard EC | | | | | |
| GUADALUPE | 18 | Alamo Area Council of Governments | CPSB | Seguin | Guadalupe Valey EC | Bluebonnet EC | Pedernales EC | | | |
| HALE | 2 | South Plains Association of Governments | XCEL(SPS) | Swisher EC | Lamb County EC | Lighthouse EC | South Plains EC | | | |
| HALL | 1 | Panhandle Regional Planning Commission | WTU(AEP) | Lighthouse EC | South Plains EC | | | | | |
| HAMILTON | 23 | Central Texas Council of Governments | T-NMP | United Coop Services | Hamilton County EC | McLennan County EC | | | | |
| HANSFORD | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | T-NMP | North Plains EC | Rita Blanca EC | | | | |
| HARDEMAN | 3 | North Texas Regional Planning Commission | WTU(AEP) | South Plains EC | Southwest Rural EC | Harmon EC | | | | |
| HARDIN | 15 | South East Texas Regional Planning Commission | ENTERGY | RELIANT(CENTER POINT) | Sam Houston EC | | | | | |
| HARRIS | 16 | Houston-Galveston Area Council | RELIANT(CENTER POINT) | ENTERGY | San Benard EC | | | | | |
| HARRISON | 6 | East Texas Council of Governments | SWEPCO(AEP) | Panola-Harrison EC | Upshur-Rural EC | | | | | |
| HARTLEY | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Rita Blanca EC | | | | | | |
| HASKELL | 7 | West Central Texas Council of Governments | WTU(AEP) | Big Country EC | Tri-County EC | | | | | |
| HAYS | 12 | Capitol Area Planning Council | San Marcos | Pedernales EC | Bluebonnet EC | | | | | |
| HEMPHILL | 1 | Panhandle Regional Planning Commission | Canadian | North Plains EC | Greenbelt EC | | | | | |
| HENDERSON | 6 | East Texas Council of Governments | ONCOR | Trinity Valley EC | | | | | | |
| HIDALGO | 21 | Lower Rio Grande Valley Development Council | CPL(AEP) | Magic Valley EC | | | | | | |
| HILL | 11 | Heart of Texas Council of Governments | ONCOR | T-NMP | HILCO EC | Navasota Valley EC | Navarro County EC | | | |
| HOCKLEY | 2 | South Plains Association of Governments | XCEL(SPS) | South Plains EC | Lyntegar EC | Lamb County EC | | | | |
| HOOD | 4 | North Central Texas Council of Governments | ONCOR | T-NMP | Granbury | United Coop Services | Tri-County EC | | | |
| HOPKINS | 5 | Ark-Tex Council of Governments | ONCOR | SWEPCO(AEP) | FEC Electric | Wood County EC | | | | |
| HOUSTON | 14 | Deep East Texas Council of Governments | ONCOR | Houston County EC | | | | | | |
| HOWARD | 9 | Permian Basin Regional Planning Commission | ONCOR | Cap Rock EC | | | | | | |
| HUDSPETH | 8 | Rio Grande Council of Governments | EPEC | Rio Grande EC | | | | | | |
| HUNT | 4 | North Central Texas Council of Governments | ONCOR | T-NMP | Greenville | FEC Electric | Cap Rock EC | Trinity Valley EC | Fannin EC | |
| HUTCHINSON | 1 | Panhandle Regional Planning Committee | XCEL(SPS) | North Plains EC | Rita Blanca EC | | | | | |
| IRION | 10 | Concho Valley Council of Governments | WTU(AEP) | Cap Rock EC | Concho Valley EC | Southwest Texas EC | | | | |
| JACK | 3 | North Central Texas Council of Governments | ONCOR | T-NMP | J-A-C EC | Tri-County EC | Fort Belknap EC | Wise EC | | |

Table 4: PUCT Power Suppliers by County (Obtained from PUCT website, http://www.puc.state.tx.us. November, 2002) (Part a).

| County | Region Number | Region Name | Electric Utilities | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| JACKSON | 17 | Golden Crescent Regional Planning Commission | CPL(AEP) | Jackson EC | Victoria EC | DeWitt EC | | | | | |
| JASPER | 14 | Deep East Texas Council of Governments | ENTERGY | Jasper | Kirbyville | Jasper-Newton EC | Deep East Texas EC | Sam Houston EC | | | |
| JEFF DAVIS | 8 | Rio Grande Council of Governments | WTU(AEP) | Rio Grande EC | | | | | | | |
| JEFFERSON | 15 | South East Texas Regional Planning Commission | ENTERGY | | | | | | | | |
| JIM HOGG | 19 | South Texas Development Council | CPL(AEP) | Medina EC | | | | | | | |
| JIM WELLS | 20 | Coastal Bend Council of Governments | CPL(AEP) | Nueces EC | San Patricio EC | | | | | | |
| JOHNSON | 4 | North Central Texas Council of Governments | ONCOR | T-NMP | United Coop Services | HILCO EC | | | | | |
| JONES | 7 | West Central Texas Council of Governments | WTU(AEP) | Taylor EC | Big Country EC | | | | | | |
| KARNES | 18 | Alamo Area Council of Governments | CPL(AEP) | Floresville | Karnes EC | DeWitt EC | | | | | |
| KAUFMAN | 4 | North Central Texas Council of Governments | ONCOR | Trinity Valley EC | FEC Electric | | | | | | |
| KENDALL | 18 | Alamo Area Council of Governments | Boerne | Central Texas EC | Pedernales EC | Bandera EC | | | | | |
| KENEDY | 20 | Coastal Bend Council of Governments | Nueces EC | Magic Valley EC | | | | | | | |
| KENT | 7 | West Central Texas Council of Governments | WTU(AEP) | South Plains EC | Big Country EC | | | | | | |
| KERR | 18 | Alamo Area Council of Governments | Kerrville | Bandera EC | Central Texas EC | Pedernales EC | | | | | |
| KIMBLE | 10 | Concho Valley Council of Governments | WTU(AEP) | Central Texas EC | Pedernales EC | | | | | | |
| KING | 2 | South Plains Association of Governments | WTU(AEP) | South Plains EC | Tri-County EC | | | | | | |
| KINNEY | 24 | Middle Rio Grande Development Council | CPL(AEP) | Rio Grande EC | Medina EC | Pedernales EC | | | | | |
| KLEBERG | 20 | Coastal Bend Council of Governments | CPL(AEP) | Nueces EC | | | | | | | |
| KNOX | 7 | West Central Texas Council of Governments | WTU(AEP) | Tri-County EC | | | | | | | |
| LA SALLE | 24 | Middle Rio Grande Development Council | CPL(AEP) | Medina EC | | | | | | | |
| LAMAR | 5 | Ark-Tex Council of Governments | ONCOR | T-NMP | Lamar County EC | Fannin County EC | | | | | |
| LAMB | 2 | South Plains Association of Governments | XCEL(SPS) | Lamb County EC | Bailey County EC | South Plains EC | | | | | |
| LAMPASAS | 23 | Central Texas Council of Governments | ONCOR | Lampasas | Hamilton County EC | Pedernales EC | | | | | |
| LAVACA | 17 | Golden Crescent Regional Planning Commission | Schulenburg | Yoakum | Hallettsville | Moulton | Shiner | Sweet Home | DeWitt EC | Guadalupe Valley E | Fayette EC |
| LEE | 12 | Capitol Area Planning Council | Giddings | Lexington | Fayette EC | Bluebonnet EC | | | | | |
| LEON | 13 | Brazos Valley Council of Governments | ONCOR | ENTERGY | Navasota Valley EC | Houston County EC | | | | | |
| LIBERTY | 16 | Houston-Galveston Area Council | ENTERGY | Sam Houston EC | | | | | | | |
| LIMESTONE | 11 | Heart of Texas Council of Governments | ONCOR | ENTERGY | Navasota Valley EC | Navarro County EC | | | | | |
| LIPSCOMB | 1 | Panhandle Regional Planning Commission | T-NMP | North Plains EC | | | | | | | |
| LIVE OAK | 20 | Coastal Bend Council of Governments | CPL(AEP) | San Patricio EC | Karnes EC | Nueces EC | | | | | |
| LLANO | 12 | Capitol Area Planning Council | Llano | Pedernales EC | Central Texas EC | | | | | | |
| LOVING | 9 | Permian Basin Regional Planning Commission | ONCOR | | | | | | | | |
| LUBBOCK | 2 | South Plains Association of Governments | XCEL(SPS) | Lubbock | South Plains EC | | | | | | |
| LYNN | 2 | South Plains Association of Governments | XCEL(SPS) | ONCOR | Lyntegar EC | South Plains EC | | | | | |
| MADISON | 13 | Brazos Valley Council of Governments | ENTERGY | Houston County EC | Mid-South EC | Navasota Valley EC | | | | | |
| MARION | 6 | East Texas Council of Governments | SWEPCO(AEP) | Upshur-Rural EC | | | | | | | |
| MARTIN | 9 | Permian Basin Regional Planning Commission | ONCOR | Cap Rock EC | Lyntegar EC | | | | | | |
| MASON | 10 | Concho Valley Council of Governments | Mason | Cap Rock EC | Central Texas EC | Pedernales EC | | | | | |
| MATAGORDA | 16 | Houston-Galveston Area Council | CPL(AEP) | RELIANT(CENTER POINT) | Jackson EC | Wharton County EC | | | | | |
| MAVERICK | 24 | Middle Rio Grande Development Council | CPL(AEP) | Rio Grande EC | | | | | | | |
| McCULLOCH | 10 | Concho Valley Council of Governments | WTU(AEP) | Brady | Cap Rock EC | Central Texas EC | | | | | |
| McLENNAN | 11 | Heart of Texas Council of Governments | ONCOR | T-NMP | McLennan County EC | HILCO EC | Navasota Valley EC | | | | |
| McMULLEN | 20 | Coastal Bend Council of Governments | CPL(AEP) | Karnes EC | Medina EC | Nueces EC | San Patricio EC | | | | |
| MEDINA | 18 | Alamo Area Council of Governments | CPL(AEP) | CPSB | Castroville | Hondo | Medina EC | Bandera EC | Karnes EC | | |
| MENARD | 10 | Concho Valley Council of Governments | WTU(AEP) | Cap Rock EC | Southwest Texas EC | Pedernales EC | Central Texas EC | | | | |
| MIDLAND | 9 | Permian Basin Regional Planning Commission | ONCOR | Cap Rock EC | | | | | | | |
| MILAM | 23 | Central Texas Council of Governments | ONCOR | ENTERGY | Belfalls EC | Bartlett EC | | | | | |
| MILLS | 23 | Central Texas Council of Governments | Goldwaithe | Cap Rock EC | Hamilton County EC | Comanche EC | | | | | |
| MITCHELL | 7 | West Central Texas Council of Governments | ONCOR | Cap Rock EC | Big Country EC | Concho Valley EC | | | | | |
| MONTAGUE | 3 | North Texas Regional Planning Commission | ONCOR | T-NMP | Bowie | Cooke County EC | Wise EC | J-A-C EC | | | |
| MONTGOMERY | 16 | Houston-Galveston Area Council | ENTERGY | RELIANT(CENTER POINT) | Mid-South EC | Sam Houston EC | San Benard EC | | | | |
| MOORE | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Rita Blanca EC | | | | | | | |
| MORRIS | 5 | Ark-Tex Council of Governments | SWEPCO(AEP) | Bowie-Cass EC | Upshur-Rural EC | | | | | | |
| MOTLEY | 2 | South Plains Association of Governments | WTU(AEP) | Lighthouse EC | South Plains EC | | | | | | |
| NACOGDOCHES | 14 | Deep East Texas Council of Governments | ONCOR | Cherokee County EC | Deep East Texas EC | Rusk County EC | | | | | |
| NAVARRO | 4 | North Central Texas Council of Governments | ONCOR | Navarro County EC | | | | | | | |
| NEWTON | 14 | Deep East Texas Council of Governments | Newton | Jasper-Newton EC | Deep East Texas EC | | | | | | |
| NOLAN | 7 | West Central Texas Council of Governments | WTU(AEP) | ONCOR | Taylor EC | Cap Rock EC | Big Country EC | Concho Valley EC | | | |
| NUECES | 20 | Coastal Bend Council of Governments | CPL(AEP) | Robstown | Nueces EC | San Patricio EC | | | | | |
| OCHILTREE | 1 | Panhandle Regional Planning Commission | T-NMP | North Plains EC | | | | | | | |
| OLDHAM | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Deaf Smith EC | Rita Blanca EC | | | | | | |
| ORANGE | 15 | South East Texas Regional Planning Commission | ENTERGY | Jasper-Newton EC | | | | | | | |
| PALO PINTO | 4 | North Central Texas Council of Governments | ONCOR | T-NMP | Tri-County EC | United Coop Services | | | | | |
| PANOLA | 6 | East Texas Council of Governments | SWEPCO(AEP) | Rusk County EC | Panola-Harrison EC | Deep East Texas EC | | | | | |
| PARKER | 4 | North Central Texas Council of Governments | ONCOR | Weatherford | Wise EC | Tri-County EC | | | | | |
| PARMER | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Deaf Smith EC | Bailey County EC | | | | | | |
| PECOS | 9 | Permian Basin Regional Planning Commission | WTU(AEP) | ONCOR | T-NMP | Rio Grande EC | Southwest Texas EC | | | | |
| POLK | 14 | Deep East Texas Council of Governments | ENTERGY | Livingston | Sam Houston EC | | | | | | |
| POTTER | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Rita Blanca EC | | | | | | | |
| PRESIDIO | 8 | Rio Grande Council of Governments | WTU(AEP) | Rio Grande EC | | | | | | | |
| RAINS | 6 | East Texas Council of Governments | T-NMP | FEC Electric | Wood County EC | | | | | | |
| RANDALL | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Greenbelt EC | Swisher EC | | | | | | |
| REAGAN | 10 | Concho Valley Council of Governments | WTU(AEP) | Cap Rock EC | Concho Valley EC | Southwest Texas EC | | | | | |
| REAL | 24 | Middle Rio Grande Development Council | CPL(AEP) | Bandera EC | Central Texas EC | Medina EC | Pedernales EC | | | | |
| RED RIVER | 5 | Ark-Tex Council of Governments | ONCOR | SWEPCO(AEP) | T-NMP | Lamar County EC | Bowie-Cass EC | | | | |
| REEVES | 9 | Permian Basin Regional Planning Commission | WTU(AEP) | ONCOR | T-NMP | Rio Grande EC | | | | | |
| REFUGIO | 20 | Coastal Bend Council of Governments | CPL(AEP) | San Patricio EC | Victoria EC | | | | | | |
| ROBERTS | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Greenbelt EC | North Plains EC | | | | | | |
| ROBERTSON | 13 | Brazos Valley Council of Governments | ENTERGY | Hearne | Benchely | Wheelock | Navasota Valley EC | | | | |
| ROCKWALL | 4 | North Central Texas Council of Governments | ONCOR | FEC Electric | | | | | | | |
| RUNNELS | 7 | West Central Texas Council of Governments | WTU(AEP) | Coleman County EC | Concho Valley EC | | | | | | |
| RUSK | 6 | East Texas Council of Governments | SWEPCO(AEP) | ONCOR | Rusk County EC | Cherokee County EC | Deep East Texas EC | Upshur-Rural EC | | | |
| SABINE | 14 | Deep East Texas Council of Governments | Hemphill | Pineland | Jasper-Newton EC | Deep East Texas EC | | | | | |
| SAN AUGUSTINE | 14 | Deep East Texas Council of Governments | San Augustine | Deep East Texas EC | | | | | | | |
| SAN JACINTO | 14 | Deep East Texas Council of Governments | ENTERGY | Sam Houston EC | | | | | | | |
| SAN PATRICIO | 20 | Coastal Bend Council of Governments | CPL(AEP) | San Patricio EC | | | | | | | |
| SAN SABA | 23 | Central Texas Council of Governments | San Saba | Central Texas EC | Hamilton County EC | Cap Rock EC | Pedernales EC | | | | |
| SCHLEICHER | 10 | Concho Valley Council of Governments | WTU(AEP) | Pedernales EC | Southwest Texas EC | | | | | | |
| SCURRY | 7 | West Central Texas Council of Governments | ONCOR | Cap Rock EC | Big Country EC | | | | | | |
| SHACKELFORD | 7 | West Central Texas Council of Governments | WTU(AEP) | Fort Belknap EC | Big Country EC | Comanche EC | Taylor EC | | | | |
| SHELBY | 14 | Deep East Texas Council of Governments | SWEPCO(AEP) | Deep East Texas EC | Rusk County EC | | | | | | |
| SHERMAN | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Rita Blanca EC | | | | | | | |
| SMITH | 6 | East Texas Council of Governments | ONCOR | SWEPCO(AEP) | Wood County EC | Cherokee County EC | Upshur-Rural EC | | | | |
| SOMERVELL | 4 | North Central Texas Council of Governments | T-NMP | United Coop Services | | | | | | | |
| STARR | 19 | South Texas Development Council | CPL(AEP) | Medina EC | Magic Valley EC | | | | | | |
| STEPHENS | 7 | West Central Texas Council of Governments | ONCOR | Comanche EC | Fort Belknap EC | United Coop Services | | | | | |
| STERLING | 10 | Concho Valley Council of Governments | WTU(AEP) | Cap Rock EC | Concho Valley EC | | | | | | |
| STONEWALL | 7 | West Central Texas Council of Governments | WTU(AEP) | Big Country EC | South Plains EC | Tri-County EC | | | | | |
| SUTTON | 10 | Concho Valley Council of Governments | WTU(AEP) | Pedernales EC | Southwest Texas EC | | | | | | |
| SWISHER | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Tulia | Swisher EC | Lighthouse EC | | | | | |
| TARRANT | 4 | North Central Texas Council of Governments | ONCOR | Tri-County EC | CoServ E | United Coop Services | | | | | |
| TAYLOR | 7 | West Central Texas Council of Governments | WTU(AEP) | Taylor EC | | | | | | | |
| TERRELL | 9 | Permian Basin Regional Planning Commission | T-NMP | Rio Grande EC | | | | | | | |
| TERRY | 2 | South Plains Association of Governments | XCEL(SPS) | Brownfield | Lyntegar EC | | | | | | |
| THROCKMORTON | 7 | West Central Texas Council of Governments | WTU(AEP) | Fort Belknap EC | Big Country EC | Tri-County EC | | | | | |
| TITUS | 5 | Ark-Tex Council of Governments | SWEPCO(AEP) | T-NMP | Bowie-Cass EC | Wood County EC | | | | | |
| TOM GREEN | 10 | Concho Valley Council of Governments | WTU(AEP) | Concho Valley EC | Cap Rock EC | Southwest Texas EC | | | | | |
| TRAVIS | 12 | Capitol Area Planning Council | ONCOR | Austin Energy | Pedernales EC | Bluebonnet EC | | | | | |
| TRINITY | 14 | Deep East Texas Council of Governments | ENTERGY | Houston County EC | Sam Houston EC | | | | | | |
| TYLER | 14 | Deep East Texas Council of Governments | ENTERGY | Sam Houston EC | | | | | | | |
| UPSHUR | 6 | East Texas Council of Governments | SWEPCO(AEP) | Upshur-Rural EC | Wood County EC | | | | | | |
| UPTON | 9 | Permian Basin Regional Planning Commission | WTU(AEP) | ONCOR | Cap Rock EC | Southwest Texas EC | | | | | |
| UVALDE | 24 | Middle Rio Grande Development Council | CPL(AEP) | Bandera EC | Medina EC | Rio Grande EC | | | | | |
| VAL VERDE | 24 | Middle Rio Grande Development Council | CPL(AEP) | Rio Grande EC | Southwest Texas EC | | | | | | |
| VAN ZANDT | 6 | East Texas Council of Governments | ONCOR | SWEPCO(AEP) | Wood County EC | Trinity Valley EC | FEC Electric | | | | |
| VICTORIA | 17 | Golden Crescent Regional Planning Commission | CPL(AEP) | Victoria EC | DeWitt EC | | | | | | |
| WALKER | 16 | Houston-Galveston Area Council | ENTERGY | Mid-South EC | Sam Houston EC | Houston County EC | | | | | |
| WALLER | 16 | Houston-Galveston Area Council | RELIANT(CENTER POINT) | Hempstead | Mid-South EC | San Benard EC | | | | | |
| WARD | 9 | Permian Basin Regional Planning Commission | ONCOR | T-NMP | | | | | | | |
| WASHINGTON | 13 | Brazos Valley Council of Governments | ENTERGY | Bluebonnet EC | Fayette EC | | | | | | |
| WEBB | 19 | South Texas Development Council | CPL(AEP) | Rio Grande EC | Medina EC | | | | | | |
| WHARTON | 16 | Houston-Galveston Area Council | RELIANT(CENTER POINT) | CPL(AEP) | Wharton County EC | | | | | | |
| WHEELER | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | WTU(AEP) | Greenbelt EC | North Plains EC | | | | | |
| WICHITA | 3 | North Texas Regional Planning Commission | ONCOR | Electra | Southwest Rural EC | | | | | | |
| WILBARGER | 3 | North Texas Regional Planning Commission | WTU(AEP) | Vernon | Southwest Rural EC | Tri-County EC | | | | | |
| WILLACY | 21 | Lower Rio Grande Valley Development Council | CPL(AEP) | Magic Valley EC | | | | | | | |
| WILLIAMSON | 12 | Capitol Area Planning Council | ONCOR | Austin Energy | Georgetown | Bluebonnet EC | Bartlett EC | Pedernales EC | | | |
| WILSON | 18 | Alamo Area Council of Governments | Floresville | Guadalupe Valley EC | Karnes EC | | | | | | |
| WINKLER | 9 | Permian Basin Regional Planning Commission | ONCOR | T-NMP | | | | | | | |
| WISE | 4 | North Central Texas Council of Governments | ONCOR | Bridgeport | Wise EC | Cooke County | CoServ E | Tri-County EC | | | |
| WOOD | 6 | East Texas Council of Governments | SWEPCO(AEP) | ONCOR | Upshur-Rural EC | Wood County EC | FEC Electric | | | | |
| YOAKUM | 2 | South Plains Association of Governments | XCEL(SPS) | Lyntegar EC | Lea County Ec | | | | | | |
| YOUNG | 3 | North Texas Regional Planning Commission | ONCOR | T-NMP | Fort Belknap EC | United Coop Services | | | | | |
| ZAPATA | 19 | South Texas Development Council | CPL(AEP) | Medina EC | | | | | | | |
| ZAVALA | 24 | Middle Rio Grande Development Council | CPL(AEP) | Medina EC | Rio Grande EC | | | | | | |

Table 5: PUCT Power Suppliers by County (Obtained from PUCT website, http://www.puc.state.tx.us. November, 2002) (Part b).

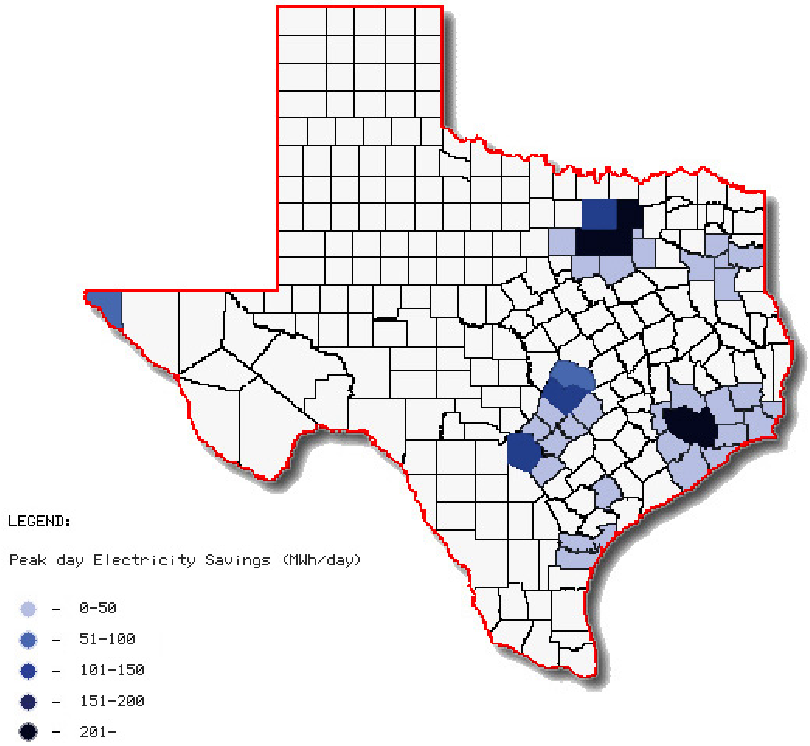



Figure 16: Distribution of 2002 Peak day Electricity Savings Due To the IECC / IRC (Single Family Residential)

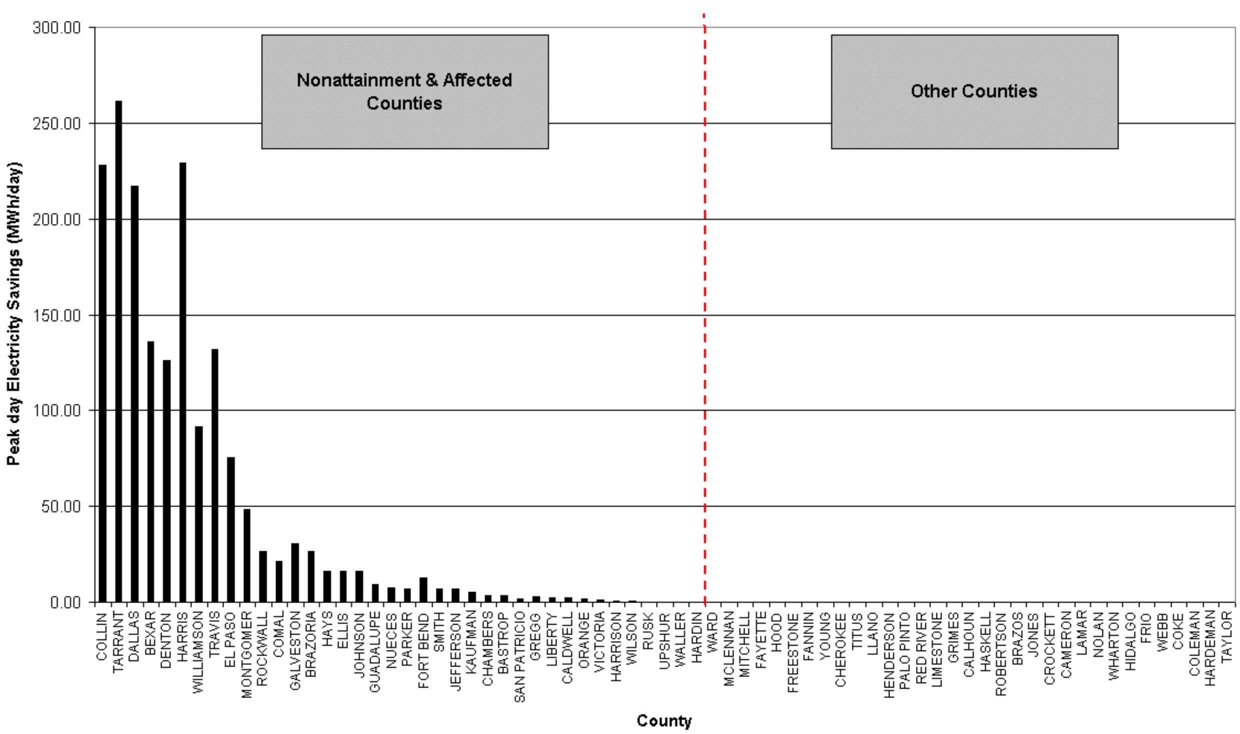



Figure 17: 2002 Peak day Electricity Savings Due To the IECC / IRC (Single Family Residential)

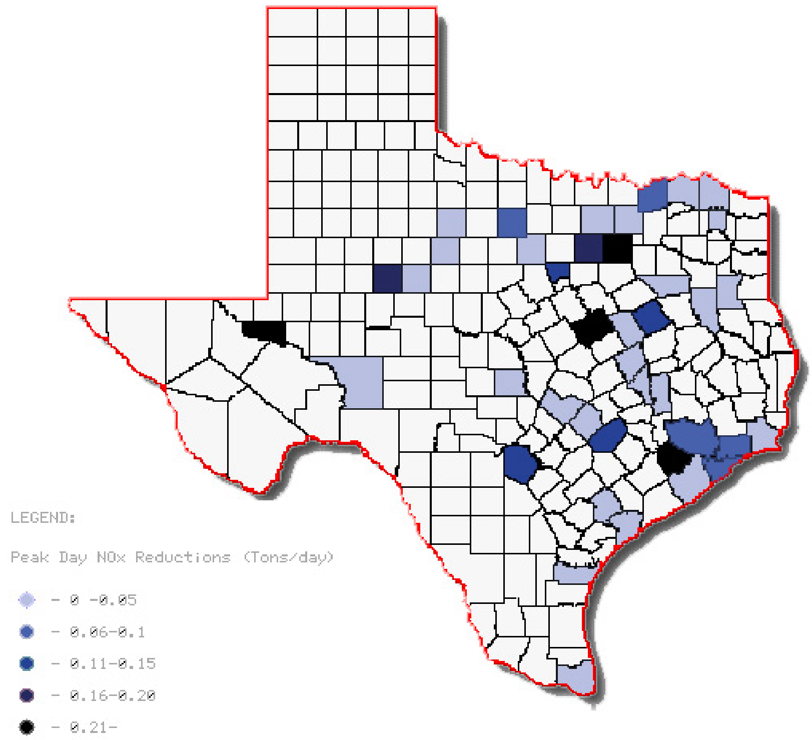



Figure 18: Distribution of Power Plant Peak Day NOx Reductions Due To The IECC / IRC (Single Family Residential)

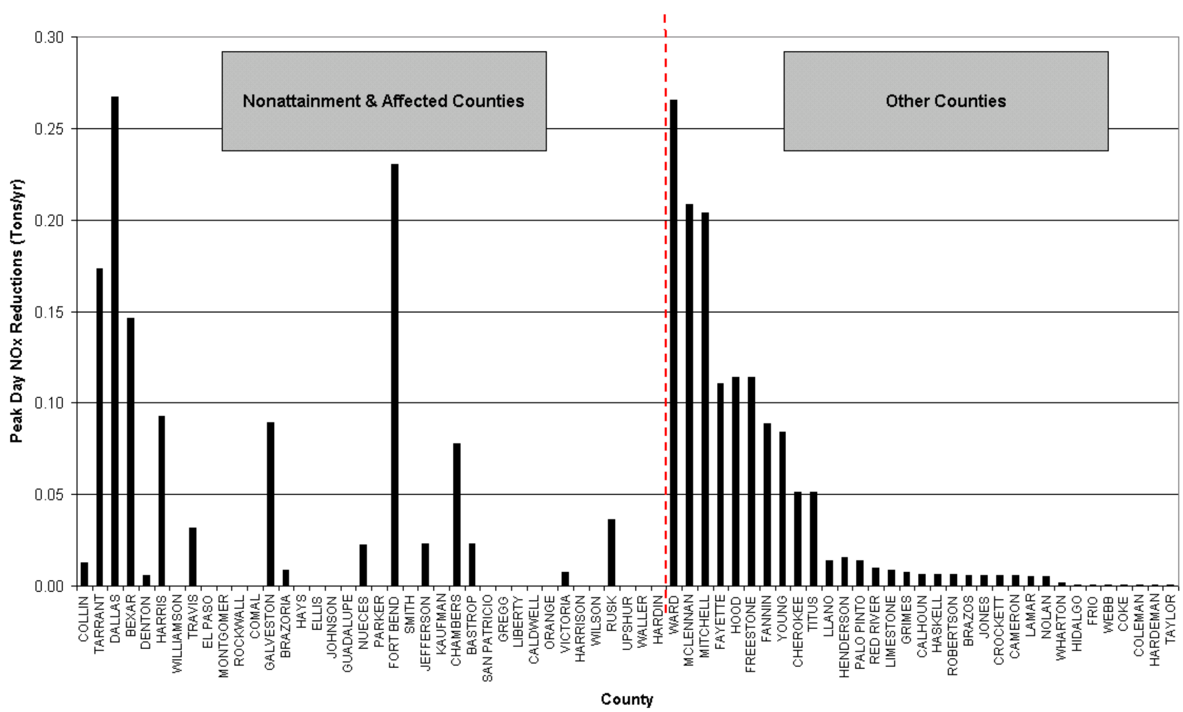



Figure 19: Power Plant Peak day NOx Reductions Due To The IECC / IRC (Single Family Residential)

### 4.4.2.4 Developed Emissions Calculation Procedures For NOx Emissions From Residential Natural Gas Savings Due to Implementation of IECC / IRC.

The Laboratory developed procedures for accounting for peak-day NOx emissions reduction from natural gas savings due to the implementation of the IECC / IRC. To accomplish this the IECC code-traceable simulation was used to simulate the natural gas savings due to improvements in the building envelope, and equipment efficiencies, as shown in Table 32 for single-family residential and Table 44 for multi-family residential. In general, the gas savings were due to improved windows, increased insulation levels and the elimination of pilot lights in the natural gas-fired furnaces[10].

In Table 6 and Figure 20 the combined natural gas savings from 96,622 single-family and 36,323 multi-family units are shown for the 38 non-attainment and affected counties. In contrast to the findings that showed a 2:1 increase in NOx reductions when peak-day simulations of electricity savings were used versus average daily NOx reductions from annual electricity savings (Figure 15), the simulated peak-day natural gas savings (Figure 20), show a decrease in NOx reductions for peak-day calculations that used the NAHB's 1999 west Texas definition for single-family residences[11]. Houses that used the NAHB's East Texas definition showed results that were equivalent for peak-day simulations and average daily values from annual savings. This difference in NOx reductions is due to the increased heating savings for houses with the NAHB's west Texas definitions versus the NAHB's east definitions. These increased heating savings were due primarily to the increased window areas (20.6% for west versus 13.8% for east) and an increase in window U-value differences (47% decrease for west versus a 32% decrease for east).

| County | Non-attainment (N) or Affected (A) County | Number of Single Family Houses | Number of Multifamily Houses | NAHB Division | Climate Zone | Total Annual N.G. Savings (Therm/County) | Annual Nox Reductions (Tons) | Average day Nox Reductions (Tons) | Total Peak-day N.G. Savings (Therm/County) | Peak-day Nox Reductions (Tons) | Peak-day Nox Reductions (Tons)/Average day Nox Reductions (Tons) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Harris | N | 21,587 | 11,287 | East | 4 | 1,401,308.00 | 17.38 | 0.0476 | 3,944.8800 | 0.0489 | 1.03 |
| Tarrant | N | 11,700 | 3,729 | West | 5 | 1,256,931.00 | 15.59 | 0.0427 | 1,851.4800 | 0.0230 | 0.54 |
| Collin | N | 9,671 | 732 | West | 5 | 1,131,042.00 | 14.02 | 0.0384 | 1,248.3600 | 0.0155 | 0.40 |
| Dallas | N | 8,170 | 7,324 | West | 5 | 1,061,786.00 | 13.17 | 0.0361 | 1,859.2800 | 0.0231 | 0.64 |
| Bexar | A | 7,671 | 2,552 | West | 4 | 662,063.00 | 8.21 | 0.0225 | 1,226.7600 | 0.0152 | 0.68 |
| Travis | A | 4,820 | 5,349 | West | 5 | 624,189.00 | 7.74 | 0.0212 | 1,220.2800 | 0.0151 | 0.71 |
| Denton | N | 4,961 | 1,406 | West | 6 | 620,388.00 | 7.69 | 0.0211 | 764.0400 | 0.0095 | 0.45 |
| Williamson | A | 4,229 | 312 | West | 5 | 368,028.00 | 4.56 | 0.0125 | 544.9200 | 0.0068 | 0.54 |
| El Paso | N | 3,388 | 251 | West | 6 | 411,079.00 | 5.10 | 0.0140 | 436.6800 | 0.0054 | 0.39 |
| Montgomery | N | 4,247 | 536 | East | 4 | 208,308.00 | 2.58 | 0.0071 | 573.9600 | 0.0071 | 1.01 |
| Galveston | N | 2,564 | 52 | East | 3 | 114,896.00 | 1.42 | 0.0039 | 313.9200 | 0.0039 | 1.00 |
| Brazoria | N | 2,349 | 343 | East | 3 | 117,076.00 | 1.45 | 0.0040 | 323.0400 | 0.0040 | 1.01 |
| Comal | A | 1,248 | 169 | West | 4 | 97,864.00 | 1.21 | 0.0033 | 170.0400 | 0.0021 | 0.63 |
| Rockwall | A | 1,246 | 0 | West | 6 | 142,044.00 | 1.76 | 0.0048 | 149.5200 | 0.0019 | 0.38 |
| Hays | A | 919 | 411 | West | 5 | 94,047.00 | 1.17 | 0.0032 | 159.6000 | 0.0020 | 0.62 |
| Nueces | A | 1,012 | 253 | East | 3 | 56,419.00 | 0.70 | 0.0019 | 151.8000 | 0.0019 | 0.98 |
| Fort Bend | N | 1,043 | 0 | East | 4 | 45,892.00 | 0.57 | 0.0016 | 125.1600 | 0.0016 | 1.00 |
| Ellis | A | 707 | 838 | West | 5 | 99,847.00 | 1.24 | 0.0034 | 185.4000 | 0.0023 | 0.68 |
| Johnson | A | 687 | 17 | West | 5 | 65,928.00 | 0.82 | 0.0022 | 84.4800 | 0.0010 | 0.47 |
| Guadalupe | A | 646 | 0 | West | 4 | 47,158.00 | 0.58 | 0.0016 | 77.5200 | 0.0010 | 0.60 |
| Kaufman | A | 403 | 2 | West | 6 | 46,020.00 | 0.57 | 0.0016 | 48.6000 | 0.0006 | 0.39 |
| Jefferson | N | 595 | 94 | East | 4 | 28,249.00 | 0.35 | 0.0010 | 82.6800 | 0.0010 | 1.07 |
| Parker | A | 345 | 4 | West | 6 | 39,486.00 | 0.49 | 0.0013 | 41.8800 | 0.0005 | 0.39 |
| Smith | A | 506 | 83 | East | 5 | 12,005.00 | 0.15 | 0.0004 | 70.6800 | 0.0009 | 2.15 |
| Bastrop | A | 215 | 88 | West | 4 | 19,215.00 | 0.24 | 0.0007 | 36.3600 | 0.0005 | 0.69 |
| Chambers | N | 298 | 0 | East | 4 | 12,218.00 | 0.15 | 0.0004 | 35.7600 | 0.0004 | 1.07 |
| Gregg | A | 256 | 0 | East | 6 | 17,152.00 | 0.21 | 0.0006 | 30.7200 | 0.0004 | 0.65 |
| San Patricio | A | 229 | 306 | East | 3 | 23,463.00 | 0.29 | 0.0008 | 64.2000 | 0.0008 | 1.00 |
| Liberty | N | 224 | 0 | East | 4 | 9,184.00 | 0.11 | 0.0003 | 26.8800 | 0.0003 | 1.07 |
| Victoria | A | 178 | 0 | East | 3 | 7,654.00 | 0.09 | 0.0003 | 21.3600 | 0.0003 | 1.02 |
| Orange | N | 197 | 0 | East | 4 | 8,077.00 | 0.10 | 0.0003 | 23.6400 | 0.0003 | 1.07 |
| Caldwell | A | 129 | 0 | West | 4 | 9,417.00 | 0.12 | 0.0003 | 15.4800 | 0.0002 | 0.60 |
| Wilson | A | 36 | 0 | West | 4 | 2,628.00 | 0.03 | 0.0001 | 4.3200 | 0.0001 | 0.60 |
| Hardin | N | 47 | 0 | East | 4 | 1,927.00 | 0.02 | 0.0001 | 5.6400 | 0.0001 | 1.07 |
| Harrison | A | 42 | 0 | East | 6 | 2,814.00 | 0.03 | 0.0001 | 5.0400 | 0.0001 | 0.65 |
| Waller | N | 23 | 183 | East | 4 | 8,332.00 | 0.10 | 0.0003 | 24.7200 | 0.0003 | 1.08 |
| Upshur | A | 18 | 0 | East | 6 | 1,206.00 | 0.01 | 0.0000 | 2.1600 | 0.0000 | 0.65 |
| Rusk | A | 16 | 2 | East | 5 | 354.00 | 0.00 | 0.0000 | 2.1600 | 0.0000 | 2.23 |
| Total | | 96,622 | 36,323 | | | 8,875,694 | 110.0586 | 0.3015 | 15,953 | 0.1978 | |

[10] An informal survey of the major gas furnace manufacturers revealed that standing pilot lights had bee eliminated in order to reach the higher AFUE efficiencies required by the 2000 IECC. To simulate this a continuous 500 Btu/hr auxiliary heat source was added to the 1999 average single-family and multi-family house. This auxiliary source was eliminated from the 2000 IECC code-compliant house. NOx emissions from the elimination of the pilot light were assumed to be 0.248 lbs-NOx/MMBtu (Ottinger et al. 1991).

[11] The NAHB's 1999 survey for multi-family residential uses one classification for Texas (versus the east and west definitions for single-family residential).

Table 6: Comparison of Peak Day Versus Average Daily NOx Reductions From Natural Gas Savings for the 38 Non-attainment and Affected Counties.

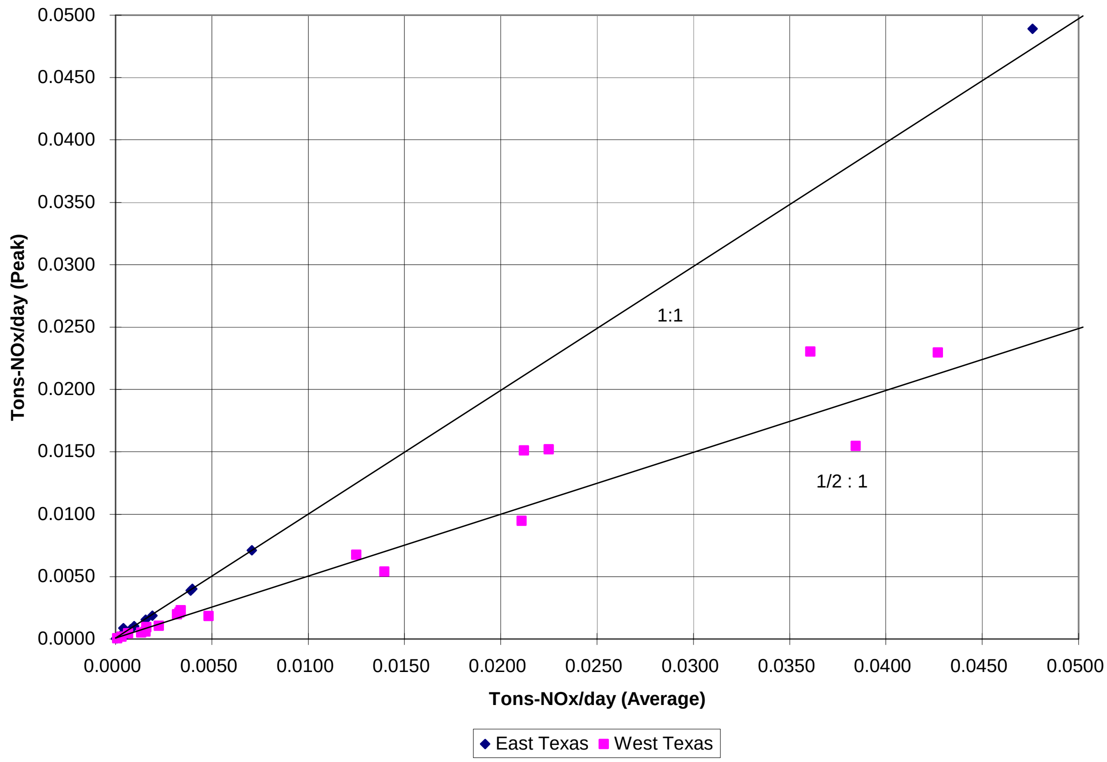



Figure 20: Comparison of Peak Day Versus Average Daily NOx Reductions From Natural Gas Savings for the 38 Non-attainment and Affected Counties.

### 4.4.2.5 Developed Preliminary Code-traceable Input Files for Fuel-neutral Single-family Residential, Multi-family, and Commercial DOE-2 Simulations.

To improve the accuracy of the IECC code-traceable, DOE-2 simulations the Laboratory developed several new simulations of single-family, multi-family and commercial buildings. An illustration of the existing code-traceable single story, single-family residence, with a slab-on-grade floor and attached two car garage is shown in Figure 21. According to the NAHB, this type of house was the predominant type of house in Texas[12], which contained a whole-house air-conditioning system, a gas-fired forced air furnace, and gas-fired domestic water heater.

In Figure 22, the newly developed two story, single-family residential simulation is shown that includes a user-selectable, one or two story simulation, and includes options for a crawlspace, fuel-neutral choices for heating (i.e., electric resistance, heat pump or natural gas-fired furnace), domestic water heating (i.e., electric or gas), and electric cooling. Figure 23 shows the user-selectable configuration for the multi-family simulation, that includes options for one, two or three story simulations, two or four apartments per floor, and fuel-neutral choices for heating (i.e., electric resistance, heat pump or natural gas-fired furnace), domestic water heating (i.e., electric or gas), and electric cooling.

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

Figure 24 shows the user-selectable configuration for the commercial office building simulation, that includes options for varying number of floors, varying floor size, varying window amounts, and system selections with fuel-neutral choices for heating (i.e., electric resistance, heat pump or natural gas-fired furnace), domestic water heating (i.e., electric or gas), and electric cooling.

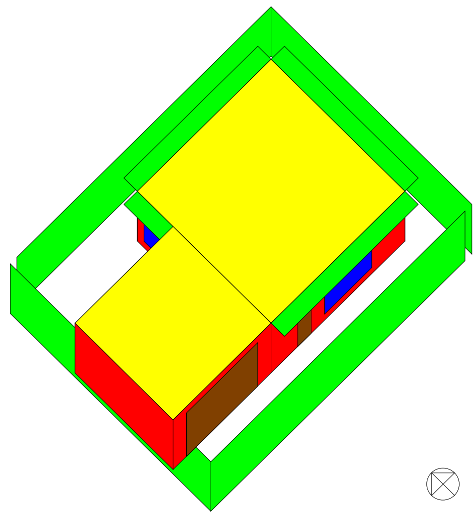


Figure 21: Illustration of Existing Single-family Residential IECC Code-traceable Simulation

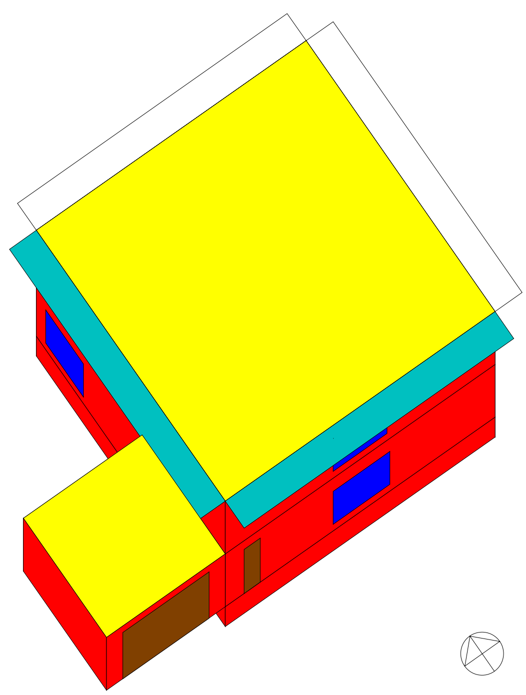


Figure 22: Illustration of New Two-story, Single-family Residential IECC Code-traceable Simulation with Selectable Crawlspace/Slab.

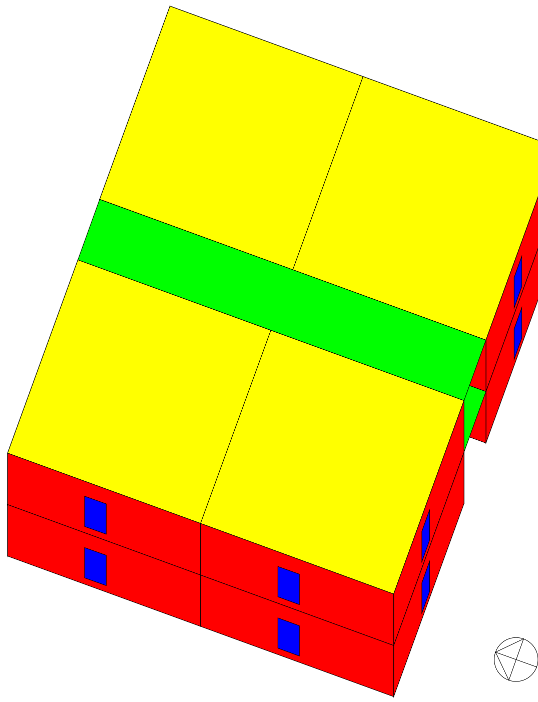


Figure 23: Illustration of Multi-family Residential IECC Code-traceable Simulation

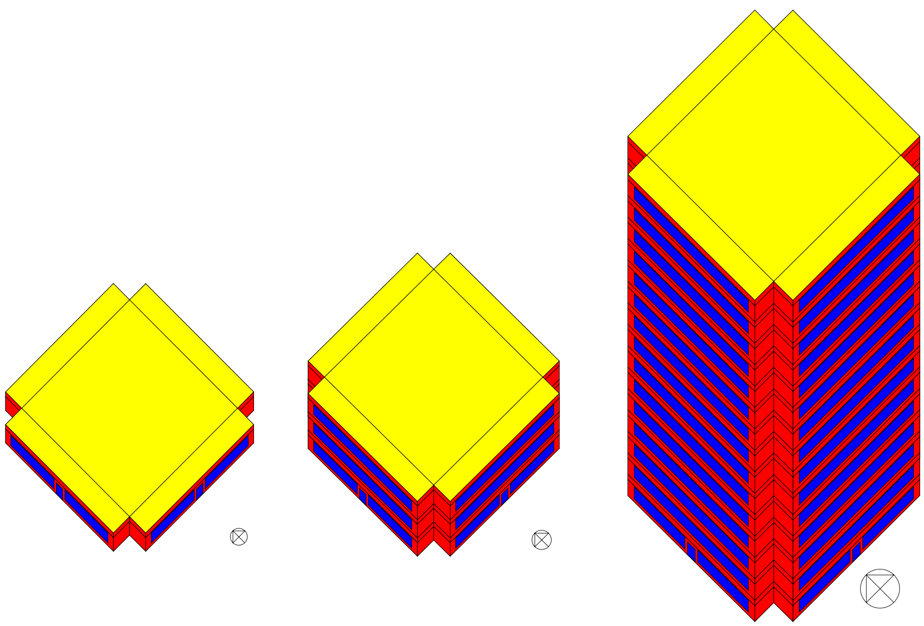


Figure 24: Illustration of Commercial Office Building IECC / IRC Code-traceable Simulation

### 4.4.3 Developed Documentation for Code-traceable Simulations.

The Laboratory is developing a complete documentation summary for the code-compliant IECC / IRC simulation. This document will then be submitted to the U.S.D.O.E. National Laboratories for expert review and comment. This expert review will improve the Laboratory's code-traceable simulation for emissions reduction.

### 4.4.4 Analyzed Impact of Proposed 2005 IECC / IRC Code Changes.

In the Spring of 2003, the USDOE published a proposal for changes to the 2000 International Energy Conservation Code (2000 IECC), which are intended to go into the 2005 version of the IECC / IRC. In general, DOE's intention with the new IECC / IRC is to simplify the code to make it easier for builders and code officials to enforce. The Laboratory was asked to review the proposed code changes to ascertain if the changes would be more/less stringent than the current IECC / IRC.

The Laboratory completed a preliminary review of the proposed changes[13]. This analysis was performed on a single-family residence in the climate zones for Harris County and Dallas County, with standard characteristics, and can be summarized by the following:

- The proposed 2005 IECC / IRC would have fewer climate zones for Texas, which will simplify the analysis of code compliance for the state, as shown in Figure 25.
- The proposed 2005 IECC / IRC contains fewer prescriptive tables that do not include increased stringency for increased window-to-wall areas. This simplification will allow houses to be built that are less stringent than the current IECC / IRC, as amended by the 2001 Supplement, if the houses have more than 20% window-to-wall area.

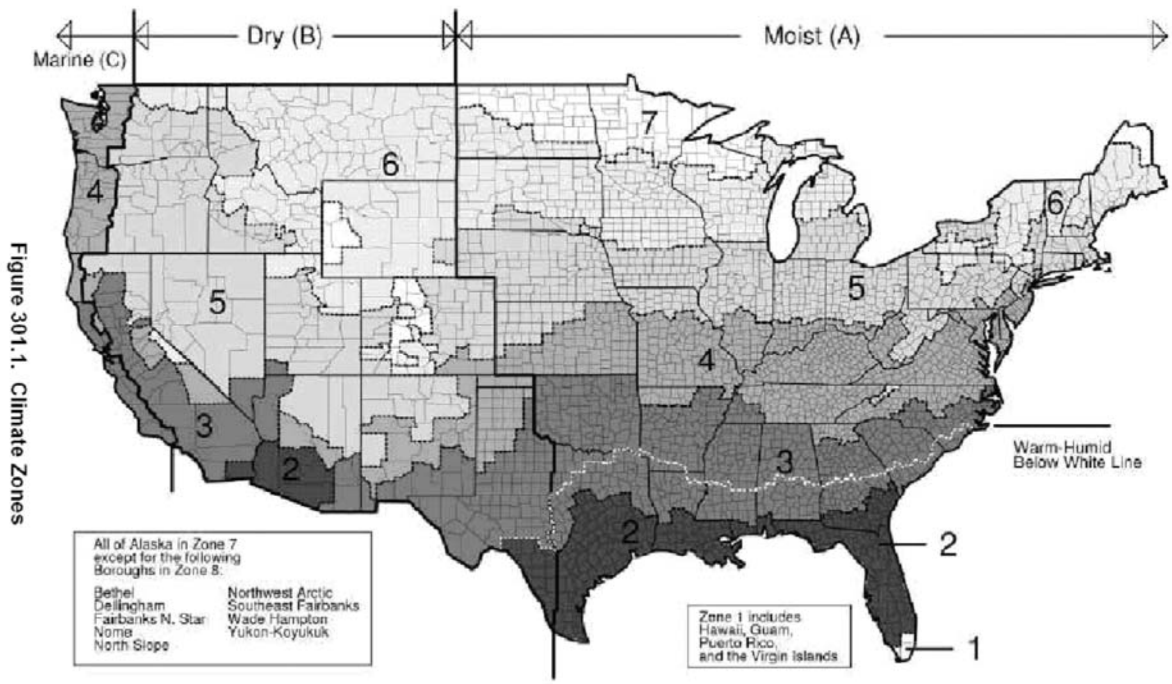



Figure 25: Proposed New Climate Zones for ICC 2003/2004 Climate Zones.

### 4.4.5 Developed and Tested Procedures for Cross-checking Simulations Against Utility Billing Data.

The Laboratory has developed and tested procedures for cross-checking simulations against utility billing data and tested these methods using a single-family residence. Additional information about these new procedures can be found in Section 6 of this report.

[13] Haberl, J., Im, P. 2003. "Analysis of the Energy Impact of the Proposed 2003/2004 IECC Code Changes for Texas", Energy Systems Laboratory Report No. ESL-TR-03/07-xx, (July).

4.4.6 Developed and Tested Input Form for the Use of Site Inspections to Verify the Simulations.

The Laboratory has developed and tested procedures for cross-checking simulations using information gathered from site inspections and tested these methods using a single-family residence. Additional information about these new procedures can be found in Section 6 of this report.

4.4.7 Provide Training Sessions

Since the September of 2001, the Laboratory has provided (64) IECC / IRC code training workshops at the locations in Texas as shown in Table 7 [14]. (48) of these workshops were focused on Residential Code trainings, with 2,239 attendees. (17) of these workshops were focused on Commercial Code trainings, with 328 attendees.

| **Residential Workshops** | | |
|---|---|---|
| **Date** | **Location** | **# of Attend** |
| October 28-29, 2002 (ESL) | Abilene | 26 |
| November 7, 2002 | Parkersburg, VA (Simonton) | 8 |
| November 12-13, 2002 (ESL) | Dallas | 13 |
| November 19, 2002 (ESL) | Houston | 18 |
| January 10, 2003 | Houston (for TML) | 50 |
| January 21-22, 2003 (ESL) | San Antonio | 19 |
| January 29, 2003 (ESL) | Galveston | 19 |
| February 21, 2003 | Austin (TCCTA Conf.) | 47 |
| March 17, 2003 | Austin (CSI) | 25 |
| April 9, 2003 (ESL) | Tyler | 15 |
| April 22, 2003 (ESL) | Austin | 18 |
| June 10, 2003 (ESL) | Dallas | 18 |
| June 12, 2003 (Certain Teed) | Dallas | 60 |
| July 8, 2003 (ESL) | Corpus Christi | 9 |
| July 22, 2003 (ESL) | Houston | 13 |
| | Total Residential Attendees: | 358 |
| **Commercial Workshops:** | | |
| October 30, 2002 (ESL) | Abilene | 17 |
| November 14, 2002 (ESL) | Dallas | 9 |
| November 20, 2002 (ESL) | Houston | 9 |
| January 23, 2003 (ESL) | San Antonio | 18 |
| January 30, 2003 (ESL) | Galveston | 11 |
| April 10, 2003 (ESL) | Tyler | 15 |
| April 23, 2003 (ESL/SECO/DOE) | Austin | 9 |
| May 6-7, 2003 (ESL/SECO/DOE) | Dallas | 25 |
| May 15, 2003 (BPI) | Arlington | 20 |
| May 28-29, 2003 (ESL/SECO/DOE) | Houston | 38 |
| June 11, 2003 (ESL/SECO/DOE) | Dallas | 21 |
| June 18, 2003 (ESL/SECO/DOE) | El Paso | 13 |
| July 9, 2003 (ESL/SECO/DOE) | Corpus Christi | 13 |
| July 17, 2003 (ESL) | Wichita Falls (CSI Chapter Meeting) | 40 |
| July 23, 2003 (ESL/SECO/DOE) | Houston | 23 |
| July 28-29, 2003 (ESL/SECO/DOE) | Austin | 27 |
| September 18, 2003 (ESL) | College Station (Brazos Co. AIA) | 20 |
| | Total Commercial Attendees: | 328 |

Table 7: IECC / IRC Residential and ASHRAE 90.1 Commercial Building Code Workshops for Senate Bill 5.

4.4.8 Responding to About 40 to 60 Calls Per Week

The Laboratory continues to respond to phone calls and email inquiries, which include questions about the IECC / IRC from builders, contractors, code officials, designers, and building owners, and homeowners. A

[14] Workshops indicated as ESL were supported by funding from the Laboratory through its Senate Bill 5 allocations from the Texas State Legislature. Workshops indicated as ESL/SECO were supported by the USDOE State Energy Program through the Texas State Energy Conservation Office (SECO).

database is being established to track questions and responses. A frequently asked questions (FAQ) feature is also being established for the Laboratory's Senate Bill 5 web page.

### 4.4.9 Develop Analysis for Residential Efficient Lighting Program

At the request of the Representative Warren Chisum, Chair, TERP Advisory Committee, and the Texas Public Citizen organization, the Laboratory developed an analysis of the impact of a proposed residential efficient lighting program. Improving existing residential building energy efficiency reduces electricity use, peak electric demand, and emissions as well as reduces customer's electricity bills[15].

It is estimated that there will be 8.8 million residences in the non-attainment and affected counties in 2003, which are expected to increase in number by about 2.5% per year. A significant amount of energy used in residences is consumed by incandescent lights, which can easily be replaced by Compact Fluorescent Lamps (CFLs), which consume about 1/6 to 1/5 the electricity and yet produce the same amount of light. In an average 2,000 ft2 household it is estimated that there are 50 incandescent lamps, of which 33 are suitable for replacement. If 5% of these household could be converted to CFLs each year, it is estimated that 1.3 tons-NOx/day could be saved in 2003. If an additional 5% of the remaining households could be converted each year, 25% of the household could be converted by 2007, resulting in 1.2 ton-NOx/day could be saved in non-attainment and affected counties. One method that has been suggested to motivate conversion to CFLs is to level the initial cost of CFLs by charging an $0.25 Emissions Reduction Fee on each incandescent lamp (252 million lamps expected in 2007), and paying a $1.00 Emissions Incentive for each CFL lamp purchased in the state (26 million lamps expected in 2003).

Exclusions would include incandescent lamps which are less than 10 Watts, decorative holiday lamps sold during the Christmas or Holiday Season during October, November and December. Such a fee would be collected at the wholesale level. Sales figures for incandescents and CFLs sold could then be used to track the effectiveness of the program.

The expected benefit for each household that converts to CFLs is estimated to be a 1,375 kWh/year-household reduction, which is $103/year-household (33 lamps replaced) at $0.075 per kWh. Additional benefits included increased lamp life, which will reduce the number of times each year residents are required to change the lamps. Disposal of CFLs could be handled through existing fluorescent lamp collection programs.

| | 2007 - 2010 | Tons NOx Saved/yr * | Tons NOx/Peak-Day | Net Tax Revenue Million $ | $/ton-10-yr |
|---|---|---|---|---|---|
| MWh Elec. Saved | 3.3 – 5.7 million | 434- 518 | 1.2 – 1.4 | $37.1 - $20.3 | Negative |

* 38 counties

Replacing incandescent lights with CFLs provides homeowners with a reduction in their electricity bill, and it reduces the frequency of replacing burned-out lamps since the expected life of an incandescent lamp is about 750 hours versus 10,000 hours for a CFL. The cost for replacing incandescent lamps with CFLs would be borne by residents, with an incentive provided by the state.

### 4.4.10 Develop Analysis for Proposed Texas Tune-up Program

At the request of the Texas Public Citizen organization, the Laboratory developed an analysis of the impact of how improved existing building energy efficiency can reduce electricity use, peak electric demand, and emissions. It is estimated that commercial building space accounts for over 2.1 billion Sq. Ft. in Texas. Texas A&M's Energy Systems Laboratory has proven building energy use can be easily reduced by 10 to 40 percent by the systematic testing and optimization of building mechanical & thermal systems, controls

[15] Copies of the letters to Representative Chisum and Public Citizen regarding the analysis can be found in the appendix.

and HVAC equipment known as Continuous Commissioning® or Building Tune-ups at a cost of $ 0.20 – 0.30/sq.ft.

If all buildings over 50,000 sq. ft. of air-conditioned space could be motivated to be tuned-up [commissioned] in non-attainment areas significant energy reduction potential exists in range of 10 – 40%. Added benefits are improved building comfort and employee productivity. If 30 million square feet could be conditioned in 2003, which could grow to 570 million square feet conditioned by 2012, then 1.3 to 3.2 million MWh of electricity could be saved. This would amount to 161 to 285 tons NOx saved per year or 0.9 to 1.6 tons NOx saved per peak day[16].

| | 2007 - 2010 | Tons NOx Saved/yr * | Tons NOx Saved Peak Day | $/ton/10 yr |
|---|---|---|---|---|
| MWh Elec. Saved (10%) | 1.3 - 3.2 mil. | 161- 285 | 0.9 – 1.6 | Negative |

* 38 counties

Tune-ups generally have a two-year payback with positive cash flow on day one. The cost in non- and near non-attainment areas would be borne by building owners using zero percent loans provided by ESCO's, banks, and state revolving fund for S.B. 5 energy. Interest subsidies would be funded through a line charge.

4.4.11 Wrote and Delivered Papers on the Prototype Emissions Reduction Calculator.

- To help foster international technology transfer the Laboratory wrote and delivered a paper on the Senate Bill 5 effort to the International Building Performance Simulation Association (IBPSA), in Eindhoven, in the Nederlands, in August 2003[17].
- To promote technology transfer within the U.S. the Laboratory wrote a paper on the Senate Bill 5 effort to be delivered at the International Conference on Enhanced Building performance, in San Francisco, California, in October 2003[18].
- To promote awareness about emissions calculations the Laboratory delivered a talk about the prototype Emissions Reduction Calculator to the Energy Efficiency/SB5 Workshop, sponsored by the Texas State Energy Conservation Office on September 16th, 2003, in Austin, Texas.
- To promote technology to other states the Laboratory prepared a lecture about the Senate Bill 5 program and presented it to the Fall 2003 meeting of the Association of State Energy Research and Technology Transfer Institutions (ASERTII), which was held in San Antonio, Texas, September 23rd, 2003[19].

4.4.12 Analyzed REScheck Software.

The Laboratory analyzed the USDOE's REScheck software. The REScheck (formerly MECcheck) software is intended to allow designers and builders to quickly and easily determine whether new homes, additions, and low-rise apartment buildings meet the requirements of the Model Energy Code (MEC) or the International Energy Conservation Code (IECC). The version of REScheck that can be accessed via the internet is REScheck-Web (http://bldgcode.pnl.gov/REScheckWeb/). This version of REScheck enables users to vary insulation levels in the ceiling, wall, floor, basement wall, slab-edge and crawl space; glazing

[16] Additional information regarding this calculation can be found in the appendix.
[17] Haberl, J., Im, P., Culp, C., Yazdani, B., Fitzpatrick, T., Turner, D. 2003. "Calculation of NOx Emissions Reductions From Implementation of the 2000 IECC/IRC Conservation Code in Texas", Proceedings of the 2003 IBPSA Conference, Eindhoven, Netherlands, August 11-14, 2003. This paper was delivered by Mr. Larry Degelman, Professor Emeritus, Department of Architecture, Texas A&M.
[18] A copy of this paper has been posted on the Laboratory's Senate Bill 5 web site, (eslsb.tamu.edu).
[19] This presentation was delivered by Mr. Malcolm Verdict, Associate Director of the Energy Systems Laboratory.

and door areas; and glazing and door U-factors. It allows the user to enter information from the proposed plans and specifications. REScheck then calculates a total "UA-value" for the project. By comparing the project's UA-value to the UA-value required for the climate zone, REScheck-Web determines if the project passes the requirements of the selected energy code. If the project does not pass, the user can experiment with different combinations of insulation levels, window or door products, and component areas to achieve compliance.

Through conversations with code officials and builders who attended the Laboratory's code training workshops, the Laboratory became aware of instances where the Laboratory's Builder's Guide, and prototype Emissions Reduction Calculator gave different answers than REScheck. Therefore a comparative analysis was performed and the results reported to the authors of REScheck at the USDOE's Pacific Northwest National Laboratory (PNNL).

#### 4.4.12.1 Test Procedure for REScheck-web software.

To test the REScheck software against the Laboratory's IECC code-traceable simulation a single-family house (1,600 sq.ft) in the Houston-Galveston area (HGA) and Dallas-Fort Worth area (DFW) were used for the test. The house was carefully constructed to comply with the IECC / IRC requirements. Table 8 and Table 9 provide the test plan for the REScheck and the Laboratory's IECC / IRC Code-traceable DOE-2 simulations, respectively. For the test, twenty REScheck runs and DOE-2 runs were performed for the twenty counties included in the HGA and DFW area. For the DOE-2 results version IECC1105.INP was used. The DOE-2 input values for each element such as the insulation levels in the ceiling, wall, floor, and slab-edge; glazing and door areas; and glazing and door U-factors referenced the IECC / IRC for the climate zone for each county.

The REScheck tests were performed twice, once on July 1, 2003 and again on July 15, 2003. The REScheck-web program generates a compliance report such as that shown in Figure 26. In Figure 27 the opening screen of REScheck is shown. In Figure 28 the user should choose the location of the building tested, and the code that the user wishes to use to check the compliance. In this figure the user will input the general project information such as code, location, and construction type. For location, user can choose either city or county. In Figure 29 the input screen for the envelope information is shown. The R-value and the area of the wall, the ceiling, and the door will be input in this step. The U-value and the area of the windows will be also input. In Figure 30 the input screen for the mechanical system information such as SEER for air-conditioner and AFUE for gas furnace is shown. In Figure 31 the screen is shown that presents the results of a test.

After completing the input screens, the user clicks the tab named "check compliance". At the bottom of the screen (Figure 31) a notice is presented by REScheck. In this example, the input house passed the compliance check since the UA of the input house is 1.4 % better than the Maximum UA. The allowed MAX UA and the UA for this house are also shown in this screen. More detailed results for a house are given by REScheck in the Compliance Certificate (Figure 26).

To complete the analysis special files were developed for the Laboratory's IECC Code-traceable simulation (ver. IECC1105.INP). A sample of the parameters that were prepared is presented in the Appendix for Brazoria County.

#### 4.4.12.2 Results of REScheck-web Comparison Against the Laboratory's IECC Code-traceable Software.

Table 10 shows the results of the test. In the results of the REScheck-web tests, the results from the first run (July 1) and second run (July 15) are presented[20]. Three major changes can be seen between the two runs. The changes are:

[20] Differences between these two runs indicate the changes that PNNL made to REScheck-web after discussions with the Laboratory.

1. It appears that the climate zone of the Harris County was changed from zone 3 to zone 4, which now correctly matches the IECC / IRC.
2. Unknown adjustments were made to the MAX UA for climate zone 6. However, it appears that the adjusted MAX UA of Zone 6 is same to the MAX UA of Zone 5.
3. It appears that climate zone of the Tarrant County was changed from zone 6 to zone 5, which now correctly matches the IECC / IRC.

These changes had a significant impact in the accuracy of REScheck. In the July 1st comparisons, differences as great as 9.8% were seen for several counties. After the results of the simulations were sent to PNNL, and REScheck was revised, the test were run again. In the July 15th comparisons, only the last 5 counties shown in climate zone 6 for the DFW comparisons showed differences greater than 1.5%, which are considered acceptable, given other, unknown differences in the simulations, which continue to exist.

This analysis of REScheck has proven useful for the Laboratory and PNNL. First, it has demonstrated that the Laboratory's IECC Code-compliant software is useful for finding errors in other software that is being used to certify code compliance. Second, it has provided a valuable cross-check for PNNL and the Laboratory that has improved the confidence in both software packages.

______________
Permit Number

______________
Checked By/Date

**RES*check* Compliance Certificate**
**2000 IECC**
Generated by RES*check-Web* Software

COUNTY: Brazoria
STATE: Texas
HDD: 1499
CONSTRUCTION TYPE: Single Family

DATE: 08/11/03

COMPLIANCE: Passes

Maximum UA = 508
Your Home UA = 501
1.4% Better Than Code (UA)
Maximum SHGC = 0.40
Your SHGC = 0.40

| | Gross Area or Perimeter | Cavity R-Value | Cont. R-Value | Glazing or Door U-Factor | UA |
|---|---|---|---|---|---|
| Ceiling 1: Flat or Scissor Truss | 1600 | 0.0 | 19.0 | | 77 |
| Wall 1: Wood Frame, 16" o.c. | 1280 | 0.0 | 11.0 | | 109 |
| Door 1: Solid | 20 | | | 0.200 | 4 |
| Window 1: Metal Frame, 2 Pane w/ Low-E SHGC: 0.40 | 192 | | | 0.750 | 144 |
| Floor1: Unheated Slab-On-Grade Insulation depth: 0.0' | 160 | | 0.0 | | 167 |

Furnace 1: Forced Hot Air (Non-Electric), 78 AFUE
Air Conditioner 1: Electric Central Air, 10 SEER

COMPLIANCE STATEMENT: The proposed building design described here is consistent with the building plans, specifications, and other calculations submitted with the permit application. The proposed building has been designed to meet the 2000 IECC requirements in RES*check-Web* and to comply with the mandatory requirements listed in the RES*check* Inspection Checklist.

Builder/Designer__________________________________ Date____________

Figure 26: Sample REScheck-web Compliance Certificate.

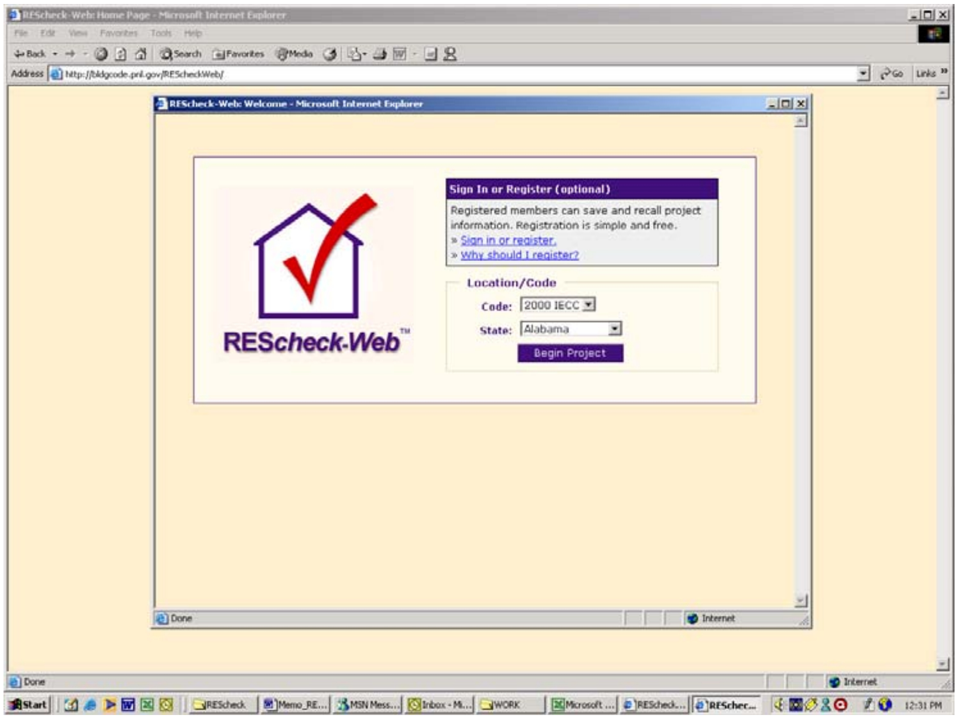



Figure 27: Start Screen of REScheck Web version.

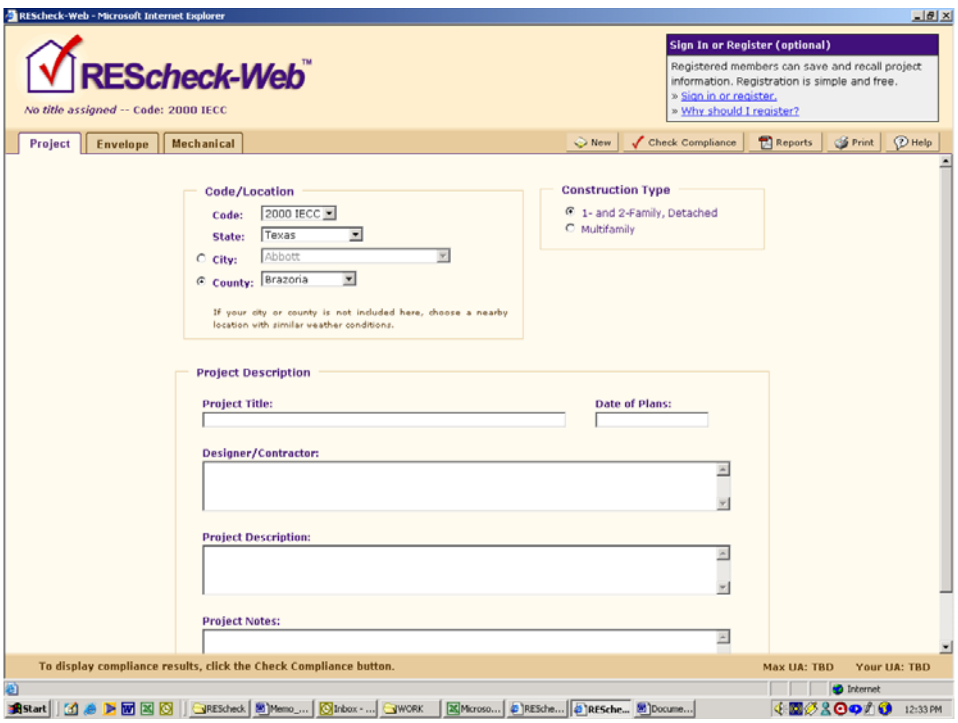



Figure 28: Input Screen for Project Information

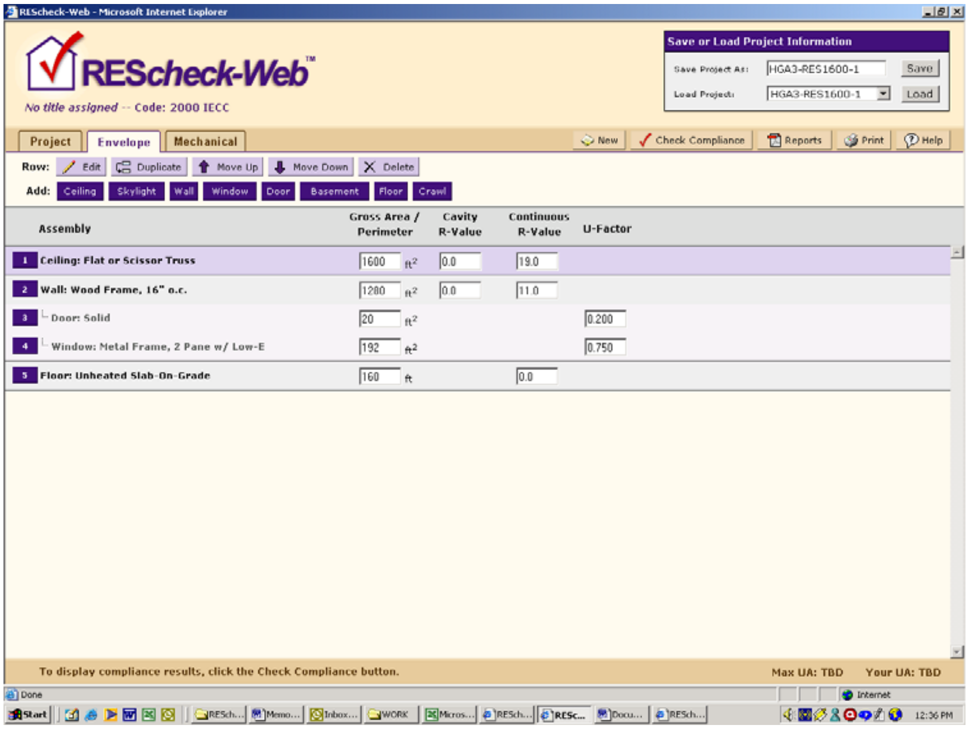


Figure 29:Input Screen for Envelope Information

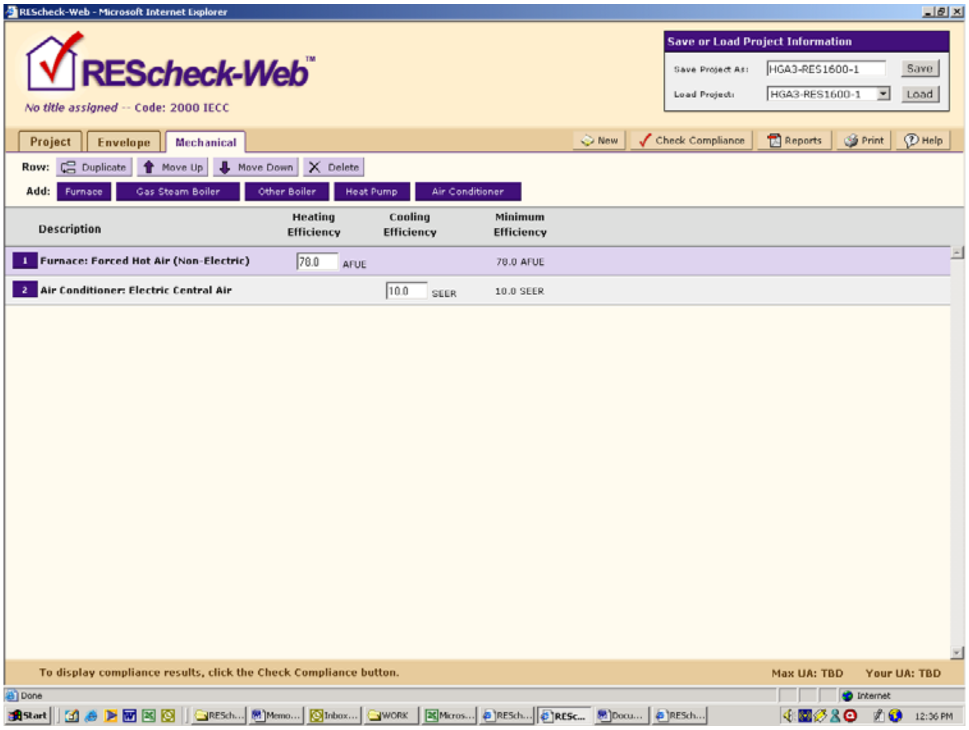


Figure 30: Input Screen for Mechanical Information

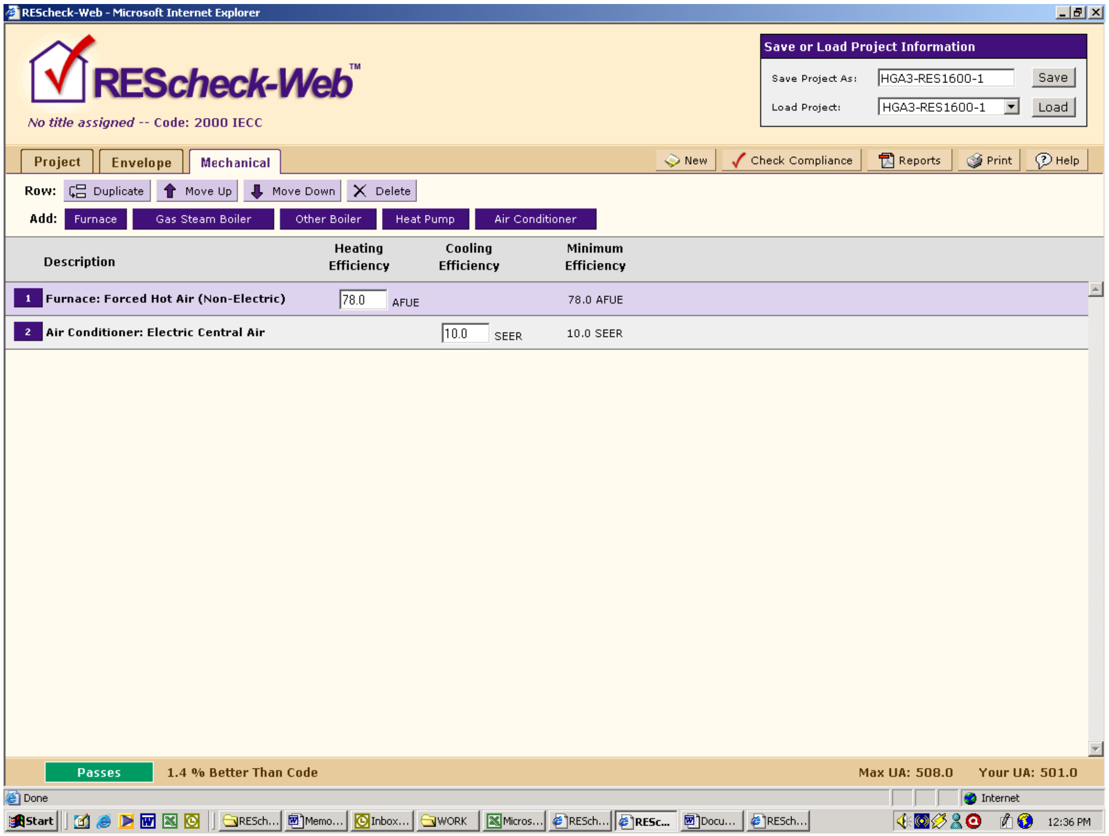



Figure 31: Screen showing Results of REScheck

| Classification | Test Number | County | Climate Zone | Building Specification | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Envelope | | | | | | | | | | | | | | |
| | | | | Ceiling | | | Wall | | | Window | | | Door | | | Floor | | |
| | | | | Ceiling Type | Gross Area | Continuous R-value | Wall Type | Gross Area | Continuous R-value | Window Type | Gross Area | U-factor | Door Type | Gross Area | U-factor | Floor Type | Perimeter | Continuous R-value |
| HGA | HGA3-RES1600-1 | Brazoria | 3 | Flat or Scissor Truss | 1600 | 19 | Wood Frame, 16" o.c. | 1280 | 11 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 160 | 0 |
| | HGA3-RES1600-2 | Galveston | 3 | Flat or Scissor Truss | 1600 | 19 | Wood Frame, 16" o.c. | 1280 | 11 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 160 | 0 |
| | HGA4-RES1600-1 | Chambers | 4 | Flat or Scissor Truss | 1600 | 26 | Wood Frame, 16" o.c. | 1280 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 160 | 0 |
| | HGA4-RES1600-2 | Fort Bend | 4 | Flat or Scissor Truss | 1600 | 26 | Wood Frame, 16" o.c. | 1280 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 160 | 0 |
| | HGA4-RES1600-3 | Hardin | 4 | Flat or Scissor Truss | 1600 | 26 | Wood Frame, 16" o.c. | 1280 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 160 | 0 |
| | HGA4-RES1600-4 | Harris | 4 | Flat or Scissor Truss | 1600 | 26 | Wood Frame, 16" o.c. | 1280 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 160 | 0 |
| | HGA4-RES1600-5 | Jefferson | 4 | Flat or Scissor Truss | 1600 | 26 | Wood Frame, 16" o.c. | 1280 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 160 | 0 |
| | HGA4-RES1600-6 | Liberty | 4 | Flat or Scissor Truss | 1600 | 26 | Wood Frame, 16" o.c. | 1280 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 160 | 0 |
| | HGA4-RES1600-7 | Montgomery | 4 | Flat or Scissor Truss | 1600 | 26 | Wood Frame, 16" o.c. | 1280 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 160 | 0 |
| | HGA4-RES1600-8 | Orange | 4 | Flat or Scissor Truss | 1600 | 26 | Wood Frame, 16" o.c. | 1280 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 160 | 0 |
| | HGA4-RES1600-9 | Waller | 4 | Flat or Scissor Truss | 1600 | 26 | Wood Frame, 16" o.c. | 1280 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 160 | 0 |
| DFW | DFW5-RES1600-1 | Ellis | 5 | Flat or Scissor Truss | 1600 | 30 | Wood Frame, 16" o.c. | 1280 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.65 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 160 | 0 |
| | DFW5-RES1600-2 | Johnson | 5 | Flat or Scissor Truss | 1600 | 30 | Wood Frame, 16" o.c. | 1280 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.65 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 160 | 0 |
| | DFW5-RES1600-3 | Dallas | 5 | Flat or Scissor Truss | 1600 | 30 | Wood Frame, 16" o.c. | 1280 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.65 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 160 | 0 |
| | DFW5-RES1600-4 | Tarrant | 5 | Flat or Scissor Truss | 1600 | 30 | Wood Frame, 16" o.c. | 1280 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.65 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 160 | 0 |
| | DFW5-RES1600-1 | Collin | 6 | Flat or Scissor Truss | 1600 | 30 | Wood Frame, 16" o.c. | 1280 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.6 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 160 | 0 |
| | DFW6-RES1600-2 | Kaufman | 6 | Flat or Scissor Truss | 1600 | 30 | Wood Frame, 16" o.c. | 1280 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.60 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 160 | 0 |
| | DFW6-RES1600-3 | Parker | 6 | Flat or Scissor Truss | 1600 | 30 | Wood Frame, 16" o.c. | 1280 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.60 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 160 | 0 |
| | DFW6-RES1600-4 | Denton | 6 | Flat or Scissor Truss | 1600 | 30 | Wood Frame, 16" o.c. | 1280 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.60 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 160 | 0 |
| | DFW6-RES1600-5 | Rockwall | 6 | Flat or Scissor Truss | 1600 | 30 | Wood Frame, 16" o.c. | 1280 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.60 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 160 | 0 |

Table 8: REScheck test plan for 1,600 ft2 single-family residence.

| Classification | Test Number | County | Climate Zone | Building Specification | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Envelope | | | | | | | | | | | | | | | | |
| | | | | Ceiling | | | Wall | | | Window | | | | Door | | | Floor | | | |
| | | | | Ceiling Type | Gross Area | Continuous R-value | Wall Type | Gross Area | Continuous R-value | Window Type | Gross Area | U-factor | SHGC | Door Type | Gross Area | U-factor | Floor Type | Perimeter | Continuous R-value | |
| HGA | HGA3-DOE1600-1 | Brazoria | 3 | Flat or Scissor Truss | 1600 | 19 | Wood Frame, 16" o.c. | 1600 | 11 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | 0.40 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 200 | 0 | |
| | HGA3-DOE1600-2 | Galveston | 3 | Flat or Scissor Truss | 1600 | 19 | Wood Frame, 16" o.c. | 1600 | 11 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | 0.40 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 200 | 0 | |
| | HGA4-DOE1600-1 | Chambers | 4 | Flat or Scissor Truss | 1600 | 26 | Wood Frame, 16" o.c. | 1600 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | 0.40 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 200 | 0 | |
| | HGA4-DOE1600-2 | Fort Bend | 4 | Flat or Scissor Truss | 1600 | 26 | Wood Frame, 16" o.c. | 1600 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | 0.40 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 200 | 0 | |
| | HGA4-DOE1600-3 | Hardin | 4 | Flat or Scissor Truss | 1600 | 26 | Wood Frame, 16" o.c. | 1600 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | 0.40 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 200 | 0 | |
| | HGA4-DOE1600-4 | Harris | 4 | Flat or Scissor Truss | 1600 | 26 | Wood Frame, 16" o.c. | 1600 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | 0.40 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 200 | 0 | |
| | HGA4-DOE1600-5 | Jefferson | 4 | Flat or Scissor Truss | 1600 | 26 | Wood Frame, 16" o.c. | 1600 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | 0.40 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 200 | 0 | |
| | HGA4-DOE1600-6 | Liberty | 4 | Flat or Scissor Truss | 1600 | 26 | Wood Frame, 16" o.c. | 1600 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | 0.40 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 200 | 0 | |
| | HGA4-DOE1600-7 | Montgomery | 4 | Flat or Scissor Truss | 1600 | 26 | Wood Frame, 16" o.c. | 1600 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | 0.40 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 200 | 0 | |
| | HGA4-DOE1600-8 | Orange | 4 | Flat or Scissor Truss | 1600 | 26 | Wood Frame, 16" o.c. | 1600 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | 0.40 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 200 | 0 | |
| | HGA4-DOE1600-9 | Waller | 4 | Flat or Scissor Truss | 1600 | 26 | Wood Frame, 16" o.c. | 1600 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.75 | 0.40 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 200 | 0 | |
| DFW | DFW5-DOE1600-1 | Ellis | 5 | Flat or Scissor Truss | 1600 | 30 | Wood Frame, 16" o.c. | 1600 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.65 | 0.40 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 200 | 0 | |
| | DFW5-DOE1600-2 | Johnson | 5 | Flat or Scissor Truss | 1600 | 30 | Wood Frame, 16" o.c. | 1600 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.65 | 0.40 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 200 | 0 | |
| | DFW5-DOE1600-3 | Dallas | 5 | Flat or Scissor Truss | 1600 | 30 | Wood Frame, 16" o.c. | 1600 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.65 | 0.40 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 200 | 0 | |
| | DFW5-DOE1600-4 | Tarrant | 5 | Flat or Scissor Truss | 1600 | 30 | Wood Frame, 16" o.c. | 1600 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.65 | 0.40 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 200 | 0 | |
| | DFW5-DOE1600-1 | Collin | 6 | Flat or Scissor Truss | 1600 | 30 | Wood Frame, 16" o.c. | 1600 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.6 | 0.40 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 200 | 0 | |
| | DFW6-DOE1600-2 | Kaufman | 6 | Flat or Scissor Truss | 1600 | 30 | Wood Frame, 16" o.c. | 1600 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.60 | 0.40 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 200 | 0 | |
| | DFW6-DOE1600-3 | Parker | 6 | Flat or Scissor Truss | 1600 | 30 | Wood Frame, 16" o.c. | 1600 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.60 | 0.40 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 200 | 0 | |
| | DFW6-DOE1600-4 | Denton | 6 | Flat or Scissor Truss | 1600 | 30 | Wood Frame, 16" o.c. | 1600 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.60 | 0.40 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 200 | 0 | |
| | DFW6-DOE1600-5 | Rockwall | 6 | Flat or Scissor Truss | 1600 | 30 | Wood Frame, 16" o.c. | 1600 | 13 | Metal Frame, 2 pane w/Low-E | 192 | 0.60 | 0.40 | Solid | 20 | 0.20 | Unheated Slab-on-Grade | 200 | 0 | |

Table 9: IECC code-traceable DOE-2 test plan for 1,600 ft2 single-family residence.

Table 3: Test Results

For 1600 sq.ft

| Classification | Test Number (REScheck) | Test Number (DOE-2) | County | Climate Zone | REScheck-Web: REScheck Calculted MAX UA | | REScheck-Web: REScheck Calculated Test House UA | | REScheck-Web: Compliance | | ESL DOE-2 Simulations (Using Fixed Furnace & Winkelmann method): Annual Energy Use for Code House | Annual Electricity Use for Code House | Annual N.G. Use for Code House | Compliance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Test Date | | | | | 07/01/03 | 07/15/03 | 07/01/03 | 07/15/03 | 07/01/03 | 07/15/03 | | | | |
| HGA | HGA3-RES1600-1 | HGA3-DOE1600-1 | Brazoria | 3 | 508 | 508 | 501 | 501 | 1.4% Better | 1.4% Better | 66.42 MBtu | 42.1 MBtu | 24.3 MBtu | 0.0% Better |
| | HGA3-RES1600-2 | HGA3-DOE1600-2 | Galveston | 3 | 508 | 508 | 501 | 501 | 1.4% Better | 1.4% Better | 66.42 MBtu | 42.1 MBtu | 24.3 MBtu | 0.0% Better |
| | HGA4-RES1600-1 | HGA4-DOE1600-1 | Chambers | 4 | 481 | 481 | 476 | 476 | 1.0% Better | 1.0% Better | 63.87 MBtu | 40.8 MBtu | 22.0 MBtu | 0.0% Better |
| | HGA4-RES1600-2 | HGA4-DOE1600-2 | Fort Bend | 4 | 481 | 481 | 476 | 476 | 1.0% Better | 1.0% Better | 64.60 MBtu | 41.4 MBtu | 22.6 MBtu | 0.0% Better |
| | HGA4-RES1600-3 | HGA4-DOE1600-3 | Hardin | 4 | 481 | 481 | 476 | 476 | 1.0% Better | 1.0% Better | 63.87 MBtu | 40.8 MBtu | 22.0 MBtu | 0.0% Better |
| | HGA4-RES1600-4 | HGA4-DOE1600-4 | Harris * | 4 | 508 | 481 | 476 | 476 | 6.3% Better | 1.0% Better | 64.60 MBtu | 41.4 MBtu | 22.6 MBtu | 0.0% Better |
| | HGA4-RES1600-5 | HGA4-DOE1600-5 | Jefferson | 4 | 481 | 481 | 476 | 476 | 1.0% Better | 1.0% Better | 63.87 MBtu | 40.8 MBtu | 22.0 MBtu | 0.0% Better |
| | HGA4-RES1600-6 | HGA4-DOE1600-6 | Liberty | 4 | 481 | 481 | 476 | 476 | 1.0% Better | 1.0% Better | 63.87 MBtu | 40.8 MBtu | 22.0 MBtu | 0.0% Better |
| | HGA4-RES1600-7 | HGA4-DOE1600-7 | Montgomery | 4 | 481 | 481 | 476 | 476 | 1.0% Better | 1.0% Better | 64.60 MBtu | 41.4 MBtu | 22.6 MBtu | 0.0% Better |
| | HGA4-RES1600-8 | HGA4-DOE1600-8 | Orange | 4 | 481 | 481 | 476 | 476 | 1.0% Better | 1.0% Better | 63.87 MBtu | 40.8 MBtu | 22.0 MBtu | 0.0% Better |
| | HGA4-RES1600-9 | HGA4-DOE1600-9 | Waller | 4 | 481 | 481 | 476 | 476 | 1.0% Better | 1.0% Better | 64.60 MBtu | 41.4 MBtu | 22.6 MBtu | 0.0% Better |
| DFW | DFW5-RES1600-1 | DFW5-DOE1600-1 | Ellis | 5 | 456 | 456 | 449 | 449 | 1.5% Better | 1.5% Better | 67.79 MBtu | 40.0 MBtu | 27.8 MBtu | 0.0% Better |
| | DFW5-RES1600-2 | DFW5-DOE1600-2 | Johnson | 5 | 456 | 456 | 449 | 449 | 1.5% Better | 1.5% Better | 67.79 MBtu | 40.0 MBtu | 27.8 MBtu | 0.0% Better |
| | DFW5-RES1600-3 | DFW5-DOE1600-3 | Dallas | 5 | 456 | 456 | 449 | 449 | 1.5% Better | 1.5% Better | 67.79 MBtu | 40.0 MBtu | 27.8 MBtu | 0.0% Better |
| | DFW5-RES1600-4 | DFW5-DOE1600-4 | Tarrant ** | 5 | 409 | 456 | 449 | 449 | 9.8% Worse | 1.5% Better | 67.79 MBtu | 40.0 MBtu | 27.8 MBtu | 0.0% Better |
| | DFW6-RES1600-1 | DFW6-DOE1600-1 | Collin ** | 6 | 409 | 456 | 439 | 439 | 7.3% Worse | 3.7% Better | 67.27 MBtu | 40.1 MBtu | 27.2 MBtu | 0.0% Better |
| | DFW6-RES1600-2 | DFW6-DOE1600-2 | Kaufman ** | 6 | 409 | 456 | 439 | 439 | 7.3% Worse | 3.7% Better | 67.27 MBtu | 40.1 MBtu | 27.2 MBtu | 0.0% Better |
| | DFW6-RES1600-3 | DFW6-DOE1600-3 | Parker ** | 6 | 409 | 456 | 439 | 439 | 7.3% Worse | 3.7% Better | 67.27 MBtu | 40.1 MBtu | 27.2 MBtu | 0.0% Better |
| | DFW6-RES1600-4 | DFW6-DOE1600-4 | Denton ** | 6 | 409 | 456 | 439 | 439 | 7.3% Worse | 3.7% Better | 67.27 MBtu | 40.1 MBtu | 27.2 MBtu | 0.0% Better |
| | DFW6-RES1600-5 | DFW6-DOE1600-5 | Rockwall ** | 6 | 409 | 456 | 439 | 439 | 7.3% Worse | 3.7% Better | 67.27 MBtu | 40.1 MBtu | 27.2 MBtu | 0.0% Better |

* It apears that climate zone of the Harris County was changed from zone 3 to zone 4, which matches the 2000 IECC

** Unknown adjustments were occurred for the MAX UA for climate zone 6. However, it appears that the adjusted MAX UA of Zone 6 is same to the MAX UA of Zone 5.
It appears that climate zone of the Tarrant County was changed from zone 6 to zone 5, which matches the 2000 IECC

Table 10: Comparison of Test Results for REScheck and the Laboratory's IECC Code-traceable DOE-2 simulation.

## 4.5 Sec. 388.008. Development Of Home Energy Ratings.

### 4.5.1 Development of a Standard Input File for Code Compliance Testing

In 2002 the Laboratory developed a code-traceable DOE-2 input file for calculating energy savings and demand reductions from implementation of the IECC / IRC state-wide to single-family residences. These simulations are needed for analyzing the energy savings from proposed municipality code amendments, and annual calculation of IECC / IRC state-wide savings. This code-traceable input file will be used to compare Home Energy Rating Scores to an IECC / IRC baseline.

In 2003 the code-traceable DOE-2 input file was substantially enhanced to include an improved heat transfer procedure to the ground-coupling, improved National Fenestration Rating Council (NFRC) window R-value and SHGC procedures, and an improved calculation of furnace efficiency. Work has also been initiated on expanding the 1-zone model into a 2-zone model with user selectable system types (i.e., gas heating/air conditioning/gas DHW, electric heating/air conditioning, electric DHW and heat pump/air conditioning/electric DHW), floors (i.e., crawlspace or slab floor), user-selectable shading, and other features. Early versions of the multi-family model, commercial model and models for solar thermal[21], and photovoltaic model[22] have also been developed.

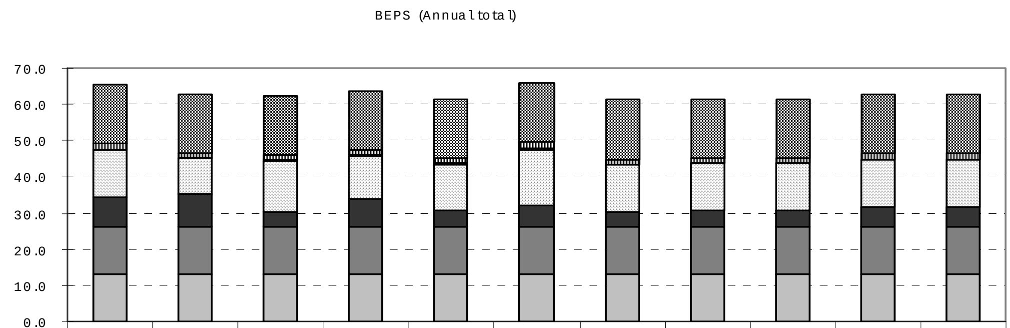
### 4.5.2 Investigated effect of thermal mass on simulation.

The Laboratory was asked to evaluate the impact of thermal mass on the simulation of electricity savings from the implementation of the 2000 IECC to single-family residential construction by the City of Houston and the North Central Texas Council of Governments (NCTCOG)[23]. This issue becomes particularly important when houses are constructed with walls of concrete block or solid masonry walls. To accomplish this analysis the Laboratory had to perform careful modifications to the Laboratory's code-traceable simulations. The analysis of a 2,000 ft2 single-family residence[24] in Houston showed that the thermal mass tables in the IECC / IRC must be closely followed to assure that the walls are performing in a similar fashion as wood-framed walls[25]. The analysis also required special modifications to the DOE-2 input file to properly account for the thermal mass, as shown in Figure 32 and Figure 33. Several features of the analysis are worth noting:

- First, the analysis of thermal mass using the DOE-2 program requires the use of ASHRAE custom-weighting-factors, as well as special instructions for the description of the heat transfer through the concrete slab to the soil below the house. Comparisons between lightweight and heavy-weight walls types must both be simulated with custom-weighting-factors to obtain an accurate assessment of the benefits (or penalties) of thermal mass.
- The 6.1% change in annual energy use (Figure 32) between pre-calculated ASHRAE weighting factors (i.e., simulation IECC1105.INP = 65.4 MBtu/yr), and ASHRAE custom weighting factors (i.e., simulation IECC1303.INP = 61.4 MBtu/yr), should not be credited toward thermal mass benefits. This change represents only the difference between different simulation algorithms in the DOE-2 program.
- The change in annual energy use between a lightweight, wood-framed house, slab-on-grade house (i.e., simulation IECC1303.INP = 61.4 Mbtu/yr), and a house with different types of masonry walls (i.e., simulation IECC1305.INP = 61.2 to IECC1309.INP = 62.6 MBtu/yr) amounts to only modest change, when one considers the proper simulation method.

[21] The solar thermal model is based on the FCHART program, developed by the University of Wisconsin.
[22] The photovoltaic model is based on the PVFCHART program, developed by the University of Wisconsin.
[23] This thermal analysis was needed to evaluate the Energy Star BOPs that were submitted by both the City of Houston and the NCTCOG.
[24] The base-case house had 15% window to wall area with walls that were 8 ft in height. Heating temperatures and cooling temperatures were set according to Chapter 4 of the IECC.
[25] Haberl, J., Kim, S. 2003. "Detailed Analysis of Thermal Mass Effects in a Code-Traceable DOE-2 Simulation of the 2000 IECC for a Single-family Residence in Texas", Energy Systems Laboratory, Report No. ESL-TR-02/09-xx, (September).

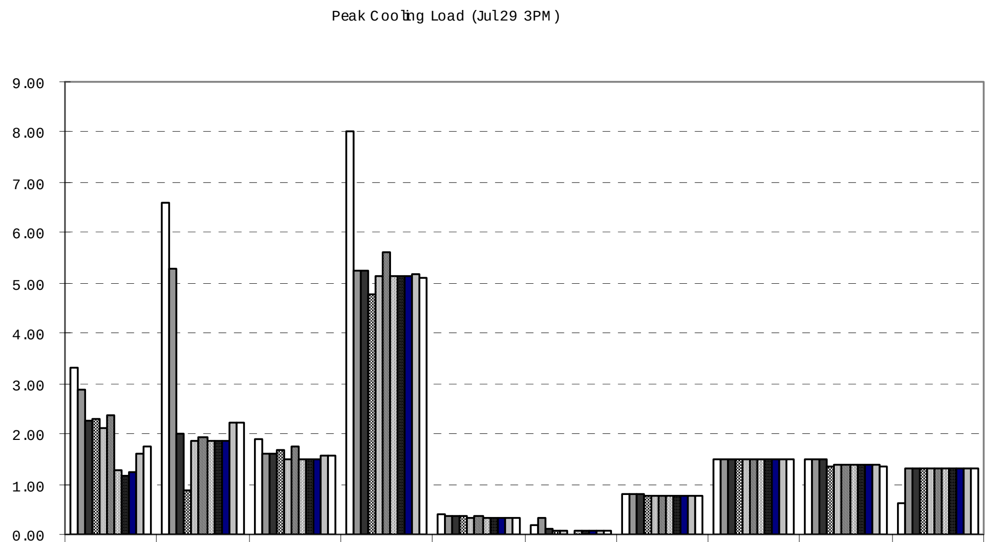
- Proper simulation of peak hourly loads requires the use of ASHRAE custom weighting factors, as shown in Figure 33. This can have a significant influence on the peak-day NOx emissions reduction from energy conserving features such as windows and roof insulation.




| | IECC1105 (65.4) | IECC1300 (62.7) | IECC1301 (62.5) | IECC1302 (63.6) | IECC1303 (61.4) | IECC1304 (65.9) | IECC1305 (61.2) | IECC1306 (61.6) | IECC1307 (61.6) | IECC1308 (62.7) | IECC1309 (62.6) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DOM HOT WATER | 16.3 | 16.3 | 16.3 | 16.3 | 16.3 | 16.3 | 16.3 | 16.3 | 16.3 | 16.3 | 16.3 |
| VENT FANS | 1.7 | 1.2 | 1.7 | 1.4 | 1.5 | 1.9 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| PUMPS & MISC | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| SPACE COOL | 12.8 | 9.8 | 14.1 | 11.7 | 12.8 | 15.4 | 12.8 | 12.8 | 12.8 | 13.0 | 12.9 |
| SPACE HEAT | 8.0 | 8.8 | 3.8 | 7.6 | 4.2 | 5.7 | 4.0 | 4.4 | 4.4 | 5.3 | 5.3 |
| MISC EQUIPMT | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 |
| AREA LIGHTS | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 | 13.2 |

Figure 32: Simulated Comparisons of a Single-family Residence With Varying Amounts of Thermal Mass Using Different DOE-2 Calculation Schemes (Annual Energy use, MBtu/year).

- IECC1105 = base-case model, ASHRAE pre-calculated weighting factors, quick walls, FW=13.5
- IECC1300 = ASHRAE pre-calculated weighting factors, quick walls, FW=87.
- IECC1301 = ASHRAE pre-calculated weighting factors, real walls, FW=87
- IECC1302 = ASHRAE custom weighting factors, real walls, FW=0
- IECC1303 = ASHRAE custom weighting factors, real walls, FW=0, LBNL floor.
- IECC1304 = ASHRAE custom weighting factors, real walls, FW=0, LBNL floor, floor area = 0.
- IECC1305 = ASHRAE custom weighting factors, real walls, FW=0, LBNL floor, 3" face brick, insulation inside.
- IECC1306 = ASHRAE custom weighting factors, real walls, FW=0, LBNL floor, 8" perlite-filled block, insulation inside.
- IECC1307 = ASHRAE custom weighting factors, real walls, FW=0, LBNL floor, 8" perlite-filled block and concrete-filled block, insulation inside.
- IECC1308 = ASHRAE custom weighting factors, real walls, FW=0, LBNL floor, stucco, 8" perlite-filled concrete block, insulation outside.
- IECC1309 = ASHRAE custom weighting factors, real walls, FW=0, LBNL floor, stucco, 8" perlite-filled and concrete-filled block, insulation outside.




| | WALL CONDUCTION | ROOF CONDUCTION | WINDOW GLASS+FRM COND | WINDOW GLASS SOLAR | DOOR CONDUCTION | UNDERGROUND SURF COND | OCCUPANTS TO SPACE | LIGHT TO SPACE | EQUIPMENT TO SPACE | INFILTRATION |
|---|---|---|---|---|---|---|---|---|---|---|
| 1105 (24.81) | 3.30 | 6.60 | 1.88 | 8.02 | 0.40 | 0.19 | 0.80 | 1.50 | 1.50 | 0.61 |
| 1300 (20.85) | 2.89 | 5.29 | 1.61 | 5.25 | 0.36 | 0.34 | 0.80 | 1.50 | 1.50 | 1.32 |
| 1301 (16.72) | 2.27 | 2.01 | 1.61 | 5.25 | 0.36 | 0.10 | 0.80 | 1.50 | 1.50 | 1.32 |
| 1302 (14.97) | 2.30 | 0.86 | 1.69 | 4.77 | 0.36 | 0.09 | 0.76 | 1.50 | 1.33 | 1.32 |
| 1303 (16.01) | 2.11 | 1.86 | 1.50 | 5.16 | 0.33 | 0.09 | 0.77 | 1.50 | 1.38 | 1.32 |
| 1304 (16.99) | 2.38 | 1.92 | 1.75 | 5.60 | 0.37 | 0.00 | 0.77 | 1.50 | 1.39 | 1.32 |
| 1305 (15.19) | 1.29 | 1.86 | 1.50 | 5.16 | 0.33 | 0.09 | 0.77 | 1.50 | 1.38 | 1.32 |
| 1306 (15.04) | 1.16 | 1.87 | 1.50 | 5.13 | 0.33 | 0.09 | 0.77 | 1.50 | 1.38 | 1.32 |
| 1307 (15.14) | 1.23 | 1.87 | 1.51 | 5.15 | 0.33 | 0.09 | 0.77 | 1.50 | 1.38 | 1.32 |
| 1308 (15.94) | 1.61 | 2.22 | 1.58 | 5.17 | 0.32 | 0.09 | 0.76 | 1.50 | 1.37 | 1.31 |
| 1309 (15.99) | 1.74 | 2.22 | 1.58 | 5.12 | 0.32 | 0.09 | 0.76 | 1.50 | 1.37 | 1.31 |

Figure 33: Simulated Comparisons of a Single-family Residence With Varying Amounts of Thermal Mass Using Different DOE-2 Calculation Schemes (Peak Day Cooling Use, kBtu/peak-day).

# 5 RECOMMENDATIONS FOR REPORTING ENERGY SAVINGS AND EMISSIONS REDUCTION ACCEPTABLE TO THE EPA FOR SIP CREDITS

At the request of the TCEQ the Energy Systems Laboratory has developed the following recommendations to the TCEQ for reporting energy savings and emissions reduction that are intended to be acceptable to the EPA for SIP credits. These recommendations include the development of standardized methods for reporting energy savings that utilize the USDOE's International Performance Measurement and Verification Protocols (IPMVP), and the calculation of the resultant NOx emissions reduction using the EPA's eGRID program.

## 5.1 The TCEQ Should Develop Standardized Methods for Reporting NOx Reductions, Including Adjustments to Electricity Savings Needed for the eGRID Program.

### 5.1.1 Review of Nationally Accepted Protocols for Measurement and Verification of Energy Conservation Retrofits.

In general, the nationally accepted procedures include the protocols of the International Performance Measurement and Verification Protocols (IPMVP)[26], and ASHRAE Guideline 14-2002 (Guideline 14)[27]. Extension of the IPMVP and Guideline 14 procedures is necessary to allow for the accurate calculation of peak-day emissions, which are required by the EPA for SIP credits.

Nationally-recognized protocols for measurement and verification have evolved since the publication of the 1996 NEMVP. This evolution reflects the consensus process that the Department of Energy has chosen as a basis for the protocols. In 1996 three M&V methods were included in the NEMVP: Option A: measured capacity with stipulated consumption; Option B: end-use retrofits, which utilized measured capacity and measured consumption; and Option C: whole-facility or main meter measurements, which utilize before after regression models.

In 1997, Options A, B and C were modified and relabeled, and Option D: calibrated simulation was added. Also included in the 1997 IPMVP was a chapter on measuring the performance of new construction, which primarily utilized calibrated simulation. A discussion of the measurement of savings due to water conservation efforts was also included in the 1997 IPMVP.

In 2001 the IPMVP was published in two volumes: Volume I, which covers Options A, B, and C, which were redefined and relabeled from the 1997 IPMVP, and Volume II, which covers indoor environmental quality (IEQ), and includes five M&V approaches for IEQ, including: no IEQ M&V, M&V based on modeling, short-term measurements, long-term measurements, and a method based on occupant perceptions of IEQ. In 2003 the IPMVP released Volume III, which contains four M&V methods: Option A: partially measured Energy Conservation Measure (ECM) isolation, Option B: ECM isolation, Option C: whole-building comparisons, and Option D: whole-building calibrated simulation.

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[26] USDOE 1996. North American Energy Measurement and Verification Protocol (NEMVP), United States Department of Energy DOE/EE-0081, (March).
USDOE 1997. International Performance Measurement and Verification Protocol (IPMVP), United States Department of Energy DOE/EE-0157, (December).
USDOE 2001. International Performance Measurement and Verification Protocol (IPMVP): Volume I: Concepts and Options for Determining Energy and Water Savings, United States Department of Energy DOE/GO-102001-1187 (January).
USDOE 2001. International Performance Measurement and Verification Protocol (IPMVP): Volume II: Concepts and Practices for Improved Indoor Environmental Quality, United States Department of Energy DOE/GO-102001-1188 (January).
USDOE 2003. International Performance Measurement and Verification Protocol (IPMVP): Volume II: Concepts and Practices for Improved Indoor Environmental Quality, United States Department of Energy DOE/GO-102001-1188 (January).
[27] ASHRAE 2002.Guideline 14: Measurement of Energy and Demand Savings, American Society of Heating Refrigeration Air-conditioning Engineers, Atlanta, GA (September).

In 2002 ASHRAE released Guideline 14-2002: Measurement of Energy and Demand Savings, which is intended to serve as the technical document for the IPMVP. As the name implies, Guideline 14 contains approaches for measuring energy and demand savings from energy conservation retrofits to buildings. This includes three methods: a retrofit isolation approach, which parallels Option B of the IPMVP, a whole-building approach, which parallels Option C of the IPMVP, and a whole-building calibrated simulation approach, which parallels Option D of the 1997 and 2001 IPMVP. ASHRAE's Guideline 14 does not explicitly contain an approach that parallels Option A in the IPMVP, although several of the retrofit isolation approaches use partial measurement procedures. In the IPMVP and Guideline 14 these procedures are recommended for calculating the energy and demand savings from energy conservation retrofits in buildings where hourly, daily or monthly before-after energy use data are available. Table 11 shows the evolution of the M&V protocols as presented in the 1996 NEMVP, 1997, 2001 and 2003 IPMVP, and ASHRAE Guideline 14.

The procedures for calculating whole-building, weather-dependent or weather-independent energy use are listed in Table 12 and shown in Figure 34. To calculate savings using monthly utility billing data, 12 months of pre-retrofit utility billing data, and the coincident daily ambient temperatures are used to develop a model of the building's energy use during the baseline (or pre-retrofit period). After the retrofit, the procedure is repeated and the savings calculated by comparing the projected baseline energy use against the post-retrofit energy use using the baseline regression model.

| 1996 NEMVP | 1997 IPMVP | 2001/2003 IPMVP | 2002 ASHRAE GUIDELINE 14 |
|---|---|---|---|
| OPTION A:<br>Measured Capacity Stipulated Consumption | OPTION A:<br>End-use Retrofits:<br>Measured Capacity,<br>Stipulated Consumption | VOLUME I: OPTION A:<br>Partially Measured Retrofit Isolation | |
| OPTION B:<br>End-use Retrofits: Measured Capacity, Measured Consumption | OPTION B:<br>End-use Retrofits:<br>Measured Capacity,<br>Measured Consumption | VOLUME I: OPTION B:<br>Retrofit Isolation | RETROFIT ISOLATION APPROACH |
| OPTION C:<br>Whole-facility or Main Meter Measurement | OPTION C:<br>Whole-facility or Main Meter Measurement | VOLUME I: OPTION C:<br>Whole-building | WHOLE-BUILDING APPROACH |
| | OPTION D:<br>Calibrated Simulation | VOLUME I: OPTION D:<br>Calibrated Simulation | WHOLE-BUILDING CALIBRATED SIMULATION APPROACH |
| | | VOLUME II: IEQ M&V<br>5 Approaches | |
| | Measurement and Verification of New Buildings | VOLUME III:<br>New Construction | |
| | EXAMPLE:<br>Water Projects | | |

Table 11: Evolution of M&V Protocols in the United States.

| Name | Independent Variable(s) | Form | Examples |
|---|---|---|---|
| No Adjustment /Constant Model | None | $E = E_b$ | Non weather sensitive demand |
| Day Adjusted Model | None | $E = E_b \times \frac{day_b}{day_c}$ | Non weather sensitive use (fuel in summer, electricity in summer) |
| Two Parameter Model | Temperature | $E = C + B_1 (T)$ | |
| Three Parameter Models | Degree days/Temperature | $E = C + B_1 (DD_{BT})$<br>$E = C + B_1 (B_2 - T)^+$<br>$E = C + B_1 (T - B_2)^+$ | Seasonal weather sensitive use (fuel in winter, electricity in summer for cooling)<br>Seasonal weather sensitive demand |
| Four Parameter, Change Point Model | Temperature | $E = C + B_1 (B_3 - T)^+ - B_2 (T - B_3)^+$<br>$E = C - B_1 (B_3 - T)^+ + B_2 (T - B_3)^+$ | |
| Five Parameter Models | Degree days/Temperature | $E = C - B_1 (DD_{TH}) + B_2 (DD_{TC})$<br>$E = C + B_1 (B_3 - T)^+ + B_2 (T - B_4)^+$ | Heating and cooling supplied by same meter. |
| Multi-Variate Models | Degree days/Temperature, other independent variables | Combination form | Energy use dependent non-temperature based variables (occupancy, production, etc.). |

Table 12: Before-after or Main Meter Models for the Whole-Building Approach from ASHRAE Guideline 14-2002

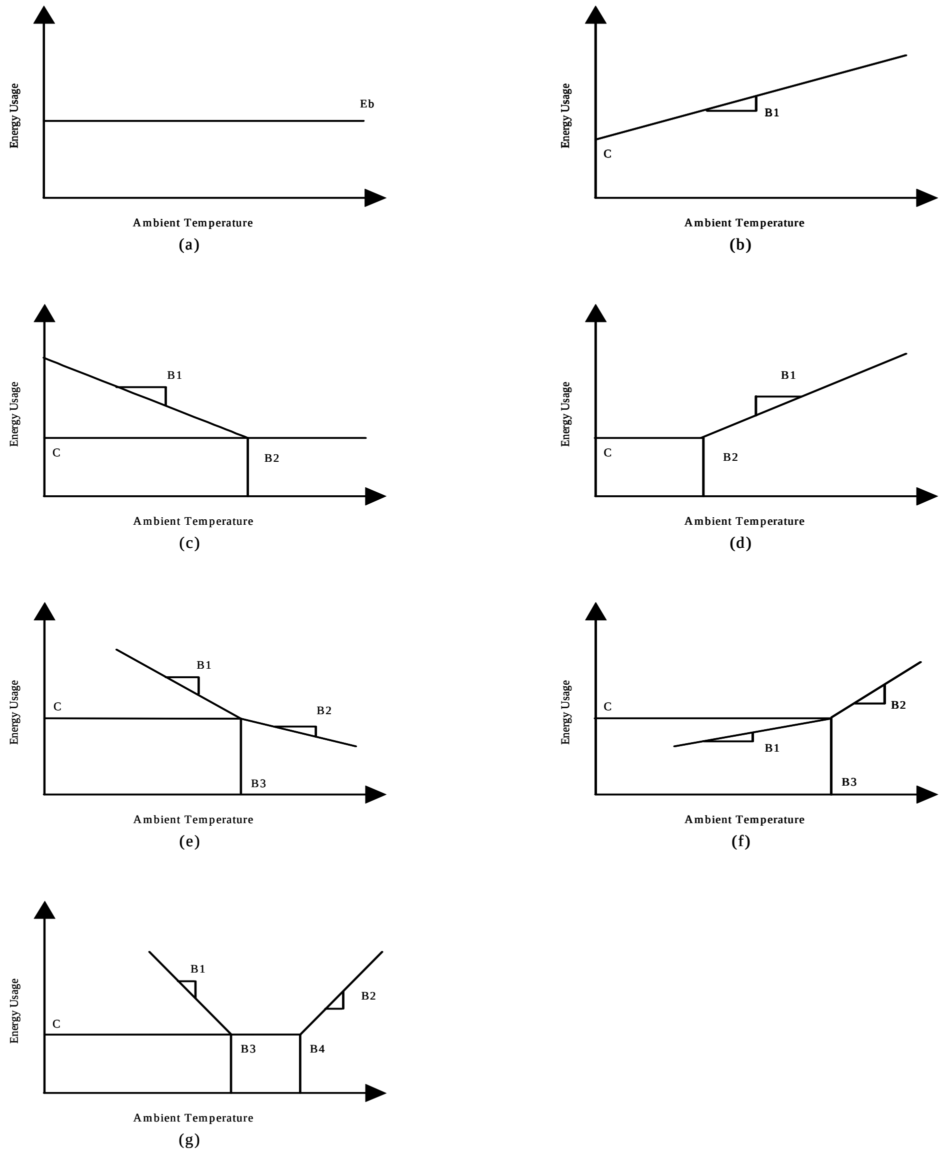


Figure 34: Sample Models for the Whole-building Approach. Included in this figure is: (a) mean or 1 parameter model, (b) 2 parameter model, (c) 3 parameter heating model (similar to a variable based degree-day model (VBDD) for heating), (d) 3 parameter cooling model (VBDD for cooling), (e) 4 parameter heating model, (f) 4 parameter cooling model, and (g) 5 parameter model.

5.1.2 The TCEQ should Develop Standardized Calculations of Emissions Reduction.

In general, most energy conservation measures that are being proposed for city, county and municipal facilities include energy savings measures that are applied to new and existing energy consuming equipment such as: water and waste water improvements, streetlights, and traffic signal lighting improvements, municipal building improvements, and renewable energy systems such as wind, solar thermal, and solar PV systems. At the request of the TCEQ the Laboratory has developed the following recommendations regarding the development of standardized calculations for reporting energy savings and the associated NOx emissions reduction.

### 5.1.2.1 The TCEQ Should Develop Standardized Calculations in Facilities With Monthly Utility Billing Data.

To develop standardized calculations in facilities with monthly utility billing data the Laboratory recommends enhancing the IPMVP/Guideline 14 procedure to calculate emissions reduction using monthly utility billing data with the following method:

1. 12 months of utility billing data are collected from a facility in the pre-retrofit or baseline period, and the coincident daily ambient temperatures.
2. A regression model is created using the linear or change-point linear models as recommended by the IPMVP and Guideline 14.
3. The coefficients of the regression model are used to calculate the peak-day energy use in the pre-retrofit and post-retrofit period, using the appropriate weather data[28].
4. Emissions reduction are calculated using one of the two methods:
    - If the energy savings are natural gas use, the appropriate pre-retrofit and post-retrofit emissions factors are applied for the combustion process to determine the emissions reduction for the county in which the retrofit occurred.
    - If the energy use is electricity use, a utility provider is assigned (if this is not already known), and the emissions factor calculated with the EPA's eGRID database, which determines the reduction in the county in which the power was produced by the utility provider that supplied the electricity[29].
5. This procedure is repeated annually to assure that the savings continue to occur from the installed retrofit.

These procedures would be appropriate for cost-effective applications to:

- water and waste water improvements, and
- energy conservation retrofits to municipal buildings.

### 5.1.2.2 The TCEQ Should Develop Standardized Calculations for Street Lighting and Traffic Signal Lighting Improvements.

The Laboratory recommends extending the IPMVP/Guideline 14 procedure to calculate emissions reduction from street lighting and traffic signal lighting improvements using the following method(s):

#### 5.1.2.2.1 Street Lighting Retrofits.

1. Measure the wattage of the pre-retrofit lamp[30].
2. Measure the wattage of the post-retrofit lamp[31].
3. Calculate the peak-day savings by multiplying the difference in the lamp wattage times the monthly-average hours per day from sunset to sunrise for the latitude and month in which the peak-day occurs[32].
4. Multiply the peak-day savings times the number of lamps that are being retrofitted.
5. Assign a utility provider (if this is not already known), and the emissions factor calculated with the EPA's eGRID database, which determines the reduction in the county in which the power was produced by the utility provider that supplied the electricity.

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[28] This weather data can be from TMY2 weather files, or from the appropriate Ozone Episode Day for the area of interest.

[29] This procedure has been tested using the Laboratory's IECC code traceable simulation using data from a residence in Harris county for an IECC-code-compliant house, and a house with NAHB 1999 characteristics. The results showed the modified monthly utility billing analysis produced peak-day kWh reductions that are within a few percent of the actual peak day reductions.

[30] This can be obtained from field measurements from NIST-traceable manufacturer data.

[31] This assumes the post-retrofit lamp produces a similar lumen output as the pre-retrofit lamp and that the intended illumination levels satisfy with the requirements of the IESNA.

[32] This assumes that the lamp is controlled by photocell that is properly adjusted. If the lamp is controlled by a time clock then the hours per day of illumination from the time clock should be substituted for the sunset to sunrise hours.

6. Each year, verify that the lamps that are still in service or have been replaced by lamps with wattage and lumen output similar to the original post-retrofit lamps.

These procedures would be appropriate for cost-effective applications to:

- Municipal street lighting retrofits.

5.1.2.2.2 Traffic Signal Lighting Retrofits.

1. Measure the wattage of the pre-retrofit lamp[33].
2. Measure the wattage of the post-retrofit lamp.
3. Calculate the peak-day savings by multiplying the difference in the lamp wattage times the burn time per day for the lamp[34].
4. Multiply the peak-day savings times the number of lamps that are being retrofitted.
5. Assign a utility provider (if this is not already known), and the emissions factor calculated with the EPA's eGRID database, which determines the reduction in the county in which the power was produced by the utility provider that supplied the electricity.
6. Each year, verify that the lamps that are still in service or have been replaced by lamps with wattage and lumen output similar to the original post-retrofit lamps.

These procedures would be appropriate for cost-effective applications to:

- Traffic Signal Lighting Retrofits.

5.1.2.3 The TCEQ Should Develop Standardized Calculations for Solar Thermal Installations.

To develop standardized calculations in facilities with solar thermal installations the Laboratory recommends extending the IPMVP procedures to calculate emissions reduction from solar thermal retrofits with the following method:

1. Determine the system type and solar panel characteristics.
2. Determine the panel orientation (i.e., off-south azimuth and tilt).
3. Use the FCHART[35] program to calculate the peak day thermal production from the solar thermal system.
4. Verify the thermal savings using a utility billing analysis as described above.
5. Emissions reduction are calculated using one of the two methods:
   - If the energy savings are natural gas use, the appropriate pre-retrofit and post-retrofit emissions factors are applied for the combustion process to determine the emissions reduction for the county in which the retrofit occurred.
   - If the energy use is electricity use, a utility provider is assigned (if this is not already known), and the emissions factor calculated with the EPA's eGRID database, which determines the reduction in the county in which the power was produced by the utility provider that supplied the electricity[36].
6. Each year verify the thermal savings using a utility billing analysis as described above.

These procedures would be appropriate for cost-effective applications to:

- Solar thermal installations.

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[33] This can be obtained from field measurements from NIST-traceable manufacturer data.

[34] The burn time per day per lamp depends on the type of traffic light being retrofitted and the type of control utilized on the traffic signal system.

[35] The FCHART program was developed by the Solar Energy Laboratory at the University of Wisconsin for the U.S.D.O.E., which is widely used for designing solar thermal systems.

[36] This procedure has been tested using the Laboratory's IECC code traceable simulation using data from a residence in Harris county for an IECC-code-compliant house, and a house with NAHB 1999 characteristics. The results showed the modified monthly utility billing analysis produced peak-day kWh reductions that are within a few percent of the actual peak day reductions.

#### 5.1.2.4 The TCEQ Should Develop Standardized Calculations for Solar PV Installations.

To develop standardized calculations in facilities with solar PV installations the Laboratory recommends extending the IPMVP procedures to calculate emissions reduction from solar PV retrofits with the following method:

1. For smaller systems:
    a. Determine the system type and solar panel characteristics.
    b. Determine the panel orientation (i.e., off-south azimuth and tilt).
    c. Use the PVFCHART[37] program to calculate the peak day electricity production from the solar thermal system.
    d. Verify the thermal savings using a utility billing analysis as described above.
2. For larger systems install a Watt-hour meter on the system interface to the utility grid and record the monthly electricity production. Calculate the peak day electric production using the monthly average daily production for the peak month.
3. Assign a utility provider (if this is not already known), and the emissions factor calculated with the EPA's eGRID database, which determines the reduction in the county in which the power was produced by the utility provider that supplied the electricity.
4. Each year verify the thermal savings using a utility billing analysis as described above.

These procedures would be appropriate for cost-effective applications to:

- Solar PV installations.

#### 5.1.2.5 The TCEQ Should Develop Standardized Calculations for Wind Energy Installations.

To develop standardized calculations in facilities with wind energy installations the Laboratory recommends the following method:

1. Install a Watt-hour meter on the wind mill and determine the monthly electricity production.
2. Assign a utility provider (if this is not already known), and the emissions factor calculated with the EPA's eGRID database, which determines the reduction in the county in which the power was produced by the utility provider that supplied the electricity.
3. Each year verify the thermal savings using a utility billing analysis as described above.

These procedures would be appropriate for cost-effective applications to:

- Wind Power Installations.

### 5.1.3 The TCEQ Should Develop Standardized Calculations of Emissions Reduction From PUC's SB5 and SB7 Programs

Currently, the Texas Public Utilities Commission uses published Deemed Savings Values for Residential Sector Energy Efficiency Measures to calculate and report energy savings from energy conservation measures applied to utility customers who participate in the appropriate programs. These measures include:

1. (Information listed in PUC's Appendix A: Frontier Associates Project No. 22241). Ceiling insulation; wall insulation; Air Infiltration; Energy Star Windows, Refrigerators, Dishwashers, Clothes Washers; Compact Fluorescent Lamps, Low-flow Shower Heads, Faucet Aerators, Water Heater Jackets, Water Heater Pipe Insulation.

[37] The PVFCHART program was developed by the Solar Energy Laboratory at the University of Wisconsin for the U.S.D.O.E., which is widely used for designing solar electric systems

2. (Information listed in PUC's Appendix B: Schiller Associates). Lighting Efficiency Measures, Lighting Controls Measures, Replacement and Package DX units, Cooling Equipment Retrofits, Constant Load Motor Efficiency Retrofits, Constant Baseline VSD Retrofits.

These deemed savings tables report savings as savings for each participating utility as kWh/year, and peak kW, which are converted to tons/NOx reductions per year using the EPA's eGRID emissions factors for the utility provider.

The Laboratory recommends extending the PUC's deemed savings using the following method:

1. First, the PUC will need to recalculate the deemed savings tables so that they include peak-day savings (i.e., kWh/day), as well as the already reported kWh/year and peak kW savings. It is recommended that the PUC use the ESL's code-traceable DOE-2 input file, where appropriate, to accomplish this recalculation to assure consistent savings calculations.

2. The PUC then needs to aggregate the electricity savings, which are reported by the participating utilities into countywide peak-day savings.

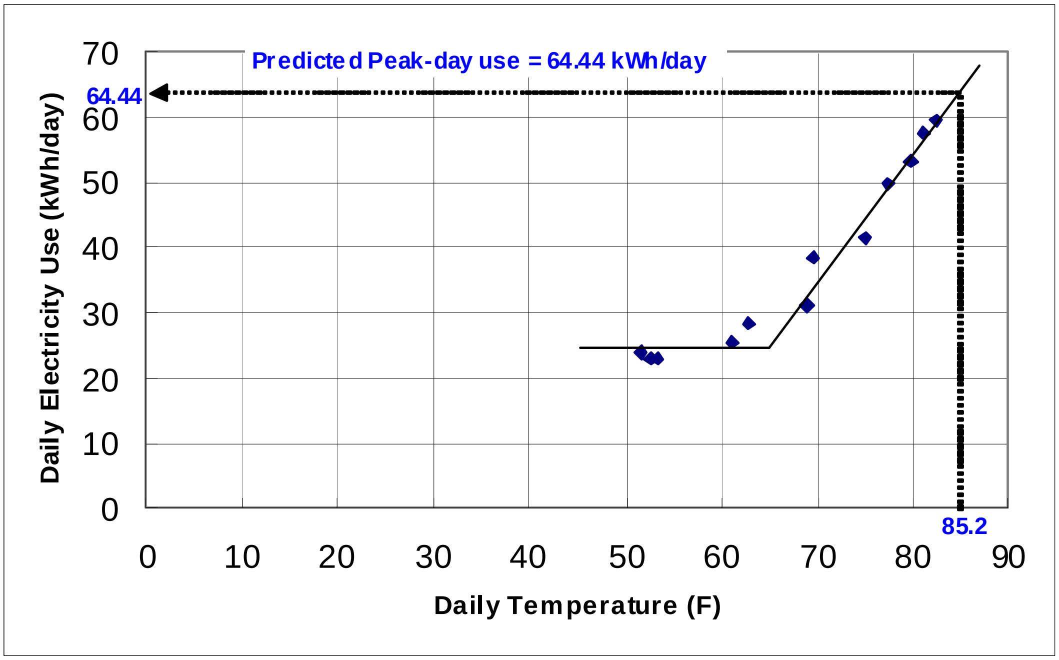
3. Emissions reduction are calculated using one of the two methods:
    - If the energy savings are natural gas use, the appropriate pre-retrofit and post-retrofit emissions factors are applied for the combustion process to determine the emissions reduction for the county in which the retrofit occurred.
    - If the energy use is electricity use, a utility provider is assigned (if this is not already known), and the emissions factor calculated with the EPA's eGRID database, which determines the reduction in the county in which the power was produced by the utility provider that supplied the electricity.
    - Each year verify that the measures are still installed.

5.1.4 Example Calculation of Peak Day Electricity Savings Calculated From Monthly Utility Billing Data.

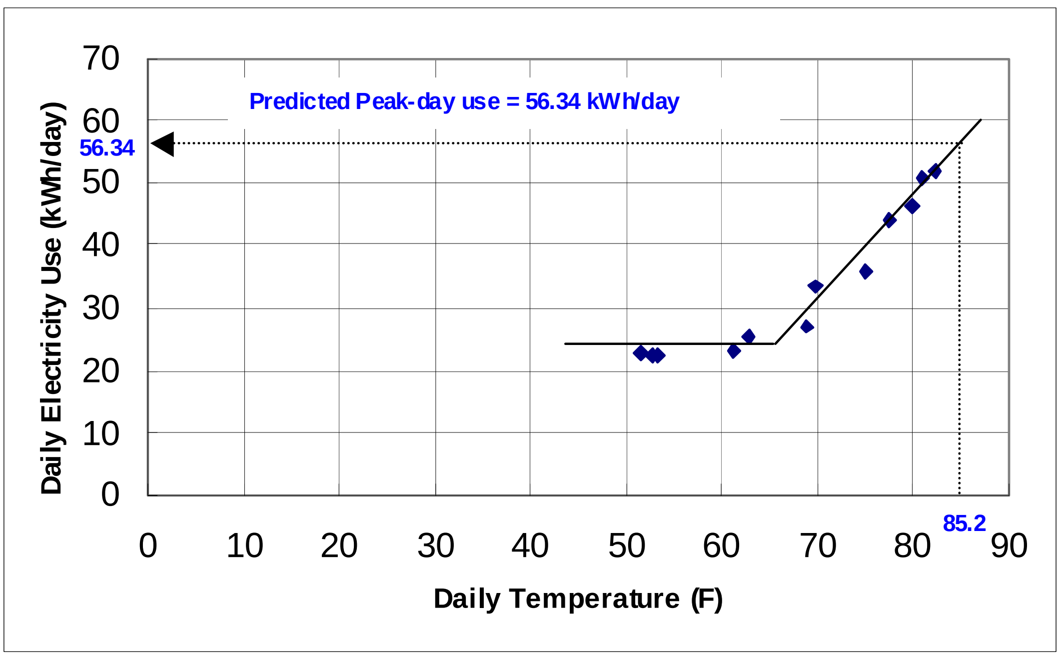
At the Request of the TCEQ the Laboratory has developed a method for calculating peak-day electricity savings from monthly utility billing data for residential, commercial or industrial utility customers, which can then be used to calculate peak-day NOx emissions reductions using the EPA's eGRID program. This method uses linear and change-point linear regression models as recommended in ASHRAE's Guideline 14, which was previously described in Section 5.1.1 above Such models can also be used to calculate peak-day NOx reductions from energy conserving measures applied to building equipment that is consuming natural gas such as furnaces, boilers, and domestic water heaters.

An example of the use of this method for calculating peak-day electricity savings from the 2000 IECC code is demonstrated using two simulated single-family residences is provided in Figure 35 and Table 13 where monthly electricity use (kWh/average-day) is shown plotted against the average billing-period temperature (degrees F). The upper figure in Figure 35 shows the simulated monthly energy use for a single-family residence in Houston, Texas that was built according to the National Association of Home Builder's 1999 survey of common building practices. The lower figure in Figure 35 shows the same house simulated with 2000 IECC code-compliant characteristics[38]. In each of the plots a three-parameter change-point linear regression model is shown super-imposed upon the simulated monthly electricity consumption. The coefficients for these models are shown directly below each plot. The calculated peak-day electricity use is indicated by the dashed line that corresponds to the predicted electricity use during a 85.2 F peak-day temperature that occurred for the Houston weather conditions used in this analysis.

[38] Table 25 contains the simulated characteristics for the 1999 NAHB average house and the 2000 IECC code-compliant house, which were simulated with the TMY-2 weather file for Houston, Texas. Table 26 contains the annual and peak-day savings for the simulations for all 38 non-attainment and affected counties.




1999 Standard House: Daily Elec.Use = 24.7609 + 1.9200 x (85.2 - 64.5360)+ = 64.44




IECC House: Daily Elec.Use = 24.1879 + 1.7063 x (85.2 - 65.7680)+ = 56.34

Figure 35: Estimation of Peak-day Electricity Use From Monthly Utility Billing Data Using ASHRAE's IMT.

Table 13 gives a comparison of the results of the peak-day electricity use for the DOE-2 hourly results versus the peak-day predicted by the monthly regression model. According to the simulation, the peak day on the TMY-2 Houston weather file was July 29th, which had an average temperature of 85.2 F. On this day the DOE-2 simulation calculated an electricity use of 65.74 kWh/day for the 1999 standard house, which was well matched by the monthly regression model that predicted 64.44 kWh/day (1.98% difference). In a similar fashion, the DOE-2 simulation calculated an electricity use of 56.78 kWh/day for the IECC-compliant house, which was also well matched by the monthly regression model that predicted 56.34 kWh/day (0.76% difference). The electricity savings predicted by the hourly DOE-2 simulation was 8.96 kWh/day, which was also well matched by the monthly regression that predicted 8.10 kWh/day (9.5% difference).

| | Peak Day (DOE-2 LS-A Report) | Daily Temperature for the Peak Day (F) | Daily Electricity Use for the Peak Day (kWh/day) (DOE-2 Hourly data) | Daily Electricity Use for the Peak Day (kWh/day) (IMT 3PC Model) | Difference (DOE-2 Hourly vs. IMT Monthly) |
|---|---|---|---|---|---|
| 1999 Standard House | Jul 29 | 85.2 | 65.74 | 64.44 | 1.98% |
| IECC House | Jul 29 | 85.2 | 56.78 | 56.34 | 0.76% |
| Peak-day Savings | | | 8.96 | 8.10 | 9.5% |

Table 13: Comparison of Peak-day Electricity Savings From IECC for Simulated vs. Estimation Using Monthly Utility Billing Data Analyzed With ASHRAE's IMT.

## 5.2 Recommendations for Additional NOx Reductions

### 5.2.1 The TCEQ Should Further Evaluate Reducing NOx Emissions by Implementing a Texas Tune-up for Building HVAC Systems

The Texas Emissions Reduction Plan established by the 77th Legislature in 2001 through the enactment of Senate Bill 5, does not contain requirements for reduction of energy use in existing buildings and industrial consumers, other than the general requirements for all political subdivisions to reduce their consumption by 5% annually through 2007. It is therefore recommended that the TCEQ should evaluate the potential for additional NOx emissions reduction from existing buildings, including Federal facilities, and industrial facilities to help achieve the EPA-mandated 2007 emissions levels in the non-attainment and affected counties.

For example, it is estimated that commercial building space accounts for over 2.1 billion Sq. Ft. in Texas. If all buildings over 50,000 sq. ft. of air-conditioned space could be motivated to be tuned-up [commissioned] in non-attainment areas significant energy reduction potential exists in range of 10 – 40%. Texas A&M's Energy Systems Laboratory has proven building energy use can be easily reduced by 10 to 40 percent by the systematic testing and optimization of building mechanical & thermal systems, controls and HVAC equipment known as Continuous Commissioning® or Building Tune-ups at a cost of $ 0.20 – 0.50/sq.ft. Added benefits are improved building comfort and employee productivity. If 30 million square feet could be conditioned in 2003, which could grow to 570 million square feet conditioned by 2012, then 1.3 to 3.2 million MWh of electricity could be saved. This would amount to 161 to 285 tons NOx saved per year or 0.9 to 1.6 tons NOx saved per peak day[39].

| | 2007 - 2010 | Tons NOx Saved/yr * | Tons NOx Saved Peak Day | $/ton/10 yr |
|---|---|---|---|---|
| MWh Elec. Saved (10%) | 1.3 – 3.2 mil. | 161- 285 | 0.9 – 1.6 | Negative |

* 38 counties

[39] Additional information regarding this calculation can be found in the appendix.

Tune-ups generally have a two-year payback with positive cash flow on day one. The cost in non- and near non-attainment areas would be borne by building owners using zero percent loans provided by ESCO's, banks, and state revolving fund for Senate Bill 5 energy conservation efforts. Interest subsidies would be funded through a line charge.

# 6 TECHNOLOGY OF REPORTING & VERIFYING EMISSIONS REDUCTIONS FROM ENERGY USED IN NEW BUILDINGS

Senate Bill 5 allows the TCEQ to obtain emissions reduction credits for reductions in electricity use and electric demand that are attributable to the adoption of the International Energy Conservation Code (IECC 2000) in non-attainment and affected counties. In order for the TCEQ to accomplish this, county-wide reductions in electricity use are calculated by the Laboratory each year and the corresponding NOx reductions reported to the TCEQ in a suitable format for obtaining the appropriate credit from the EPA. Ultimately, the format and procedures for calculating emission savings must be approved by the EPA. In this section the calculation procedures developed in 2002 and enhanced in 2003 are discussed in regards to the estimation of the emissions reduction from buildings.

## 6.1 Procedures for Calculating Electricity Reductions

### 6.1.1 Residential Buildings

The methodology to accomplish the calculation of electricity savings from the implementation of the 2000 IECC to residential housing is presented in Figure 40 - Figure 48. These methodologies are composed of procedures that calculate and verify savings using several different sources of information. These procedures include:

1. The calculation of electricity savings and peak-day demand reductions from the implementation of the 2000 IECC as amended by the 2001 Supplement (Figure 36 and Figure 37) in new residences and the 2000 IECC and ASHRAE 90.1-1999 in commercial buildings, and ASHRAE 90.1-2001 in Texas State Agencies (Figure 38 and Figure 39) in non-attainment and affected counties as compared against 1999 housing characteristics, and the appropriate commercial building characteristics using calibrated simulation.

2. A cross-check of electricity savings using a utility bill analysis method.

3. A cross-check of construction data using on-site visits.

#### 6.1.1.1 Residential: New Construction

Calculation of the Potential for Emissions Reduction. The primary procedure for calculating the emissions reduction from the adoption of the 2000 IECC in new residences is shown in Figure 40 and Figure 41. Figure 40 is a flowchart of the overall procedure. For each county, 1999 and 2003 residential housing characteristics were ascertained according to the procedures in Figure 40 and Figure 41. Using code-traceable simulation, these characteristics are entered into the prototypical DOE-2 model to calculate the annual energy use of two average-sized residences, one representing the house with the average 1999 characteristics, and one representing the appropriate characteristics from the 2000 IECC as modified by the 2001 Supplement. The annual electricity use of the 2000 IECC simulation is then subtracted from the annual electricity use of the similarly-sized 1999 residence to obtain the annual electricity savings, and peak electric demand savings. Natural gas savings associated with space heating and the heating of domestic hot water are also calculated for informative purposes. The electricity savings attributable to the 2000 IECC energy conservation options for the average house are then multiplied by the number of new house permits in each county to obtain the county-wide electricity savings. These electricity savings are then converted to $NO_x$ reductions using the EPA's eGRID database. Total annual $NO_x$ reductions associated with the implementation of the 2000 IECC are then be calculated simultaneously for all non-attainment and affected counties.

In Figure 41 the detailed flowchart is shown for calculating the 2003 annual energy use of new residential construction for houses with and without the energy conserving features contained in the 2000 IECC, Chapters 4, 5 and 6. This is accomplished with two separate calculations: a) one path that represents the standard house defined in the IECC / IRC Chapter 4 and 5, that uses average housing characteristics for houses built in 1999 (left side of figure); and b) a second path that represents the standard house defined by the 2000 IECC that includes the energy conserving features[40] defined in Chapter 4, 5 and 6 (right side of figure).

6.1.1.1.1 Calculating baseline energy use of new construction.

The procedure for calculating the 2003 baseline residential energy consumption (left side of Figure 41) begins with the definitions of the standard house found in Chapter 4 of the IECC / IRC. These definitions are used to create a standard input file for the DOE-2 simulation program (LBNL 2000). This standard input file is then adjusted to reflect the average 1999 construction characteristics for each county[41] for type A-1 (single-family) and type A-2 (all others) housing. The annual electricity and natural gas consumption for the average house[42] is then simulated using the DOE-2 program and the appropriate weather data[43] for each location. The annual, countywide, baseline energy consumption for new houses built in 2003 with characteristics that reflect the IECC / IRC and 1999 published data is calculated by multiplying the annual simulated energy use for an average house times the projected A-1 and A-2 county-wide housing permits for 2003. The projected A-1 and A-2 housing permits for each county are projected using the previous year's housing permits as shown in Figure 41. This baseline represents the expected annual energy use of all new construction in each county had those houses been constructed with the IECC / IRC Chapter 4 and 5 "standard house" and average 1999 characteristics.

6.1.1.1.2 Calculating code-compliant energy use of new construction.

The procedure for calculating the code-compliant 2003 residential energy consumption (right side of Figure 41) also begins with the definitions of the standard house found in Chapter 4 and 5 of the IECC / IRC. This code-compliant input file reflects the average 1999 house size[44] for each county and IECC / IRC Chapter 5 or 6 construction characteristics[45] for type A-1 (single-family) and type A-2 (all others) housing. The annual electricity and natural gas consumption for a code-compliant house is then simulated using the DOE-2 program and the appropriate weather data for each location. The annual, countywide, code-compliant energy consumption for new houses built in 2003 with code-compliant characteristics is calculated by multiplying the annual simulated energy use for a code-complaint house times the projected A-1 and A-2 housing permits for 2003. This code-compliant use represents the expected annual energy use of all new code-complaint construction in each county. The total electricity savings, which can be attributed to the adoption of the IECC / IRC, are then calculated by comparing the difference in annual energy use of the baseline housing versus the code-compliant housing as shown in Figure 40.

Figure 42 shows the basic calculation procedures used by the DOE-2 program to calculate the energy use of a building. The DOE-2 program is a FORTRAN 90 computer program, which was developed by the Lawrence Berkeley National Laboratory for the United States Department of Energy. DOE-2 contains four sub-programs, including LOADS, SYSTEMS, PLANT and ECONOMICS that calculate the building energy using beginning with the thermal loads on the building envelope (LOADS), followed by a simulation of the secondary HVAC system (SYSTEM), primary HVAC systems (PLANT), and economic calculations that are capable of accurately reproducing time-of-day and time-of-year utility charges. DOE-2

[40] The energy conserving features in the 2000 IECC are the same as those contained in Chapter 11 of the 2000 IRC, as modified by the 2001 Supplement (IECC 2001), which is required by Senate Bill 5.
[41] The average 1999 construction characteristics represent the published data by the NAHB (2002), which has been cross-checked with data from F.W. Dodge (2002), RECS (1999) and LBNL (1995).
[42] The average house size for each county is determined from the NAHB data. For .east Texas the average size house is 2,548 square feet, for west Texas the average sized house is 2,426 square feet.
[43] The appropriate weather data for each county is the nearest TMY2 weather file that most accurately represents the 2000 IECC climate zone as shown in Figure 2.
[44] This uses the same average house size for each county as determined from published NAHB data.
[45] These characteristics include insulation levels, glazing type, etc., as defined in Chapter 6 of the 2001 IECC or Chapter 11 of the 2001 IRC.

uses hourly, or design day weather data, libraries of building material characteristics, and a user input file that represents the building being simulated, which are processed and controlled by the BDL processor.

In 2003, one of the enhancements to the 2002 code-traceable simulation was an improved window preprocessing program that more accurately simulates residential windows. To accomplish this a realistic window, including the windows glass panes and window frame are entered and converted into a equivalent window for simplifying the simulation as shown in Figure 43. This is accomplished with the multi-step procedure shown in Figure 44, which takes the house characteristics, glazing properties, and window-to-wall area, and determines the appropriate DOE-2 fenestration parameters using the National Fenestration Rating Council's 100 and 200 procedures. A second enhancement is shown in Figure 45, which shows the new procedures that were developed to calculate the annual energy use and peak-day electricity use for the pre-code (i.e., 1999) and code-compliant house.

6.1.1.1.3 Reconciliation of the Total Savings.

Several procedures have been developed and tested to reconcile the savings calculations, including[46]:

a) a cross-check of energy savings using a utility bill analysis method as shown in Figure 46, and
b) a cross-check of construction data using on-site visits as shown in Figure 47.

Cross-check of energy savings using utility bill analysis.

In 2003 a procedure for reconciling the energy savings attributable to the adoption of the IECC / IRC against monthly utility billing data from representative houses using the ASHRAE Inverse Modeling Toolkit (Kissock et al. 2001) was developed and tested. This procedure is based in part on the linear and change-point linear regression models developed as part of the Texas LoanSTAR program (Turner et al. 2000), as well as the well-known Princeton Scorekeeping Method (PRISM) (Fels 1986; Fels et al. 1995) as shown in Figure 46. In general, this method is based on the premise that the difference between a statistically representative sample of 1999 and 2002 utility bills [47] should decrease by an amount that is similar to the calculated savings from the IECC / IRC adoption for similar sized houses, with equal numbers of occupants, in similar neighborhoods.

In Figure 46 the procedure for accomplishing this is displayed. The procedure has two parallel paths, one for the 1999 housing stock (left side of Figure 46) and one for the 2002 housing stock (right side of Figure 46). For the housing cross-check with utility billing data, the procedure begins by selecting a 1999 house and a code-compliant house that have similar characteristics to the construction characteristics that were used for the primary calculation shown in Figure 40 and Figure 41. For each house 12 months of utility billing data are obtained and analyzed with the ASHRAE IMT. The resultant, valid parameters from IMT [48] are then normalized by conditioned area to obtain a weather-normalized, averaged energy use per square foot. After the appropriate number of houses have been analyzed that represent a statistically significant sample of houses constructed in 1999 for each county (or for the code-compliant house), the Normalized Annual Consumption (i.e., $NAC_{1999}$ expressed as kWh/yr-ft$^2$) is compared against the similar parameter for houses constructed in 2003 (i.e., $NAC_{2000\ IECC}$ expressed as kWh/yr- ft$^2$) to obtain the average electricity savings per square foot of conditioned area. This difference is then multiplied by the number of houses constructed in a given year (i.e., 2001, 2002, 2003, etc.) and the average conditioned area of the houses constructed in 2002 to obtain the total annual electricity savings per county. This total, county-wide, annual electricity savings calculated by utility bill analysis can then be compared to the total, county-wide, annual electricity savings calculated by simulation (i.e., Figure 40 and Figure 41). For each county, savings from the difference in 1999 versus 2002 utility bills are expected to be similar to savings calculated by

[46] Additional, detailed information about these procedures can be found in (Im 2003) "A Methodology to Evaluate Energy Savings and NOx Emissions Reductions From the Adoption of the 2000 IECC to New Residences in Non-attainment and Affected Counties in Texas", Master's Thesis, Department of Architecture, Texas A&M University, (December).

[47] As determined by a statistically significant survey sample for each county.

[48] The primary parameter of interest from the IMT analysis is the Normalized Annual Consumption (NAC). The goodness of fit indicators used to determine a valid IMT run include the CV(NAC), and the adjusted R^2.

simulation for similar houses, with similar household characteristics[49]. In 2003 this method was tested with several representative houses with acceptable results. Additional information can be found in Im (2003).

Cross-check of construction data using on-site visits.

A reconciliation will also be carried out to cross-check selected parameters for both the 1999 and IECC / IRC housing characteristics for each county as shown in Figure 47. For the 1999 housing stock, on-site surveys of a statistically significant sample will be used to cross-check the average building characteristics[50] used to simulate the average house in each county. Adjustments can then be made to the average 1999 characteristics should significant differences be found.

As shown in the right side of Figure 47, a similar procedure will be carried out for newly constructed houses to determine if the on-site housing characteristics meet, or exceed the IECC / IRC. Differences found in the IECC / IRC characteristics will be noted as to whether or not these differences represent characteristics that are less stringent or more stringent than code. Characteristics that are less stringent than code will be communicated with code officials to determine how enforcement procedures to the code need to be modified to better assure code compliance. Characteristics that are more stringent than code will be credited to the countywide energy savings as above code savings[51].

#### 6.1.1.2 Residential: Existing Construction

Existing residential buildings that undergo a significant remodeling are also addressed by the IECC / IRC. To account for the energy savings from these activities, procedures would be similar to those for new construction that track remodeling permits, including how the buildings are complying with the IECC / IRC. Different procedures may need to be developed for tracking existing building IECC / IRC activities. For example, it may be more efficient to track the activity by the type of retrofit, including: envelope, HVAC system, etc. Once a tracking procedure has been developed, then a suitable accounting scheme can be developed and implemented to include these savings in with the savings from new construction activities.

[49] If necessary, a similar procedure can be used to cross-check heating savings with either a 4 or 5 parameter change-point model using monthly electricity utility bills, or a model applied to monthly natural gas utility bills.
[50] As previously mentioned the 1999 average building characteristics represent the average characteristics published by NAHB, and compared against F.W. Dodge and LBNL.
[51] Such savings are also referred to as “green” construction.

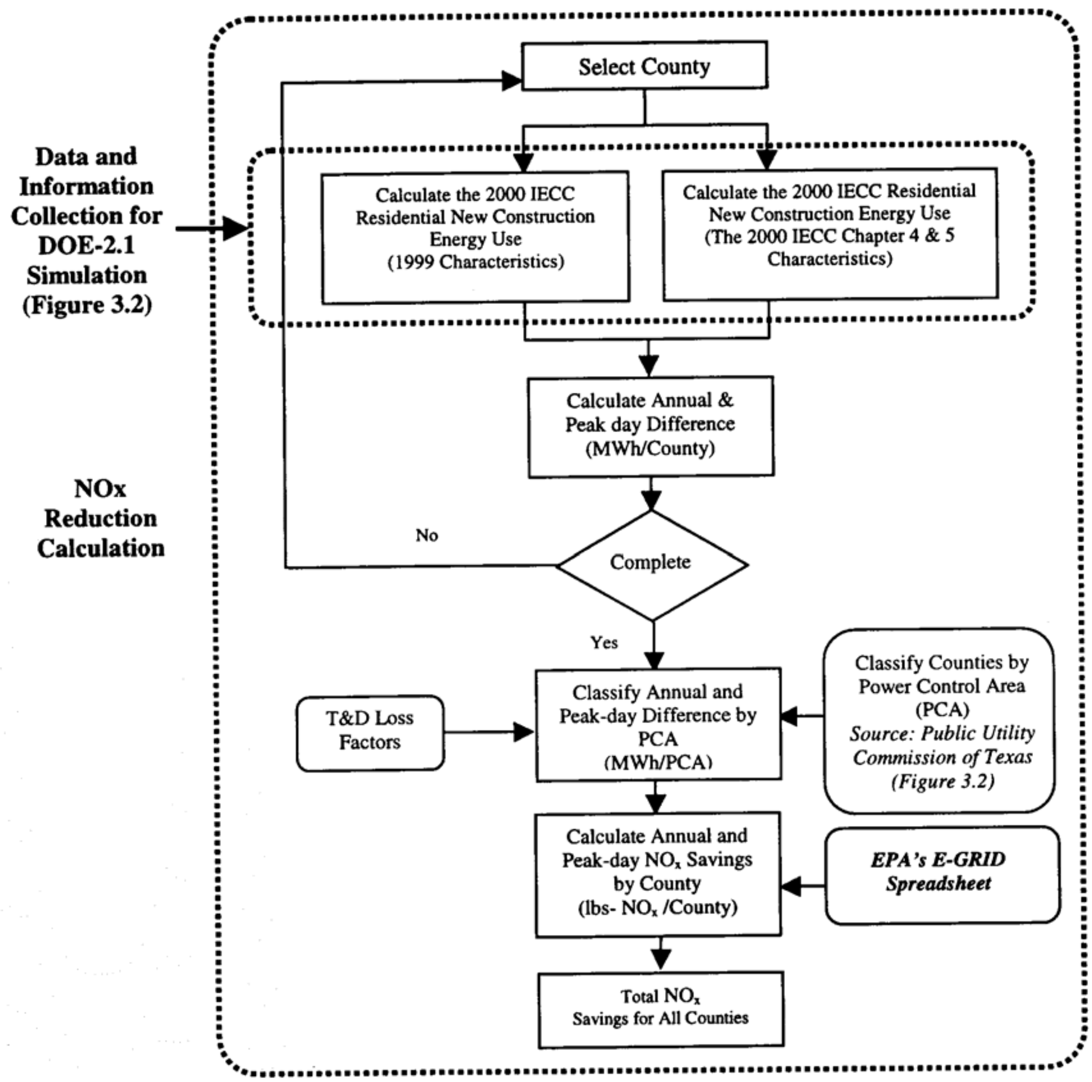



Figure 40: Overall flowchart for calculation of emission reduction from implementation of the IECC / IRC in residential construction in non-attainment and affected counties (Im 2003) [52].

[52] Im 2003. op. cit.

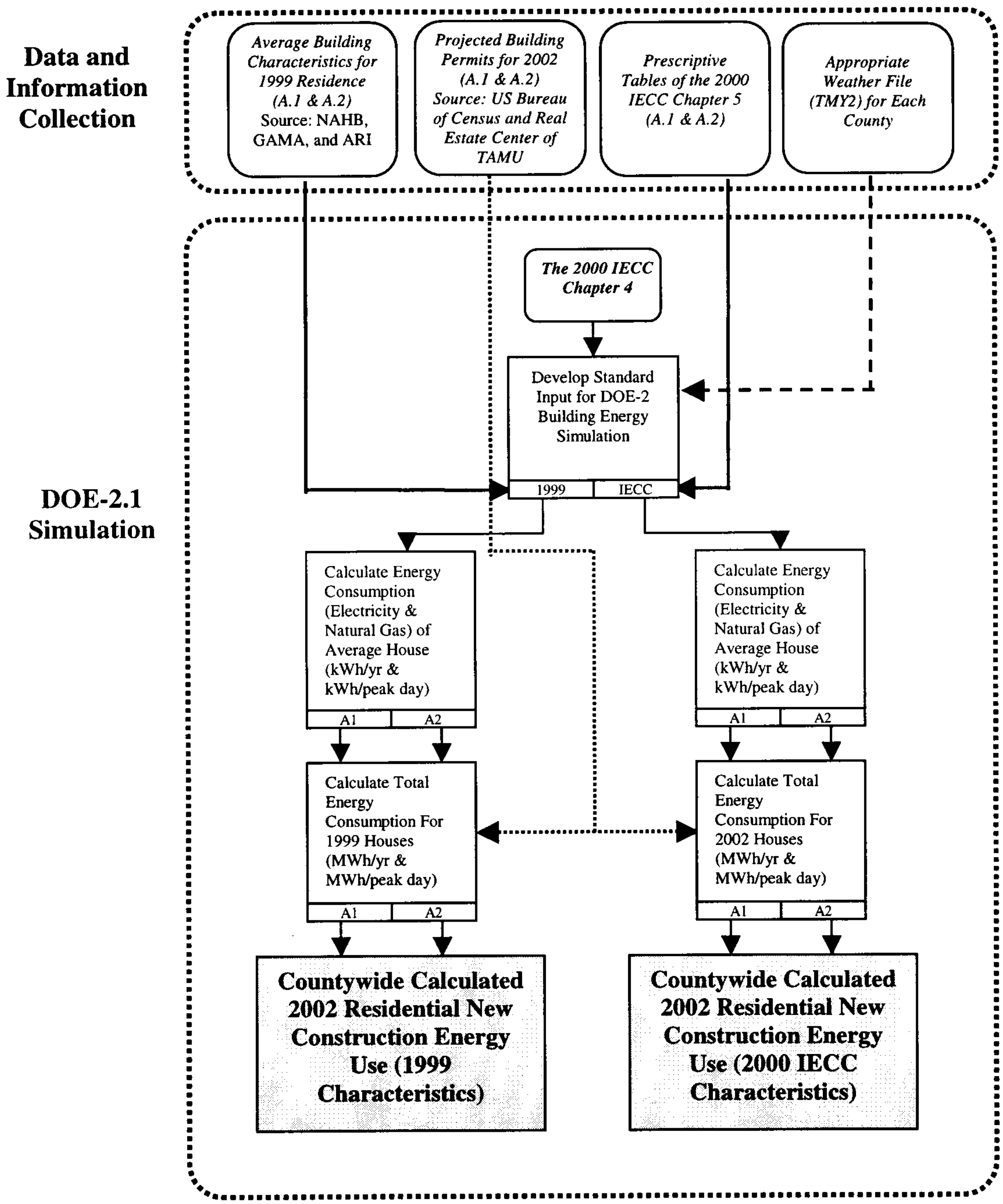



Figure 41: Procedures for Preparation and Calculation of Countywide Energy Use for New Single Family Houses Before and After Code Adoption (Im 2003).

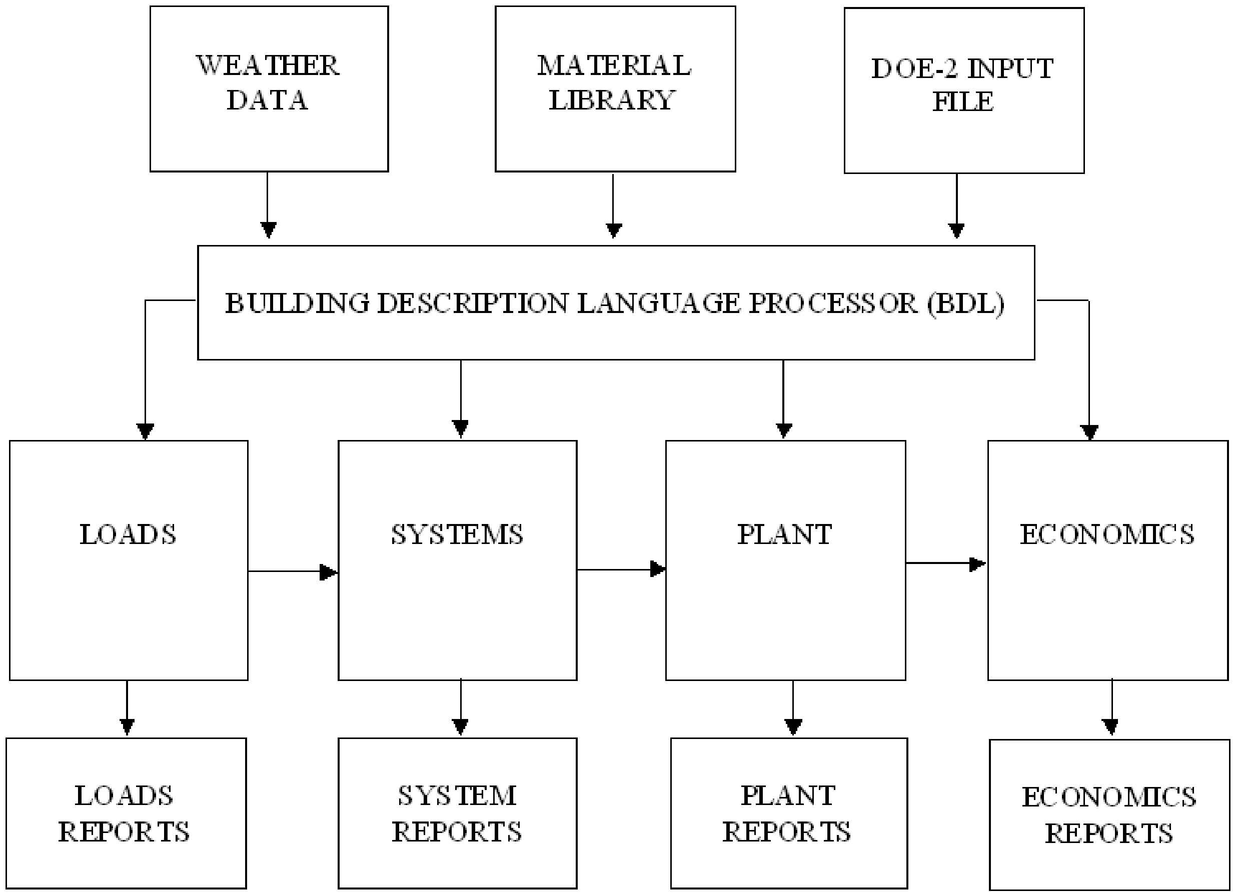



Figure 42: DOE-2 Subprograms and Data Input Requirements.

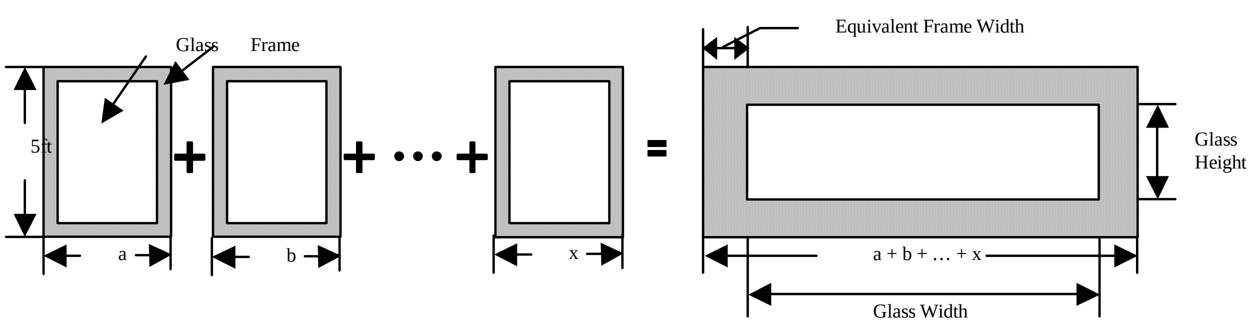



Figure 43: Calculation of the Equivalent Frame Width and Glass Width (Im 2003).

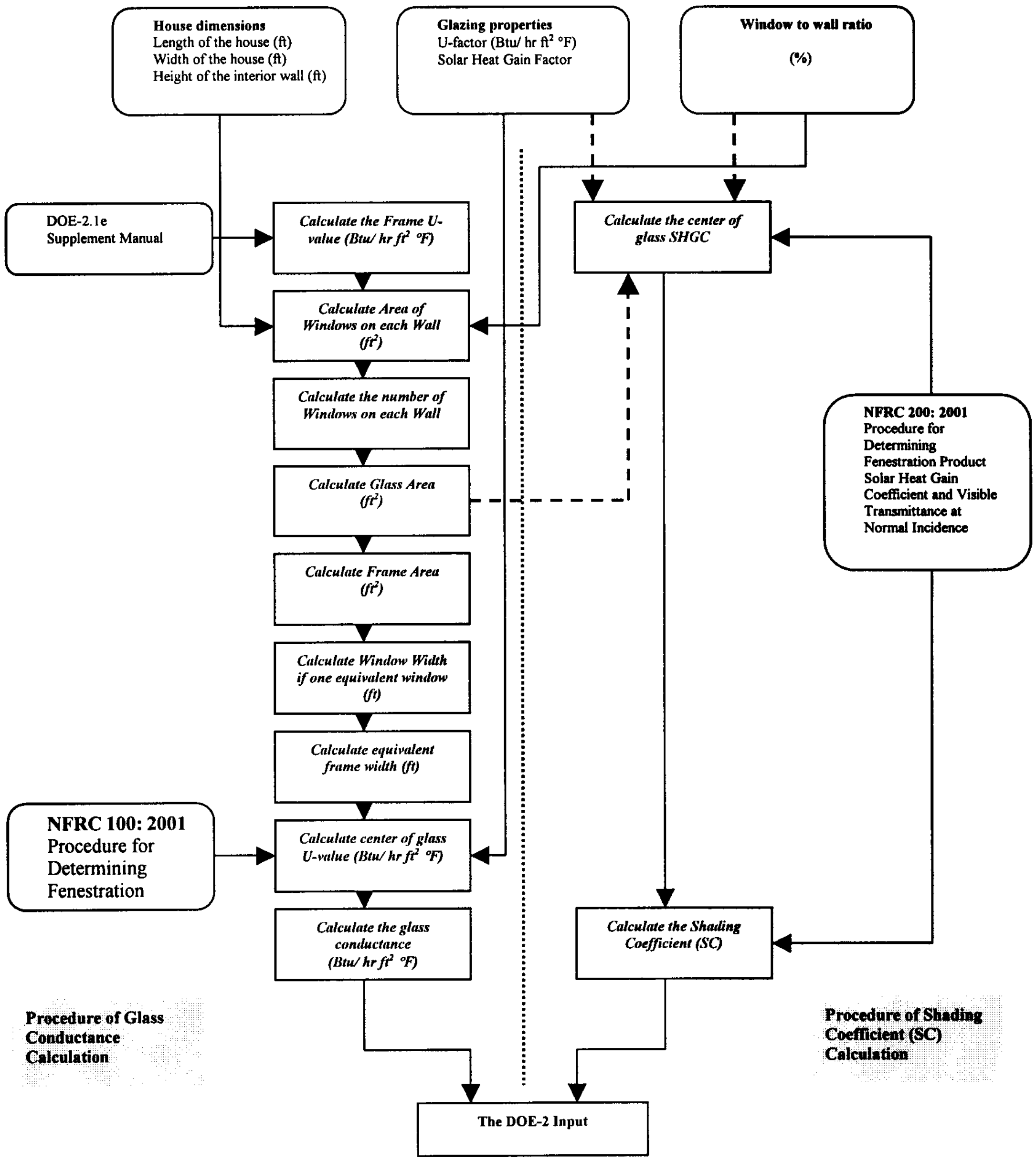



Figure 44: Conversion procedure of window U-value to glass conductance and SHGF to shading coefficient.

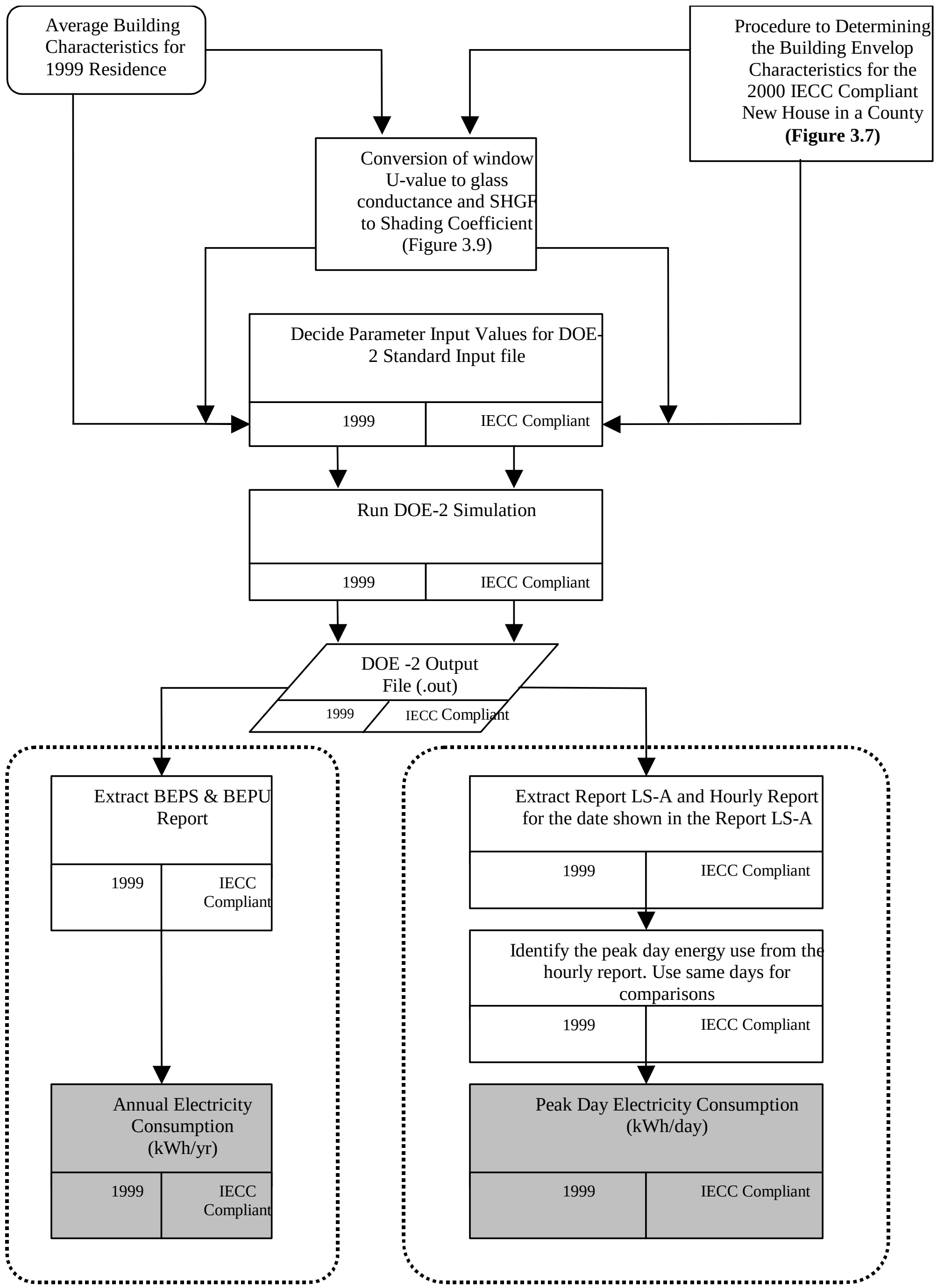



Figure 45: Procedures for Extracting Annual and Peak Day Electricity Use from DOE-2 (Im 2003).

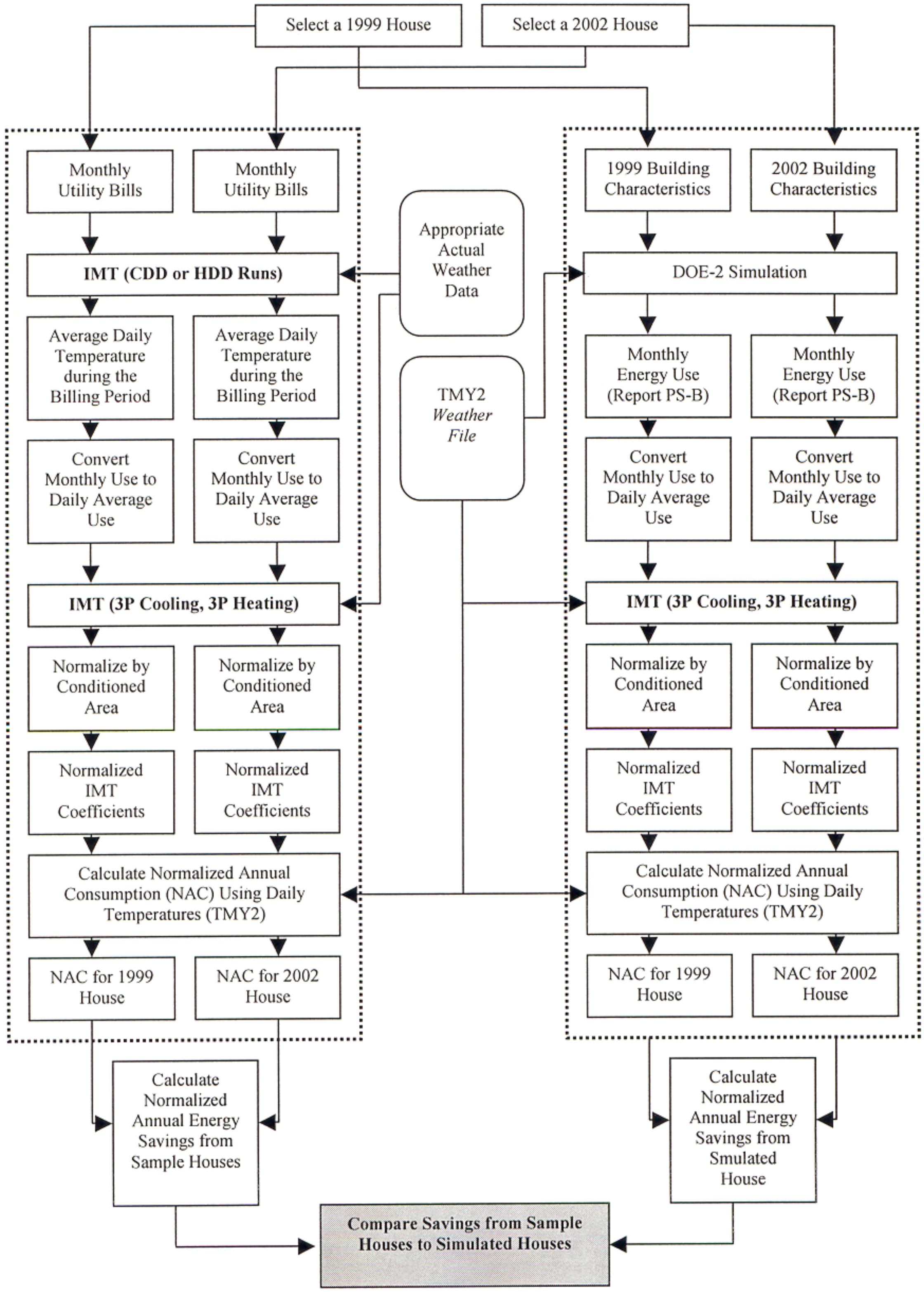



Figure 46: Reconciliation of residential energy savings using utility bill analysis (Im 2003).

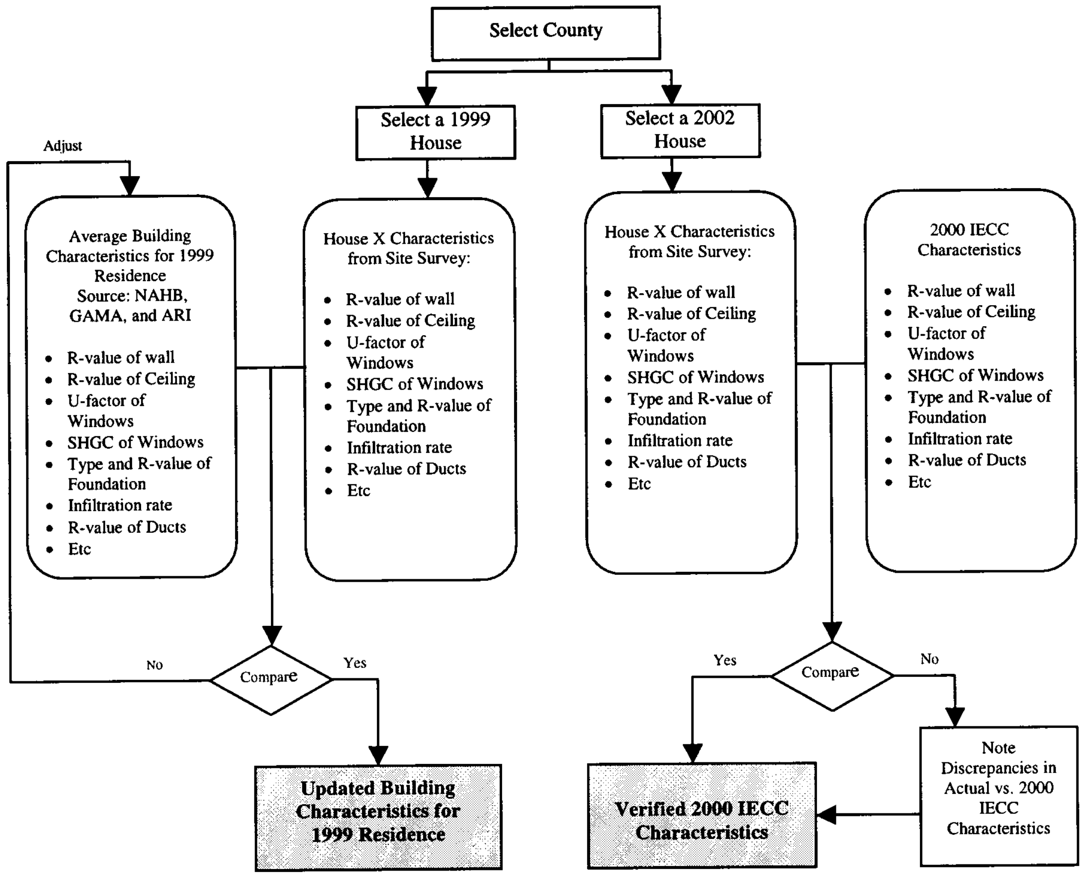



Figure 47: Reconciliation residential housing characteristics using on-site surveys (Im 2003).

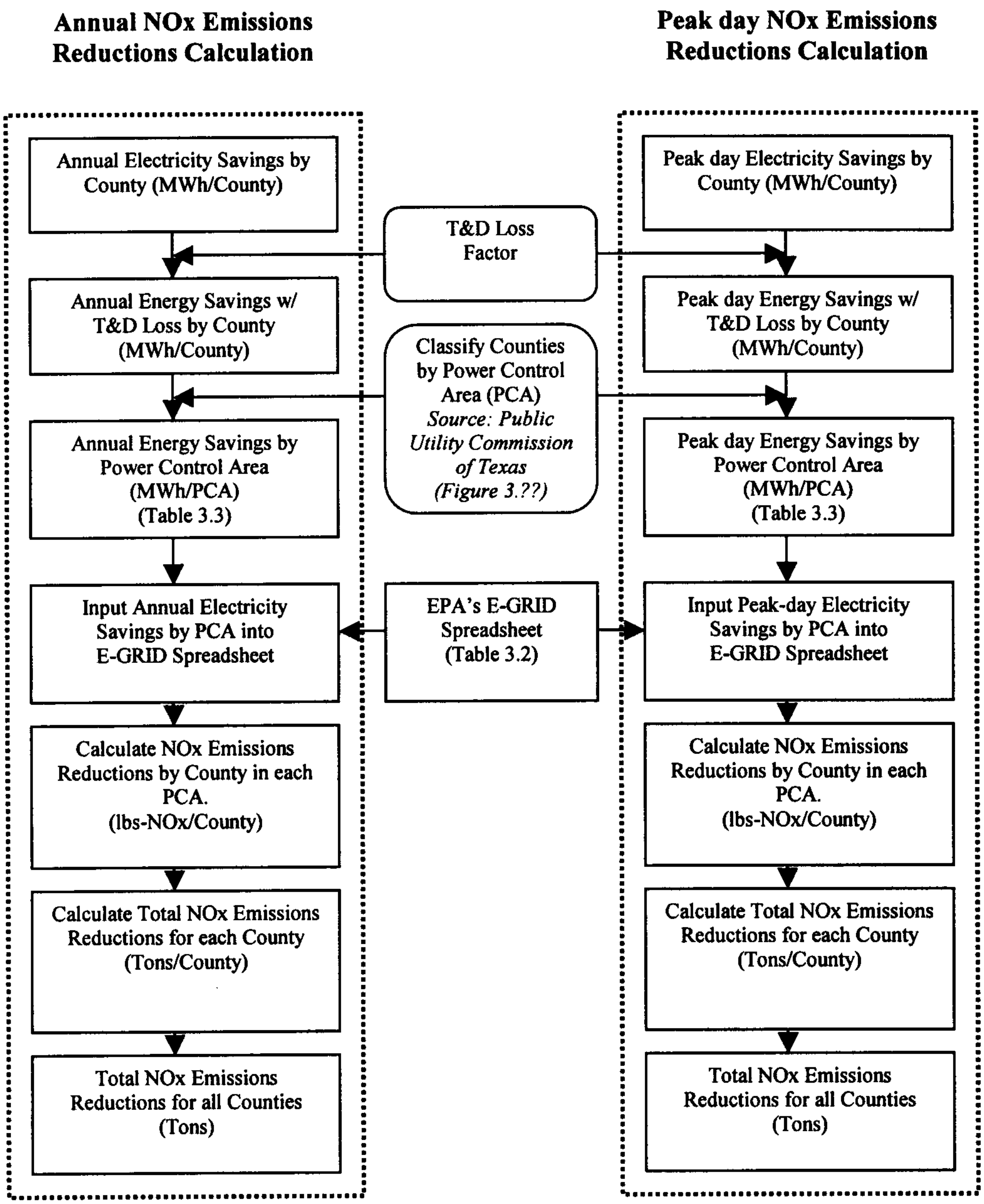



Figure 48: Annual and Peak Day NOx Calculations (Im 2003).

### 6.1.2 Commercial/Industrial Buildings

#### 6.1.2.1 General Description of Procedure.

The methodology to accomplish this for commercial buildings is presented in Figure 49 through Figure 53. These procedures incorporate and verify savings using several different sources of information. These procedures include a flowchart of the overall procedure (Figure 49), which includes the information obtained from Figure 50. For each county, 1999 and 2002 commercial building characteristics will be ascertained according to the procedures in Figure 50. Using simulation, these characteristics are entered into the DOE-2 simulation to calculate the annual energy use of two representative buildings, one representing the commercial building with the average 1999 characteristics, and one representing the appropriate characteristics from the IECC / IRC[53]. The annual electricity use of the IECC / IRC simulation is then subtracted from the annual electricity use of the similarly-sized 1999 building to obtain the annual electricity savings, and peak electric demand savings. Natural gas savings associated with space heating and the heating of domestic hot water would be calculated for informative purposes. The electricity savings attributable to the IECC / IRC energy conservation options would then be converted to $NO_x$ reductions per building using eGRID. Electricity savings would then be scaled to represent the county-wide savings by multiplying the annual commercial building permits for each county. Total $NO_x$ reductions associated with the implementation of the IECC / IRC would then be calculated simultaneously for all non-attainment and affected counties using a state-wide eGRID values.

In Figure 50 the detailed flowchart is shown for calculating the 2002 annual energy use of new commercial building construction with and without the energy conserving features contained in the IECC / IRC, chapters 4, and 8. This is accomplished with two separate calculations: a) one path that represents the standard building defined in the IECC / IRC chapter 4 and 8, that uses average characteristics for buildings built in 1999 (left side of figure); and b) a second path that represents the standard building defined by the IECC / IRC that includes the energy conserving features[54] defined in chapter 7 and 8 (right side of figure).

Calculating baseline energy use of new construction. The procedure for calculating the 2002 baseline commercial building energy consumption (left side of Figure 50) begins with the definitions of the standard building found in Chapters 4 and 8 of the IECC / IRC. These definitions are used to create a standard input file for the DOE-2 simulation program (LBNL 2000). This standard input file is then adjusted to reflect the average 1999 construction characteristics for each county[55] for office, retail and industrial buildings. The annual electricity and natural gas consumption for each building type[56] is then simulated using the DOE-2 program and the appropriate weather data[57] for each location. The annual, countywide, baseline energy consumption for new buildings built in 2002 with characteristics that reflect the IECC / IRC and 1999 published data is calculated by multiplying the annual simulated energy use for an average building times the projected county-wide construction permits for 2002. The projected office, retail and industrial construction permits for each county are projected using regression that utilizes countywide population growth and construction permits. This baseline represents the expected annual energy use of all new construction in each county had those buildings been constructed with the IECC / IRC chapter 4 and 8 “standard building” and average 1999 characteristics.

Calculating code-compliant energy use of new construction. The procedure for calculating the code-compliant 2002 commercial building energy consumption (right side of Figure 50) also begins with the definitions of the standard building found in Chapter 4 and 8 of the IECC / IRC. This code-compliant input file reflects the 1999 floor area[58] for office, retail, industrial permits in each county and IECC / IRC Chapter 7 or 8 construction characteristics[59]. The annual electricity and natural gas consumption for a code-compliant building is then simulated using the DOE-2 program and the appropriate weather data for each location. The annual, county-wide, code-compliant energy consumption for new buildings built in 2002 with code-compliant characteristics is calculated by multiplying the annual simulated energy use for a code-complaint buildings times the projected building permits for 2002. This code-compliant use represents

[53] In some cases this will require comparing the building to the code requirements of ASHRAE Standard 90.1 1999, which is referenced by the 2000 IECC (including the 2001 Supplement), in Chapter 7.
[54] The energy conserving features in the IECC 2001 are those contained in chapter 8 of the 2000 IRC, as modified by the 2001 Supplement (IECC 2001).
[55] The average 1999 construction characteristics represent the published data from several sources, including F.W. Dodge (2002), CBECS (1995) and LBNL (1995).
[56] The average building size for each county is determined from published CBEC (1995) data.
[57] The appropriate weather data for each county is the nearest TMY2 weather file that most accurately represents the 2001 IECC climate zone as shown in Figure 2.
[58] This is derived from the published county-wide construction permit data on file with the Real Estate Center at Texas A&M University, also cross-checked with CBECS (1995) data.
[59] These characteristics include insulation levels, glazing type, etc., as defined in Chapter 8 of the 2001 IECC or Chapter 7 of the 2000 IECC, which references ASHRAE Standard 90.1 1999 (w/o amendments).

the expected annual energy use of all new code-complaint construction in each county. The total electricity savings that can be attributed to the adoption of the IECC / IRC are then calculated by comparing the difference in annual energy use of the baseline building versus the code-compliant building as shown in

6.1.2.2 Reconciliation of the total savings.

Several procedures have been identified to reconcile the savings calculations, including:

1. a cross-check of the calculated energy use against the published average energy use found in the USDOE's Commercial Building Energy Characteristics Survey (CBECS 1995),
2. a cross-check of energy savings using a utility bill analysis method, and
3. a cross-check of construction data using on-site visits.

Cross-check of the calculated energy use against published data. The procedure to cross-check the calculated energy use of the baseline building and code-compliant building against the average energy use published by the CBECS (1995) as shown in Figure 51. It is important to note that this procedure is proposed for informative purposes, since exact agreement between the office, retail and industrial characteristics in the IECC / IRC and CBECS is not anticipated, since the CBECS data reflects actual average occupant behavior, and the IECC / IRC reflects a controlled occupant behavior. The procedure multiplies the expected number of office, retail and industrial building area times the average annual energy use per unit area published in CBECS to obtain the county-wide annual energy use for all newly constructed buildings. This value is expected to be useful in judging whether or not any adjustments are needed in the IECC / IRC Chapter 4, 7 and 8 construction characteristics.

Cross-check of energy savings using utility bill analysis. The energy savings attributable to the adoption of the IECC / IRC will also be reconciled with monthly utility billing data using ASHRAE's Inverse Model Toolkit algorithms (IMT) (Kissock et al. 2001) is shown in Figure 52 in 2002 utility bills should decrease by an amount that is similar to the calculated savings from IECC / IRC adoption for similar sized office, retail or industrial facility with similar characteristics and functional use. In has two parallel paths, one for the 1999 building stock and one for the 2002 building stock.

For the building cross-check with utility billing data, the procedure begins by selecting a 1999 building and a 2002 building that have similar characteristics to the construction characteristics that were used for the primary calculation. For each building 12 months of utility billing data are obtained and analyzed with the ASHRAE IMT. The resultant, valid parameters from IMT[60] are then normalized by conditioned area to obtain a weather-normalized, averaged energy use per square foot. After the appropriate number of buildings have been analyzed that represent a statistically significant sample of buildings constructed in 1999 for each county (or for 2002), the normalized annual consumption (i.e., expressed as kWh/yr-ft$^2$) is compared against the similar parameter for buildings constructed in 2002 (i.e., also expressed as kWh/yr-ft$^2$) to obtain the average electricity savings per square foot of conditioned area. This difference is then multiplied by the square footage reported in the building permits constructed in 2002 and the average conditioned area of the buildings constructed in 2002 to obtain the total annual electricity savings per county. This total, county-wide, annual electricity savings calculated by utility bill analysis can then be compared to the total, county-wide, annual electricity savings calculated by simulation. For each county, savings from the difference in 1999 versus 2002 utility bills are expected to be similar to savings calculated by simulation for similar buildings, with similar characteristics.

Cross-check of construction data using on-site visits. A reconciliation will also be carried out to cross-check selected parameters for both the 1999 and 2002 building characteristics for each county as shown in Figure 53. For the 1999 building stock, on-site surveys of a statistically significant sample will be used to

[60] The primary parameter of interest from the ASHRAE IMT depends upon the model selection, which includes: a one parameter mean model, a two parameter model, three, four and five parameter change-point models, variable based degree models, and combined models that utilize multiple linear regression with 1,2,3,45 or VBDD models. The goodness of fit indicators used to determine a valid IMT run include the CV(RMSE), RMSE, and IMT's adjusted R^2.

cross-check the average building characteristics[61] used to simulate the average building in each county. Adjustments can then be made to the average 1999 characteristics should significant differences be found.

As shown in the right side of the figure adjustments will be carried out for newly constructed buildings to determine if the on-site building characteristics meet, or exceed the IECC / IRC. However, differences found in the 2002 characteristics will be noted as to whether or not these differences represent characteristics that are less stringent or more stringent than code. Characteristics that are less stringent that code will be communicated with code officials to determine how enforcement procedures to the code need to be modified to better assure code compliance. Characteristics that are more stringent than code will be credited to the countywide energy savings as above code savings.

#### 6.1.2.3 Commercial/Industrial Buildings: Existing Construction

Existing commercial buildings undergo a significant remodeling are addressed by the IECC / IRC. To account for the energy savings from these activities, procedures similar to those shown for new construction will be applied to track remodeling permits, including how the buildings are complying with the IECC / IRC. Different procedures may need to be developed for tracking existing building IECC / IRC activities. For example, it may be more efficient to track the activity by the type of retrofit, including: envelope, HVAC system, etc. Once a tracking procedure has been developed, then a suitable accounting scheme can be developed and implemented to roll these savings into the savings from new construction activities.

### 6.1.3 Renewables Applied to Buildings

The application of renewable energy systems in buildings are addressed by the IECC / IRC. To account for the energy savings from these activities, the procedures shown in Figure 54 and Figure 55 will be used to track the installation of projects that utilize renewables, according to the procedures in the IECC / IRC. In each county the number and type of renewable energy system will be evaluated to determine the displaced electricity or natural gas use. Characteristics about each system will need to be collected, including: the type of system, $ft^2$ of aperature, orientation, tilt, systems characteristics, etc. These characteristics will then be input into either the FCHART or PVFCHART[62], depending upon system type, and the annual energy use simulated with the appropriate program. Total county-wide energy use is the cumulative total energy production of all systems installed in a county.

### 6.1.4 Calculation of Total Annual County-wide IECC / IRC Electricity Reductions.

Total annual, county-wide IECC / IRC electricity reductions would be the total of the savings from IECC / IRC application to residential, commercial/industrial, and renewable energy applications. Total savings from non-attainment and affected counties would incorporate savings from the county-wide IECC / IRC reductions. Total state-wide savings would be calculated in a similar fashion using county-wide savings from all Texas non-attainment and affected counties. In the case of solar thermal systems, natural gas savings are also calculated and converted to NOx emissions reduction.

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[61] As previously mentioned the 1999 average building characteristics represent the average characteristics published by F.W. Dodge, CBECS and LBNL.

[62] FCHART and PVFCHART are nationally recognized solar analysis software developed by S.A. Klein, and W. A. Beckman at the, Solar Energy Laboratory, Mechanical Engineering Laboratory, 1500 Engineering Drive, University of Wisconsin – Madison, WI 53706.

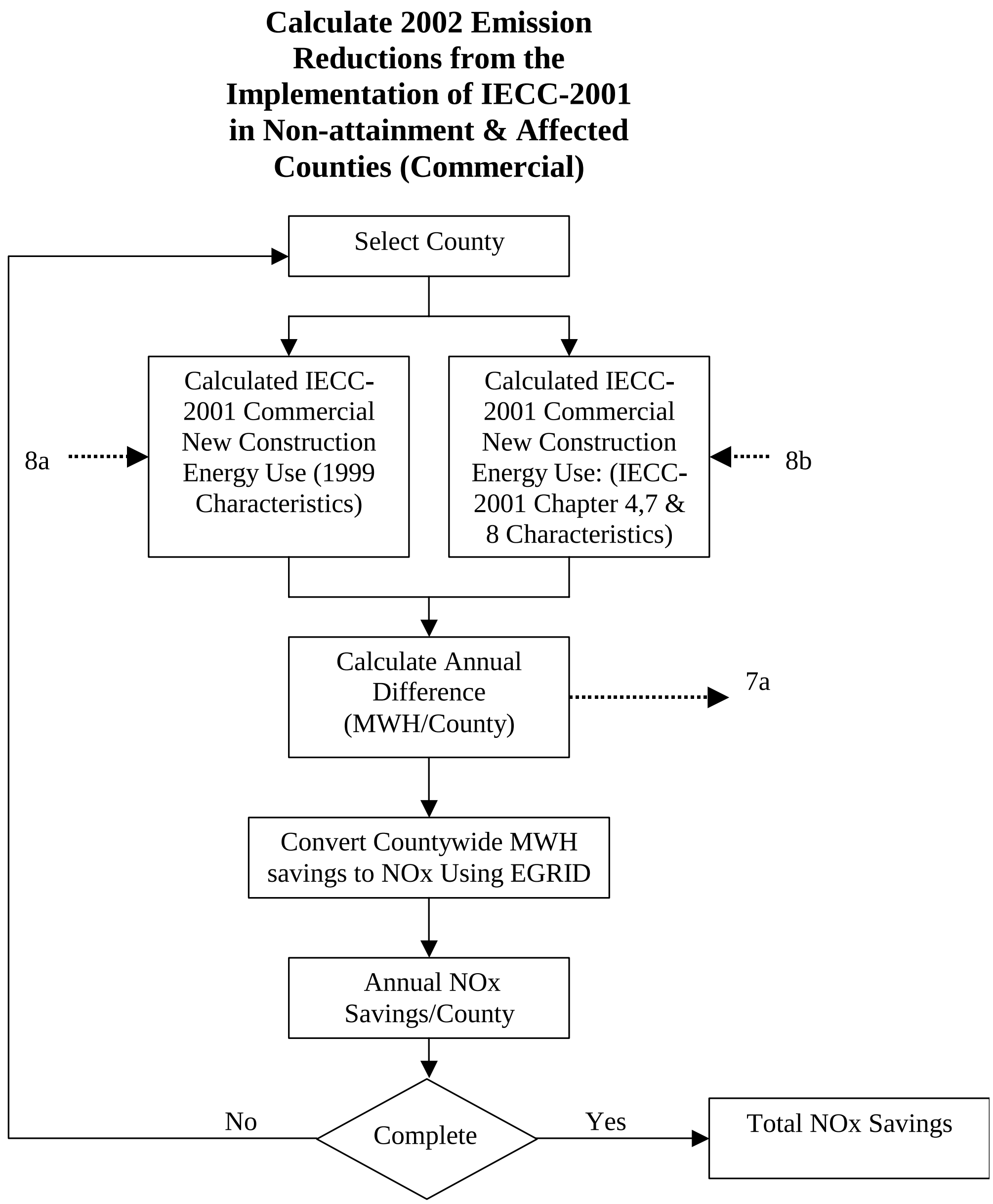


Figure 49: General flowchart for calculation of emission reduction from implementation of IECC / IRC in commercial buildings in non-attainment and affected counties.

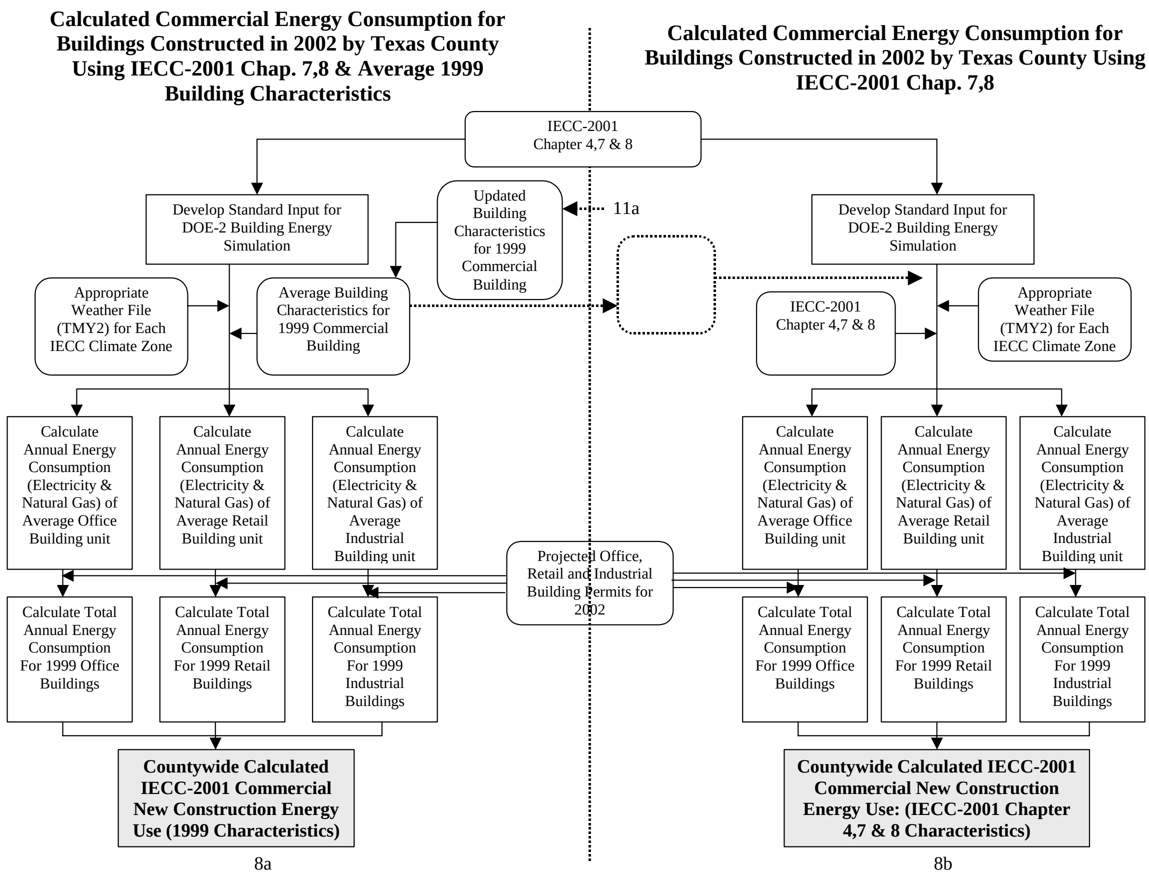


Figure 50: Calculation of countywide commercial new construction energy consumption (1999 characteristics and IECC / IRC).

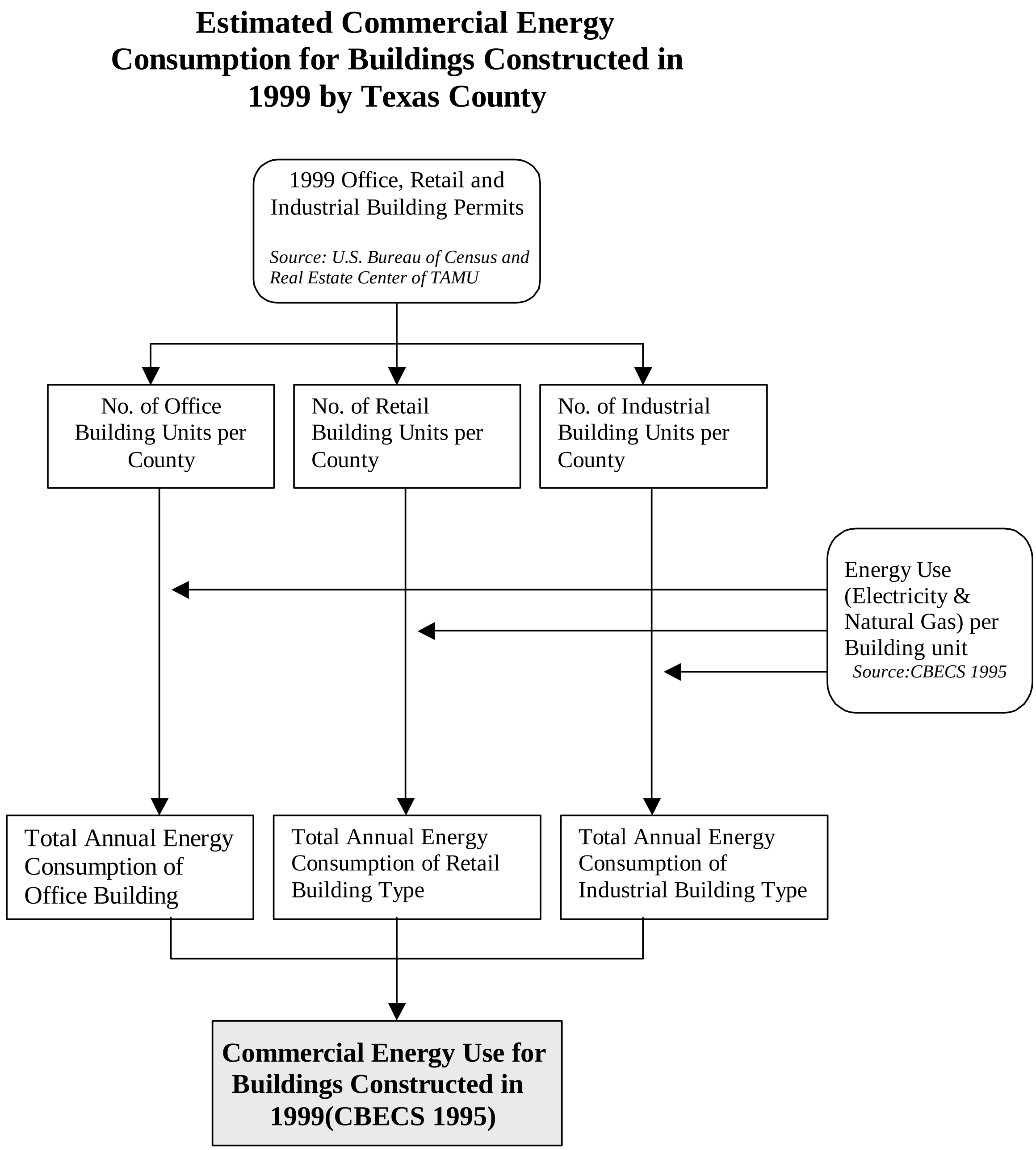


Figure 51: Estimated commercial energy consumption for buildings constructed in 1999 by Texas county.

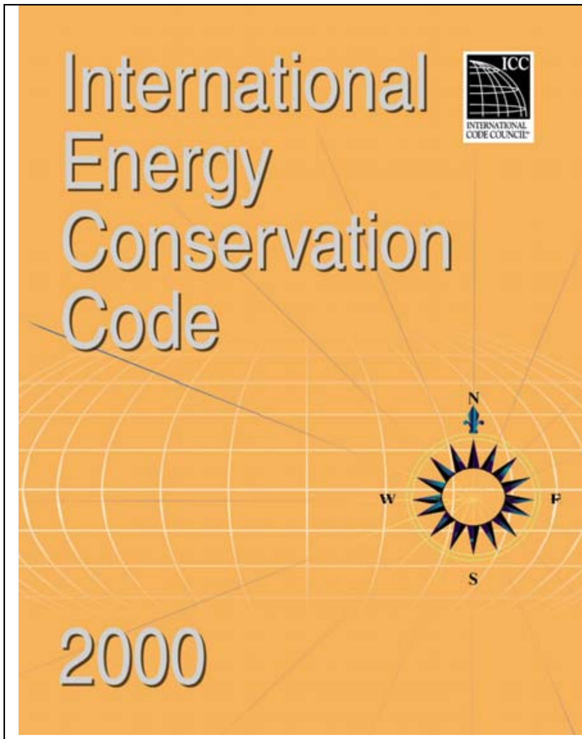


Figure 36: 2000 International Energy Conservation Code (IECC).

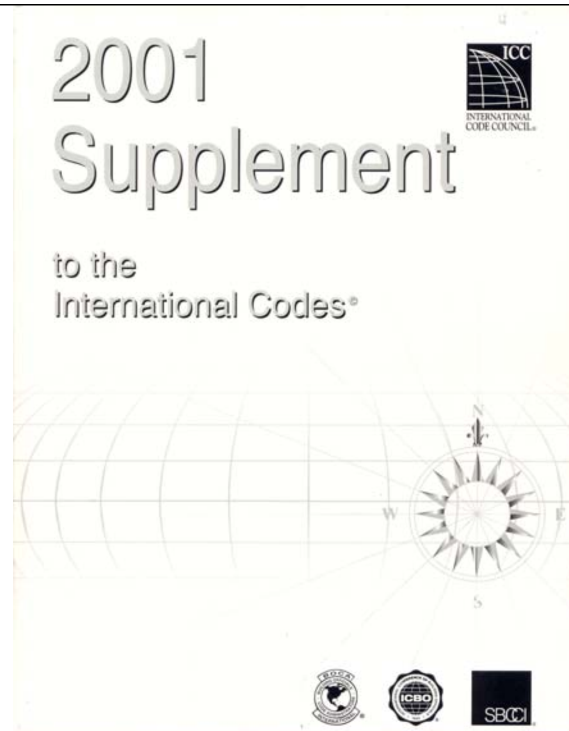


Figure 37: 2001 Supplement to the International Energy Conservation Code (IECC).

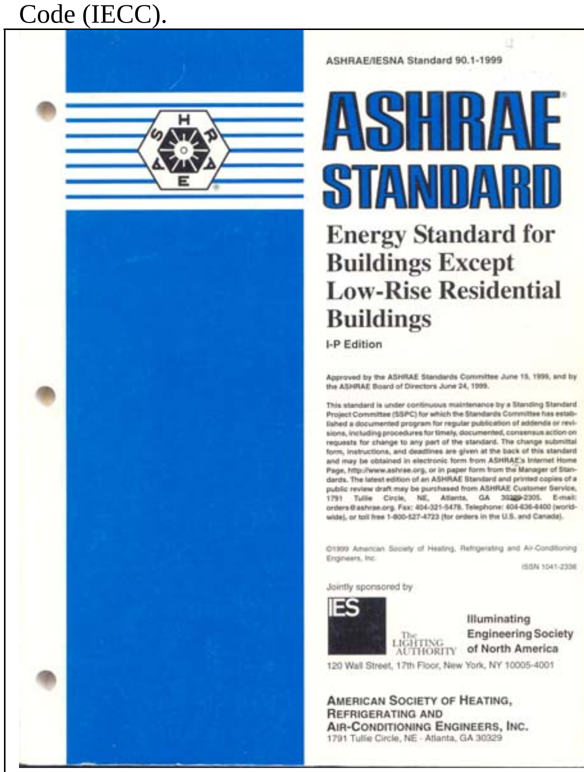


Figure 38: ASHRAE Standard 90.1- 1999, applicable to all commercial buildings.


Figure 39: ASHRAE Standard 90.1- 2001, applicable to all State Agencies.

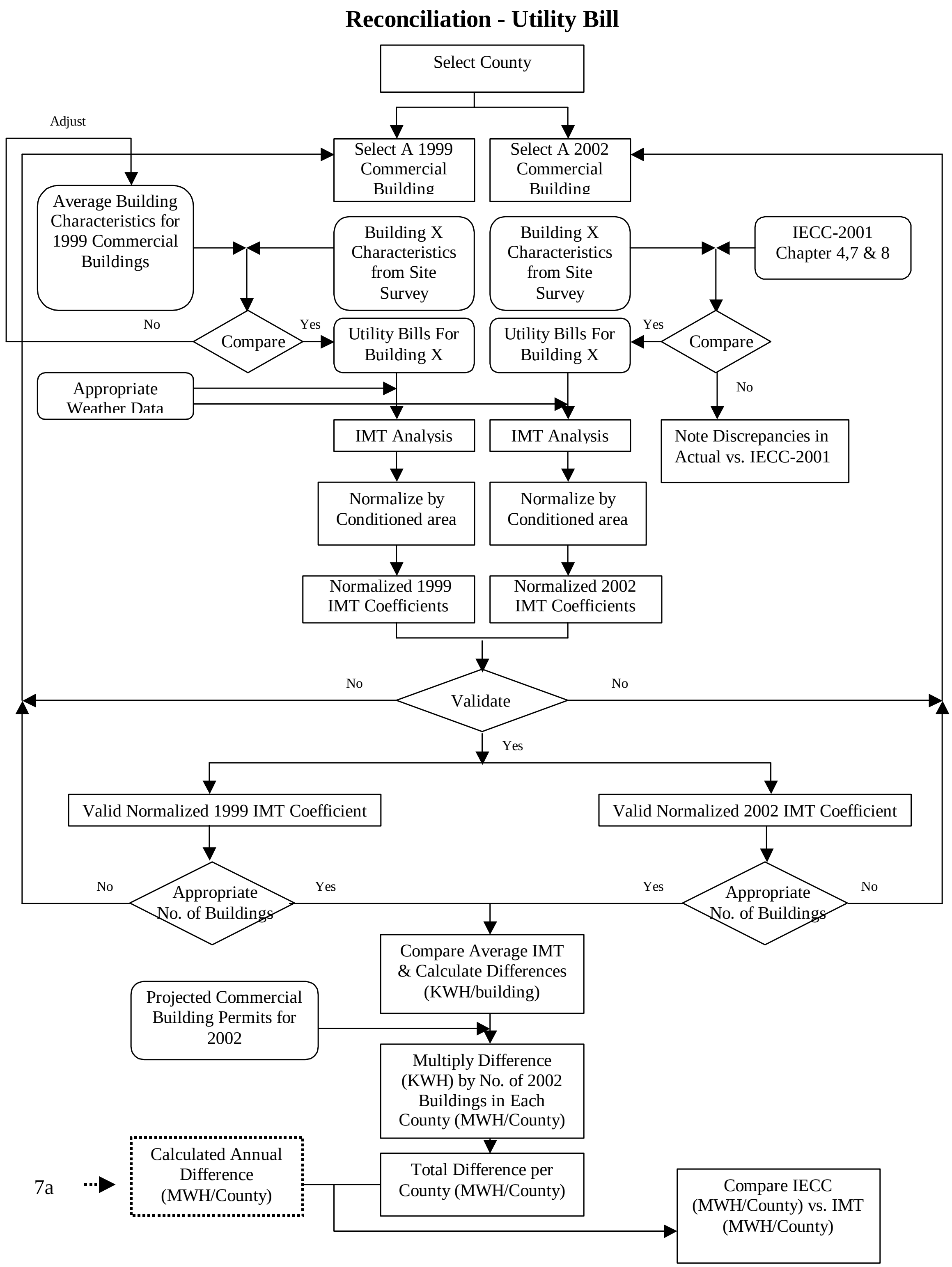


Figure 52: Reconciliation of commercial building energy savings using utility bill analysis.

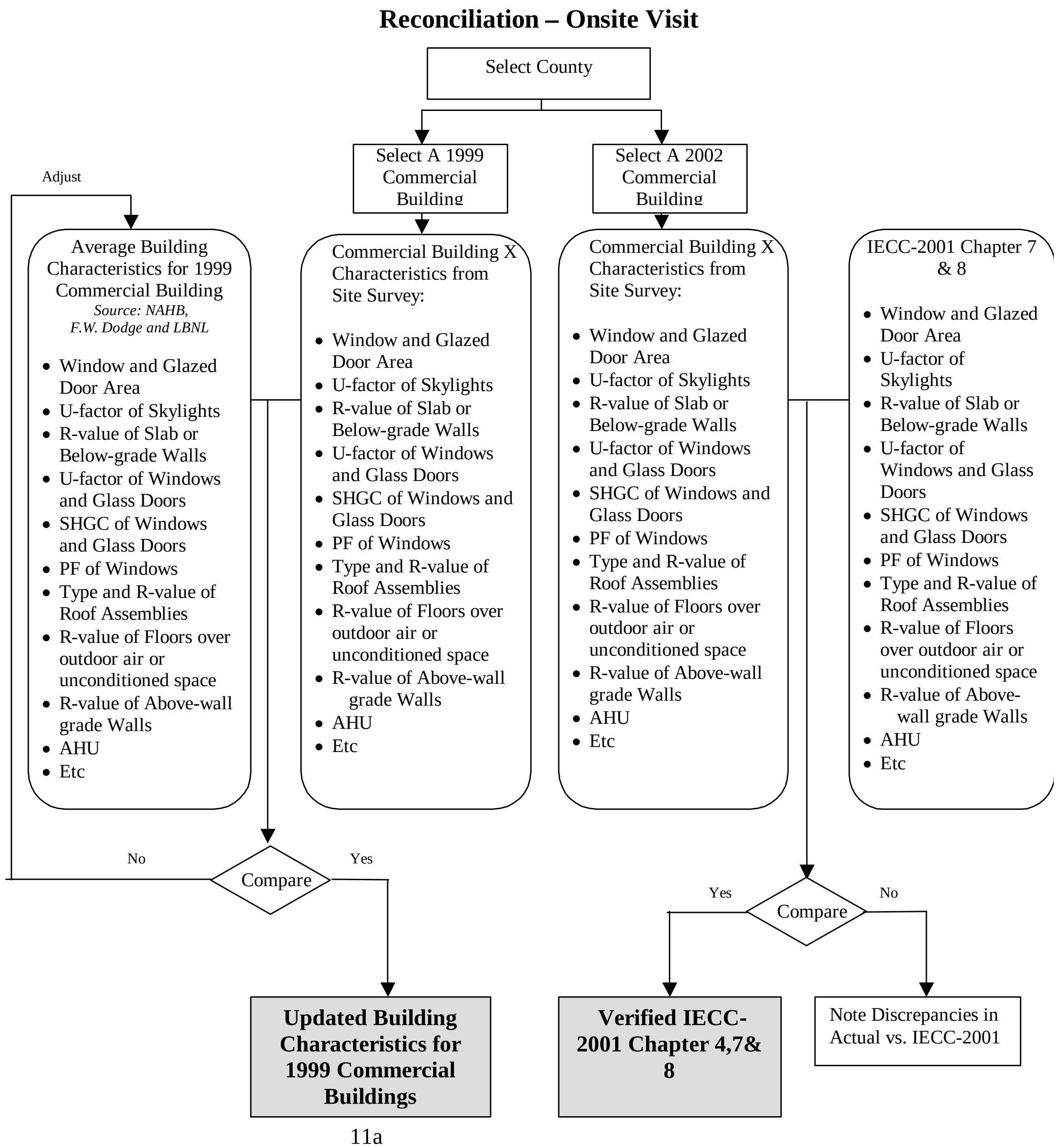


Figure 53: Reconciliation commercial building characteristics using on-site surveys.

**Calculate Emission Reductions from**

**Renewable Energy Production by Texas County**

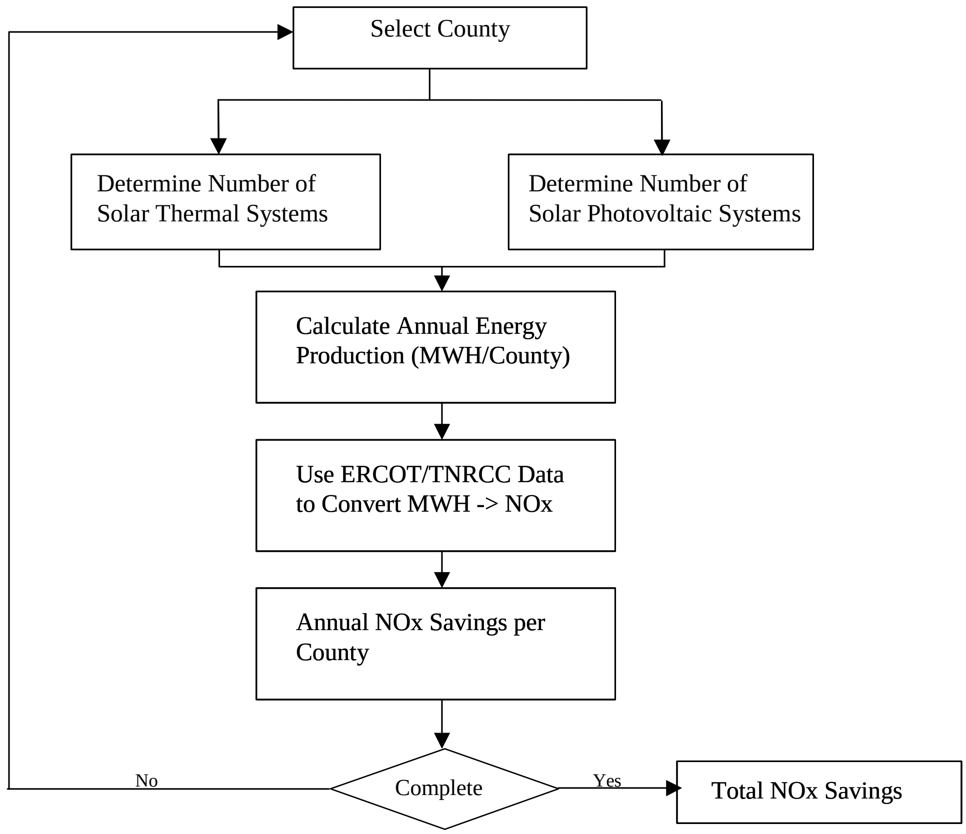


Figure 54: General flowchart for calculation of emission reduction from the use of renewables as incorporated in the IECC / IRC in residential or commercial/industrial buildings in non-attainment and affected counties.

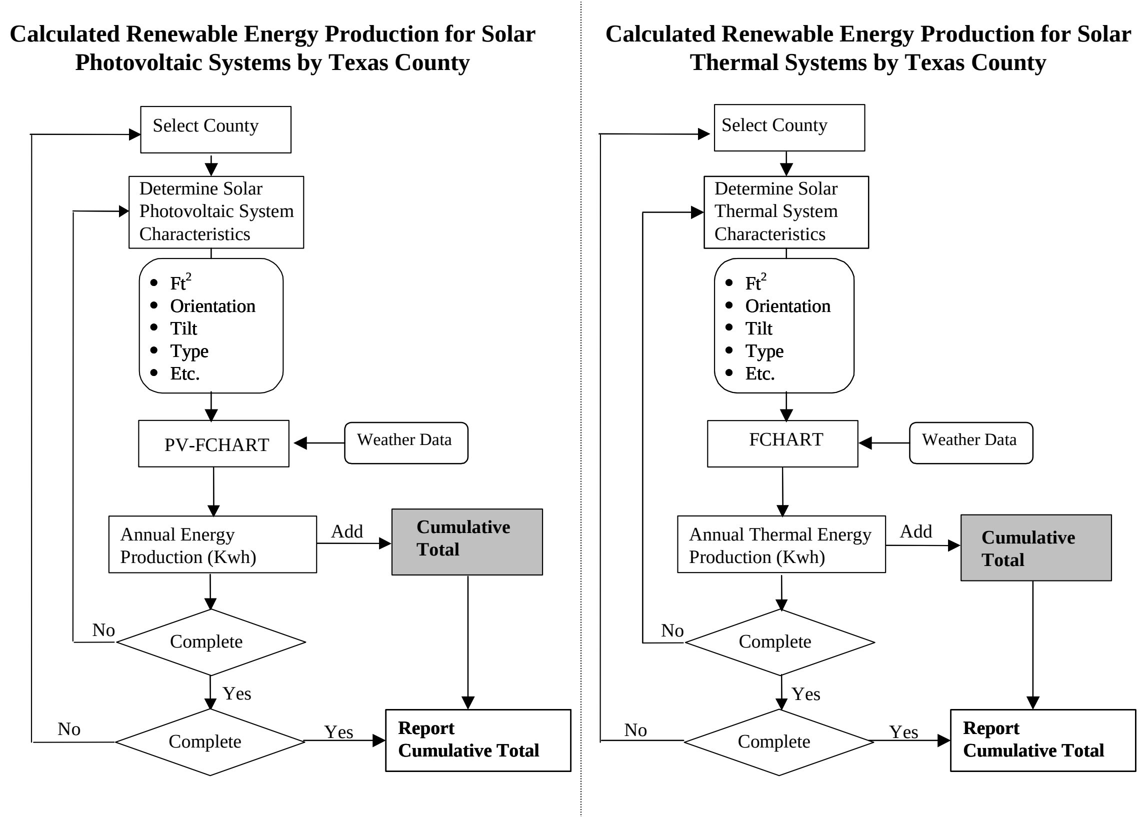


Figure 55: Detailed calculation of county-wide solar thermal or photovoltaic energy generation in residential or commercial/industrial new construction.

## 6.2 Procedures for Calculating NOx Emissions Reduction.

The annual and peak-day NOx estimations required by the EPA requires annual, and peak-day calculations of county-wide electricity reductions[63]. The proposed procedure for calculating annual and peak-day NOx reductions uses the eGRID database. eGRID is the USEPA's Emissions and Generation Resource Integrated Database. This procedure is proposed for calculating county-wide NOx reductions in pounds per MWh for Energy Efficiency and Renewable Energy projects (EE/RE) implemented in each Power Control Area (PCA) in the ERCOT region

eGRID is a comprehensive database of environmental attributes of electric power systems. eGRID is based on available plant-specific data for all U.S. electricity generating plants that provide power and report data to the U.S. government. Data reported for each power generator includes generation (in MWh), resource mix (for renewables and non-renewables), emissions (in tons for NOx, SO2, and CO2; and in pounds of mercury), emission rates (in both pounds per megawatt-hour [lbs/MWh] and pounds per million Btu [lbs/MMBtu] for NOx, SO2, and CO2; and in both pounds per gigawatt-hour [lbs/GWh] and pounds per billion Btu [lbs/BBtu] for mercury), heat input (in MMBtu), and capacity (in MW). eGRID also reports changes in ownership and industry structure as well as power flows between states and grid regions. For more information on eGRID, see http://www.epa.gov/cleanenergy/egrid.htm.

[63] For additional details regarding this procedure see: Draft Houston/Galveston Attainment Demonstration and Post-1999 Rate-of-Progress SIP: Appendix A – Description of the Methodology for Determining Credit for Energy Efficiency, Texas Natural Resources Conservation Commission, Austin, Texas, June 5th, 2002 proposal.

Table 14 shows the eGRID table published in November 2002.[64] This table is the result of a methodology Art Diem of USEPA performed using eGRID data. This methodology distributes reductions in energy generation within the ERCOT territory using eGRID power flow data and eGRID plant level capacity factor data. The eGRID plant level NOx emission factors are applied to these generation changes and aggregated to the county level.

For the ESL's Senate Bill 5 project, several tables are needed to convert the county-wide electricity savings from IECC / IRC code implementation into NOx reductions at the power plants that provided the electricity using the EPA's eGRID database. In this section, an explanation of the procedure and a detailed description of the tables (i.e., spreadsheets) used to perform the calculations are presented.
Table 14 shows county-wide NOx reductions per MWh of energy savings by each Power Control Area (PCA). The column headings indicate each PCA in the ERCOT region. The first column shows Federal Implementation Plan (FIP) code for each county, and the second column gives each corresponding county in the ERCOT region having electric generators that could be affected by the energy savings. The next ten columns give the NOx reductions by each PCA for one megawatt of energy savings.

In Table 15, fifty counties have electric generating plants that would be affected by energy savings based on the methodology in the ERCOT region. Each cell shows the average amount of NOx (in pounds) that could be reduced by electric generators in that county if one megaWatt-hour of electricity (i.e., savings) is realized within the PCA for that column. Counties that do not have NOx values do not contain electric power generating plants that would be affected by energy savings realized within the PCAs shown in the column. The Total values shown at the bottom of each column represent the total NOx reduced by one megaWatt-hour of energy savings.

Table 16 presents an expanded version of Table 14. The shaded counties do not have an electricity-generating plant that would be affected by energy savings according to this EPA methodology, or are not in the ERCOT region analyzed by eGRID. Seventy-one (71) county names are shown in Table 16. Of the thirty-eight (38) non-attainment or affected counties[65], there are five (5) counties that do not have electricity-generating plants owned by PCAs. Eleven (11) counties of the 38 are not in the ERCOT region, and may contain power plants from other generators. Finally, not all municipal power generating plants appear to be in the eGRID database.

In Table 16, Table 15 was modified to allow for the calculation of NOx reductions when electricity production (i.e., savings) is entered in the bottom row for each PCA. To accomplish this, an empty column was added next to the each PCA column. NOx emissions reduction for each county in the specific PCA are calculated in this column according to the total MWh entered into the bottom of the PCA column. One additional column was added to the right side of the spreadsheet that calculates total NOx reductions (Tons/yr) for each county. This value represents the NOx produced by all PCAs in one particular county, as reported by eGRID. The modified parts of the table are shaded.

Table 17 and Table 18 show all electric utility providers for each county in Texas. These tables were obtained from the Public Utility Commission of Texas (PUCT) website (http://www.puc.state.tx.us, November 2002). These tables provide each county's region name and the electric utility providers for each county. For the calculations performed by the ESL in this report, the first electric utility shown in each row was assumed to be the only electric utility for that county, since the % electricity distribution are not published by the PUCT, and could not be obtained for purposes of publishing this report.

Table 19 is the summary table from the ESL's 2002 Senate Bill 5 report to the TNRCC[66]. In this table, each county was assigned to a corresponding PCA using the PCA map published by ERCOT in May of 2002[67].

[64] The Energy Systems Laboratory (ESL) received this table from Mr. Art Diem ((Environment and Energy Integration) Phone: 202-564-3525 (diem.art@epa.gov)) at the USEPA in November 2002.
[65] In 2003 this was expanded to 41 counties, which now include Henderson, Hood and Hunt counties.
[66] Haberl, J., Culp, C., Yazdani, B., Fitzpatrick, T., and Turner, D. 2002. "Texas Senate Bill 5 Legislation for Reducing Pollution in Non-attainment and Affected Areas: Annual Report", submitted to the Texas Natural Resources Conservation Commission, Energy Systems Laboratory Report ESL-TR-02/07-01, Texas A&M University, 116 pages, (Revised: September).

The assigned PCA is important because the September 2002 NOx emissions rate was decided according to the PCA shown, using the June 2002 NOx emissions rates published by the TNRCC. The third column shows the assigned PCA for each county using the ERCOT map. The fourth column gives the TMY2 weather locations that was used to perform the simulation. The fifth column lists the IECC / IRC climate zone that corresponds to the county. This climate zone was used to select the code compliant design characteristics. The sixth column shows the National Association of Home Builder's (NAHB) designation regarding which division of survey data pertained to the county shown. The seventh column shows the number of projected housing units according to the Real Estate Center at Texas A&M. This projection was determined using linear regression of the last several years of available data for each county. The eighth column gives the average floor area for a single-family house according to the NAHB survey data for 1999. The ninth column gives the simulated energy use for the house calculated with the code-traceable DOE-2 simulation using the TMY2 weather location for each county. The tenth column shows the energy use of a similar house[68] built to code-complaint specifications. Columns eleven and twelve show the peak day electricity use for the average 1999 house and the code-compliant house for each county. Column thirteen shows the annual electricity savings for each house and column fourteen shows the total savings for all houses built in each county and includes a 20% transmission and distribution loss. Column fifteen shows the NOx emissions rates for the utility provider that was assumed to provide the electricity to each county[69]. Column 16 provides the annual tons of NOx emissions savings from implementation of the IECC / IRC to the new single-family housing units listed for each county and includes the 20% T&D losses. Column 17 provides the average tons-NOx/day for each county, which represents the annual total (tons-NOx/year) divided by 365. Column 18 provides the tons-NOx/day calculated by multiplying the peak electricity savings for each county times the NOx emissions rates for the utililty provider[70]. The bottom row in Table 19 gives the total values for all non-attainment and affected counties.

In Table 20, the electric utility providers were updated to reflect the data in Table 17 and Table 18. The columns in Table 20 show the updated NOx values that including the new values from Table 17 and Table 18. Table 20 also provides peak day savings that include the 20% T&D losses. It is worth noting that the combination of the 20% T&D loss and the new NOx values increased the previously reported total peak-day emissions rates from 2.09 to 2.6 tons-NOx/peak-day for the same MWh/county values.

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[67] The map obtained from the ERCOT was presented by Mr. Ken Donoho at the Hot and Humid conference in Houston, Texas in May. This map is contained on page 71 of the ESL's September 2002 report to the TNRCC (ESL-TR-02/07-01). County assignments were made by choosing the predominate utility provider from the map.

[68] Characteristics such as floor area, window-to-wall ratio, etc., are held constant, wall R-value, roof R-value, window U-value, window SHGC, air-conditioner SEER and furnace AFUE were changed.

[69] These values represent the June 2002 values published by the TNRCC from the EPA's E-GRID report.

[70] This value does not include a 20% T&D factor.

| | | County-wide NOx Reductions in pounds per MWh for EE/RE implemented in each listed PCA | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cnty_FIP | County | American Electric Power - West (ERCOT)/PCA | Austin Energy/PCA | Brownsville Public Utils Board/PCA | Lower Colorado River Authority/PCA | Reliant Energy HL&P/PCA | San Antonio Public Service Bd/PCA | South Texas Electric Coop Inc/PCA | Texas Municipal Power Pool/PCA | Texas-New Mexico Power Co/PCA | TXU Electric/PCA |
| 48021 | **BASTROP** | 0.01 | 0.20 | | 0.34 | | 0.01 | | | | |
| 48029 | **BEXAR** | 0.06 | 0.09 | 0.04 | 0.16 | | 2.00 | 0.08 | 0.01 | | |
| 48039 | **BRAZORIA** | 0.01 | 0.01 | | | 0.05 | 0.01 | | | | |
| 48041 | **BRAZOS** | | 0.01 | | 0.01 | | | 0.03 | 0.11 | | 0.01 |
| 48057 | **CALHOUN** | 0.19 | | 0.14 | 0.01 | | | 0.04 | 0.01 | | 0.01 |
| 48061 | **CAMERON** | 0.14 | | 0.20 | | | | 0.03 | | | 0.01 |
| 48071 | **CHAMBERS** | 0.05 | 0.06 | 0.03 | 0.02 | 0.35 | 0.08 | 0.03 | 0.02 | 0.02 | 0.03 |
| 48073 | **CHEROKEE** | 0.01 | 0.01 | 0.01 | 0.02 | | | 0.02 | 0.06 | 0.02 | 0.10 |
| 48081 | **COKE** | 0.03 | | 0.02 | | | | 0.01 | | | |
| 48083 | **COLEMAN** | 0.02 | | 0.01 | | | | | | | |
| 48085 | **COLLIN** | 0.01 | 0.01 | | 0.02 | 0.01 | | 0.05 | 0.19 | | 0.02 |
| 48105 | **CROCKETT** | 0.14 | | 0.11 | | | | 0.03 | | | 0.01 |
| 48113 | **DALLAS** | 0.06 | 0.06 | 0.04 | 0.09 | 0.03 | 0.01 | 0.09 | 0.30 | 0.09 | 0.51 |
| 48121 | **DENTON** | | 0.01 | | 0.01 | | | 0.04 | 0.15 | | 0.01 |
| 48147 | **FANNIN** | 0.02 | 0.02 | 0.01 | 0.03 | 0.01 | | 0.03 | 0.09 | 0.03 | 0.17 |
| 48149 | **FAYETTE** | 0.02 | 0.86 | 0.02 | 1.51 | 0.01 | 0.04 | 0.01 | 0.02 | | 0.02 |
| 48157 | **FORT BEND** | 0.13 | 0.17 | 0.10 | 0.06 | 1.01 | 0.23 | 0.09 | 0.06 | 0.07 | 0.10 |
| 48161 | **FREESTONE** | 0.02 | 0.02 | 0.02 | 0.04 | 0.01 | | 0.03 | 0.12 | 0.04 | 0.22 |
| 48163 | **FRIO** | 0.05 | | 0.04 | 0.01 | | | 1.15 | 0.07 | | |
| 48167 | **GALVESTON** | 0.05 | 0.06 | 0.04 | 0.02 | 0.39 | 0.09 | 0.04 | 0.03 | 0.42 | 0.04 |
| 48185 | **GRIMES** | 0.01 | 0.01 | | 0.02 | 0.01 | | 0.06 | 0.23 | | 0.01 |
| 48197 | **HARDEMAN** | 0.01 | | 0.01 | | | | | | | |
| 48201 | **HARRIS** | 0.05 | 0.07 | 0.04 | 0.02 | 0.41 | 0.09 | 0.04 | 0.02 | 0.03 | 0.04 |
| 48207 | **HASKELL** | 0.16 | | 0.12 | 0.01 | | | 0.03 | 0.01 | | 0.01 |
| 48213 | **HENDERSON** | | | | 0.01 | | | | 0.02 | 0.01 | 0.03 |
| 48215 | **HIDALGO** | 0.13 | | 0.10 | | | | 0.03 | | | |
| 48221 | **HOOD** | 0.02 | 0.02 | 0.02 | 0.04 | 0.01 | | 0.03 | 0.12 | 0.04 | 0.22 |
| 48251 | **JOHNSON** | | | | | | | | 0.01 | | |
| 48253 | **JONES** | 0.14 | | 0.11 | | | | 0.03 | | | 0.01 |
| 48277 | **LAMAR** | | | | | | | | | | 0.01 |
| 48293 | **LIMESTONE** | 0.01 | 0.01 | | | 0.05 | 0.01 | | | | |
| 48299 | **LLANO** | | 0.12 | | 0.21 | | 0.01 | | | | |
| 48309 | **MCLENNAN** | 0.04 | 0.04 | 0.03 | 0.07 | 0.02 | 0.01 | 0.06 | 0.22 | 0.07 | 0.40 |
| 48335 | **MITCHELL** | 0.04 | 0.04 | 0.03 | 0.07 | 0.02 | 0.01 | 0.06 | 0.21 | 0.07 | 0.39 |
| 48353 | **NOLAN** | | | | | | | | | | 0.01 |
| 48355 | **NUECES** | 0.74 | 0.01 | 0.55 | 0.02 | 0.01 | 0.01 | 0.15 | 0.02 | 0.01 | 0.03 |
| 48363 | **PALO PINTO** | 0.01 | 0.02 | 0.01 | 0.03 | 0.01 | | 0.09 | 0.36 | | 0.02 |
| 48367 | **PARKER** | | | | | | | 0.01 | 0.03 | | |
| 48387 | **RED RIVER** | | | | | | | | 0.01 | | 0.02 |
| 48395 | **ROBERTSON** | | | | | 0.01 | | | | 0.40 | 0.01 |
| 48401 | **RUSK** | 0.01 | 0.01 | 0.01 | 0.01 | | | 0.01 | 0.04 | 0.01 | 0.07 |
| 48439 | **TARRANT** | 0.04 | 0.04 | 0.03 | 0.06 | 0.02 | 0.01 | 0.05 | 0.18 | 0.06 | 0.33 |
| 48441 | **TAYLOR** | 0.01 | | | | | | | | | |
| 48449 | **TITUS** | 0.01 | 0.01 | 0.01 | 0.02 | | | 0.02 | 0.05 | 0.02 | 0.10 |
| 48453 | **TRAVIS** | | 0.46 | | 0.05 | | | | | | |
| 48469 | **VICTORIA** | 0.30 | 0.01 | 0.22 | 0.01 | | | 0.68 | 0.05 | | 0.01 |
| 48475 | **WARD** | 0.06 | 0.06 | 0.04 | 0.09 | 0.02 | 0.01 | 0.08 | 0.28 | 0.10 | 0.51 |
| 48479 | **WEBB** | 0.06 | | 0.05 | | | | 0.01 | | | |
| 48481 | **WHARTON** | | | | | 0.01 | | | | | |
| 48503 | **YOUNG** | 0.02 | 0.02 | 0.01 | 0.03 | 0.01 | | 0.03 | 0.09 | 0.03 | 0.16 |
| | ***TOTAL*** | ***2.90*** | ***2.56*** | ***2.24*** | ***3.16*** | ***2.50*** | ***2.65*** | ***3.28*** | ***3.22*** | ***1.59*** | ***3.66*** |

Table 14: EPA's eGRID table: County-wide NOx Reductions in pounds per MWh for EE/RE Implemented in each listed PCA (Received from USEPA November 2002)

| Area | County | American Electric Power - West (ERCOT)/PCA | Austin Energy/PCA | Brownsville Public Utils Board/PCA | Lower Colorado River Auhotrity/PCA | Reliant Energy HL&P/PCA | San Antonio Public Service Bd/PCA | South Texas Electric Coop INC/PCA | Texas Municipal Power Pool/PCA | Texas-New Mexico Power Co/PCA | TXU Electric/PCA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Austin-San Antonio Area | BASTROP | 0.01 | 0.20 | | 0.34 | | 0.01 | | | | |
| | BEXAR | 0.06 | 0.09 | 0.04 | 0.16 | | 2.00 | 0.08 | 0.01 | | |
| | TRAVIS | | 0.46 | | 0.05 | | | | | | |
| | FAYETTE | 0.02 | 0.86 | 0.02 | 1.51 | 0.01 | 0.04 | 0.01 | 0.02 | | 0.02 |
| | LLANO | | 0.12 | | 0.21 | | 0.01 | | | | |
| | CALDWELL | | | | | | | | | | |
| | COMAL | | | | | | | | | | |
| | GUADALUPE | | | | | | | | | | |
| | HAYS | | | | | | | | | | |
| | WILLIAMSON | | | | | | | | | | |
| | WILSON | | | | | | | | | | |
| Dallas-Fort Worth Area | COLLIN | 0.01 | 0.01 | | 0.02 | 0.01 | | 0.05 | 0.19 | | 0.02 |
| | DALLAS | 0.06 | 0.06 | 0.04 | 0.09 | 0.03 | 0.01 | 0.09 | 0.30 | 0.09 | 0.51 |
| | DENTON | | 0.01 | | 0.01 | | | 0.04 | 0.15 | | 0.01 |
| | JOHNSON | | | | | | | | 0.01 | | |
| | PARKER | | | | | | | 0.01 | 0.03 | | |
| | CHEROKEE | 0.01 | 0.01 | 0.01 | 0.02 | | | 0.02 | 0.06 | 0.02 | 0.10 |
| | COKE | 0.03 | | 0.02 | | | | 0.01 | | | |
| | COLEMAN | 0.02 | | 0.01 | | | | | | | |
| | FANNIN | 0.02 | 0.02 | 0.01 | 0.03 | 0.01 | | 0.03 | 0.09 | 0.03 | 0.17 |
| | FRIO | 0.05 | | 0.04 | 0.01 | | | 1.15 | 0.07 | | |
| | HARDEMAN | 0.01 | | 0.01 | | | | | | | |
| | HASKELL | 0.16 | | 0.12 | 0.01 | | | 0.03 | 0.01 | | 0.01 |
| | HENDERSON | | | | 0.01 | | | | 0.02 | 0.01 | 0.03 |
| | HOOD | 0.02 | 0.02 | 0.02 | 0.04 | 0.01 | | 0.03 | 0.12 | 0.04 | 0.22 |
| | JONES | 0.14 | | 0.11 | | | | 0.03 | | | 0.01 |
| | LAMAR | | | | | | | | | | 0.01 |
| | LIMESTONE | 0.01 | 0.01 | | | 0.05 | 0.01 | | | | |
| | MCLENNAN | 0.04 | 0.04 | 0.03 | 0.07 | 0.02 | 0.01 | 0.06 | 0.22 | 0.07 | 0.40 |
| | MITCHELL | 0.04 | 0.04 | 0.03 | 0.07 | 0.02 | 0.01 | 0.06 | 0.21 | 0.07 | 0.39 |
| | NOLAN | | | | | | | | | | 0.01 |
| | PALO PINTO | 0.01 | 0.02 | 0.01 | 0.03 | 0.01 | | 0.09 | 0.36 | | 0.02 |
| | RED RIVER | | | | | | | | 0.01 | | 0.02 |
| | TAYLOR | 0.01 | | | | | | | | | |
| | TITUS | 0.01 | 0.01 | 0.01 | 0.02 | | | 0.02 | 0.05 | 0.02 | 0.10 |
| | YOUNG | 0.02 | 0.02 | 0.01 | 0.03 | 0.01 | | 0.03 | 0.09 | 0.03 | 0.16 |
| | TARRANT | 0.04 | 0.04 | 0.03 | 0.06 | 0.02 | 0.01 | 0.05 | 0.18 | 0.06 | 0.33 |
| | ELLIS | | | | | | | | | | |
| | KAUFMAN | | | | | | | | | | |
| | ROCKWALL | | | | | | | | | | |
| Houston - Galveston Area | BRAZORIA | 0.01 | 0.01 | | | 0.05 | 0.01 | | | | |
| | BRAZOS | | 0.01 | | 0.01 | | | 0.03 | 0.11 | | 0.01 |
| | GRIMES | 0.01 | 0.01 | | 0.02 | 0.01 | | 0.06 | 0.23 | | 0.01 |
| | WHARTON | | | | | 0.01 | | | | | |
| | CHAMBERS | 0.05 | 0.06 | 0.03 | 0.02 | 0.35 | 0.08 | 0.03 | 0.02 | 0.02 | 0.03 |
| | FORT BEND | 0.13 | 0.17 | 0.10 | 0.06 | 1.01 | 0.23 | 0.09 | 0.06 | 0.07 | 0.10 |
| | GALVESTON | 0.05 | 0.06 | 0.04 | 0.02 | 0.39 | 0.09 | 0.04 | 0.03 | 0.42 | 0.04 |
| | ROBERTSON | | | | | 0.01 | | | | 0.40 | 0.01 |
| | HARRIS | 0.05 | 0.07 | 0.04 | 0.02 | 0.41 | 0.09 | 0.04 | 0.02 | 0.03 | 0.04 |
| | HARDIN | | | | | | | | | | |
| | JEFFERSON | | | | | | | | | | |
| | LIBERTY | | | | | | | | | | |
| | MONTGOMERY | | | | | | | | | | |
| | ORANGE | | | | | | | | | | |
| | WALLER | | | | | | | | | | |
| El Paso Area | EL PASO | | | | | | | | | | |
| OTHER | RUSK | 0.01 | 0.01 | 0.01 | 0.01 | | | 0.01 | 0.04 | 0.01 | 0.07 |
| | CROCKETT | 0.14 | | 0.11 | | | | 0.03 | | | 0.01 |
| | FREESTONE | 0.02 | 0.02 | 0.02 | 0.04 | 0.01 | | 0.03 | 0.12 | 0.04 | 0.22 |
| | CALHOUN | 0.19 | | 0.14 | 0.01 | | | 0.04 | 0.01 | | 0.01 |
| | HIDALGO | 0.13 | | 0.10 | | | | 0.03 | | | |
| | CAMERON | 0.14 | | 0.20 | | | | 0.03 | | | 0.01 |
| | WARD | 0.06 | 0.06 | 0.04 | 0.09 | 0.02 | 0.01 | 0.08 | 0.28 | 0.10 | 0.51 |
| | WEBB | 0.06 | | 0.05 | | | | 0.01 | | | |
| | NUECES | 0.74 | 0.01 | 0.55 | 0.02 | 0.01 | 0.01 | 0.15 | 0.02 | 0.01 | 0.03 |
| | VICTORIA | 0.30 | 0.01 | 0.22 | 0.01 | | | 0.68 | 0.05 | | 0.01 |
| | GREGG | | | | | | | | | | |
| | HARRISON | | | | | | | | | | |
| | SMITH | | | | | | | | | | |
| | UPSHUR | | | | | | | | | | |
| | SAN PATRICIO | | | | | | | | | | |
| | **TOTAL** | **2.89** | **2.54** | **2.22** | **3.12** | **2.48** | **2.63** | **3.27** | **3.19** | **1.54** | **3.65** |

Table 15: EPA's eGRID table: County-wide NOx Reductions in pounds per MWh for EE/RE Implemented in each listed PCA (Including 38 Non-attainment and Affected Counties)

| Area | County | American Electric Power - West (ERCOT) /PCA | NOx Reductions (lbs) | Austin Energy/PCA | NOx Reductions (lbs) | Brownsville Public Utils Board/PCA | NOx Reductions (lbs/year) | Lower Colorado River Auhotrity /PCA | NOx Reductions (lbs) | Reliant Energy HL&P/PCA | NOx Reductions (lbs) | San Antonio Public Service Bd/PCA | NOx Reductions (lbs) | South Texas Electric Coop INC/PCA | NOx Reductions (lbs) | Texas Municipal Power Pool/PCA | NOx Reductions (lbs) | Texas-New Mexico Power Co/PCA | NOx Reductions (lbs) | TXU Electric/PCA | NOx Reductions (lbs) | Total Nox Reductions (Tons) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austin-San Antonio Area | BASTROP | 0.01 | 0.00 | 0.20 | 0.00 | | 0.00 | 0.34 | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | BEXAR | 0.06 | 0.00 | 0.09 | 0.00 | 0.04 | 0.00 | 0.16 | 0.00 | | 0.00 | 2.00 | 0.00 | 0.08 | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | TRAVIS | | 0.00 | 0.46 | 0.00 | | 0.00 | 0.05 | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | FAYETTE | 0.02 | 0.00 | 0.86 | 0.00 | 0.02 | 0.00 | 1.51 | 0.00 | 0.01 | 0.00 | 0.04 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | | 0.00 | 0.02 | 0.00 | 0.00 |
| | LLANO | | 0.00 | 0.12 | 0.00 | | 0.00 | 0.21 | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | CALDWELL | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | COMAL | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | GUADALUPE | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | HAYS | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | WILLIAMSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | WILSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| Dallas-Fort Worth Area | COLLIN | 0.01 | 0.00 | 0.01 | 0.00 | | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | | 0.00 | 0.05 | 0.00 | 0.19 | 0.00 | | 0.00 | 0.02 | 0.00 | 0.00 |
| | DALLAS | 0.06 | 0.00 | 0.06 | 0.00 | 0.04 | 0.00 | 0.09 | 0.00 | 0.03 | 0.00 | 0.01 | 0.00 | 0.09 | 0.00 | 0.30 | 0.00 | 0.09 | 0.00 | 0.51 | 0.00 | 0.00 |
| | DENTON | | 0.00 | 0.01 | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | 0.04 | 0.00 | 0.15 | 0.00 | | 0.00 | 0.01 | 0.00 | 0.00 |
| | JOHNSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | PARKER | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | CHEROKEE | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | | 0.00 | | 0.00 | 0.02 | 0.00 | 0.06 | 0.00 | 0.02 | 0.00 | 0.10 | 0.00 | 0.00 |
| | COKE | 0.03 | 0.00 | | 0.00 | 0.02 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | COLEMAN | 0.02 | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | FANNIN | 0.02 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.03 | 0.00 | 0.01 | 0.00 | | 0.00 | 0.03 | 0.00 | 0.09 | 0.00 | 0.03 | 0.00 | 0.17 | 0.00 | 0.00 |
| | FRIO | 0.05 | 0.00 | | 0.00 | 0.04 | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | 1.15 | 0.00 | 0.07 | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | HARDEMAN | 0.01 | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | HASKELL | 0.16 | 0.00 | | 0.00 | 0.12 | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | 0.01 | 0.00 | | 0.00 | 0.01 | 0.00 | 0.00 |
| | HENDERSON | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.03 | 0.00 | 0.00 |
| | HOOD | 0.02 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 | 0.04 | 0.00 | 0.01 | 0.00 | | 0.00 | 0.03 | 0.00 | 0.12 | 0.00 | 0.04 | 0.00 | 0.22 | 0.00 | 0.00 |
| | JONES | 0.14 | 0.00 | | 0.00 | 0.11 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | 0.00 |
| | LAMAR | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | 0.00 |
| | LIMESTONE | 0.01 | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | 0.05 | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | MCLENNAN | 0.04 | 0.00 | 0.04 | 0.00 | 0.03 | 0.00 | 0.07 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.06 | 0.00 | 0.22 | 0.00 | 0.07 | 0.00 | 0.40 | 0.00 | 0.00 |
| | MITCHELL | 0.04 | 0.00 | 0.04 | 0.00 | 0.03 | 0.00 | 0.07 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.06 | 0.00 | 0.21 | 0.00 | 0.07 | 0.00 | 0.39 | 0.00 | 0.00 |
| | NOLAN | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | 0.00 |
| | PALO PINTO | 0.01 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.03 | 0.00 | 0.01 | 0.00 | | 0.00 | 0.09 | 0.00 | 0.36 | 0.00 | | 0.00 | 0.02 | 0.00 | 0.00 |
| | RED RIVER | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | 0.02 | 0.00 | 0.00 |
| | TAYLOR | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | TITUS | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | | 0.00 | | 0.00 | 0.02 | 0.00 | 0.05 | 0.00 | 0.02 | 0.00 | 0.10 | 0.00 | 0.00 |
| | YOUNG | 0.02 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.03 | 0.00 | 0.01 | 0.00 | | 0.00 | 0.03 | 0.00 | 0.09 | 0.00 | 0.03 | 0.00 | 0.16 | 0.00 | 0.00 |
| | TARRANT | 0.04 | 0.00 | 0.04 | 0.00 | 0.03 | 0.00 | 0.06 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.05 | 0.00 | 0.18 | 0.00 | 0.06 | 0.00 | 0.33 | 0.00 | 0.00 |
| | ELLIS | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | KAUFMAN | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | ROCKWALL | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| Houston - Galveston Area | BRAZORIA | 0.01 | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | 0.05 | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | BRAZOS | | 0.00 | 0.01 | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | 0.11 | 0.00 | | 0.00 | 0.01 | 0.00 | 0.00 |
| | GRIMES | 0.01 | 0.00 | 0.01 | 0.00 | | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | | 0.00 | 0.06 | 0.00 | 0.23 | 0.00 | | 0.00 | 0.01 | 0.00 | 0.00 |
| | WHARTON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | CHAMBERS | 0.05 | 0.00 | 0.06 | 0.00 | 0.03 | 0.00 | 0.02 | 0.00 | 0.35 | 0.00 | 0.08 | 0.00 | 0.03 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 | 0.03 | 0.00 | 0.00 |
| | FORT BEND | 0.13 | 0.00 | 0.17 | 0.00 | 0.10 | 0.00 | 0.06 | 0.00 | 1.01 | 0.00 | 0.23 | 0.00 | 0.09 | 0.00 | 0.06 | 0.00 | 0.07 | 0.00 | 0.10 | 0.00 | 0.00 |
| | GALVESTON | 0.05 | 0.00 | 0.06 | 0.00 | 0.04 | 0.00 | 0.02 | 0.00 | 0.39 | 0.00 | 0.09 | 0.00 | 0.04 | 0.00 | 0.03 | 0.00 | 0.42 | 0.00 | 0.04 | 0.00 | 0.00 |
| | ROBERTSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.40 | 0.00 | 0.01 | 0.00 | 0.00 |
| | HARRIS | 0.05 | 0.00 | 0.07 | 0.00 | 0.04 | 0.00 | 0.02 | 0.00 | 0.41 | 0.00 | 0.09 | 0.00 | 0.04 | 0.00 | 0.02 | 0.00 | 0.03 | 0.00 | 0.04 | 0.00 | 0.00 |
| | HARDIN | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | JEFFERSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | LIBERTY | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | MONTGOMERY | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | ORANGE | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | WALLER | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| El Paso Area | EL PASO | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| OTHER | RUSK | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | 0.04 | 0.00 | 0.01 | 0.00 | 0.07 | 0.00 | 0.00 |
| | CROCKETT | 0.14 | 0.00 | | 0.00 | 0.11 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | 0.00 |
| | FREESTONE | 0.02 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 | 0.04 | 0.00 | 0.01 | 0.00 | | 0.00 | 0.03 | 0.00 | 0.12 | 0.00 | 0.04 | 0.00 | 0.22 | 0.00 | 0.00 |
| | CALHOUN | 0.19 | 0.00 | | 0.00 | 0.14 | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | 0.04 | 0.00 | 0.01 | 0.00 | | 0.00 | 0.01 | 0.00 | 0.00 |
| | HIDALGO | 0.13 | 0.00 | | 0.00 | 0.10 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | CAMERON | 0.14 | 0.00 | | 0.00 | 0.20 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | 0.00 |
| | WARD | 0.06 | 0.00 | 0.06 | 0.00 | 0.04 | 0.00 | 0.09 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.08 | 0.00 | 0.28 | 0.00 | 0.10 | 0.00 | 0.51 | 0.00 | 0.00 |
| | WEBB | 0.06 | 0.00 | | 0.00 | 0.05 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | NUECES | 0.74 | 0.00 | 0.01 | 0.00 | 0.55 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.15 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.03 | 0.00 | 0.00 |
| | VICTORIA | 0.30 | 0.00 | 0.01 | 0.00 | 0.22 | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | 0.68 | 0.00 | 0.05 | 0.00 | | 0.00 | 0.01 | 0.00 | 0.00 |
| | GREGG | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | HARRISON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | SMITH | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | UPSHUR | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | SAN PATRICIO | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 |
| | **TOTAL** | **2.89** | | **2.54** | | **2.22** | | **3.12** | | **2.48** | | **2.63** | | **3.27** | | **3.19** | | **1.54** | | **3.65** | | |
| Energy Savings by PCA from ESL (MWh) | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | |

Table 16: Modified Calculation

| County | Region Number | Region Name | Electric Utilities | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ANDERSON | 6 | East Texas Council of Governments | ONCOR | Trinity Valley EC | Houston County EC | | | | | |
| ANDREWS | 9 | Permian Basin Regional Planning Commission | ONCOR | Cap Rock EC | | | | | | |
| ANGELINA | 14 | Deep East Texas Council of Governments | ONCOR | Sam Houston EC | Houston County EC | Jasper-Newton EC | | | | |
| ARANSAS | 20 | Coastal Bend Council of Governments | CPL(AEP) | San Patricio EC | | | | | | |
| ARCHER | 3 | North Texas Regional Planning Commission | ONCOR | T-NMP | J-A-C EC | Fort Belknap EC | Tri-County EC | Southwest Rural EC | | |
| ARMSTRONG | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Greenbelt EC | Swisher EC | | | | | |
| ATASCOSA | 18 | Alamo Area Council of Governments | CPL(AEP) | CPSB | Medina EC | Karnes EC | | | | |
| AUSTIN | 16 | Houston-Galvetson Area Council | RELIANT(CENTER POINT) | Bellville | San Benard EC | Bluebonnet EC | Fayette EC | | | |
| BAILEY | 2 | South Plains Association of Governments | XCEL(SPS) | Bailey County EC | Lamb County EC | | | | | |
| BANDERA | 18 | Alamo Area Council of Governments | Bandera EC | | | | | | | |
| BASTROP | 12 | Capitol Area Planning Council | ONCOR | Smithville | Bluebonnet EC | Fayette EC | | | | |
| BAYLOR | 3 | North Texas Regional Planning Commission | ONCOR | Seymour | Tri-County EC | Southwest Rural EC | | | | |
| BEE | 20 | Coastal Bend Council of Governments | CPL(AEP) | San Patricio EC | Karnes EC | | | | | |
| BELL | 23 | Central Texas Council of Governments | ONCOR | Bartlett EC | Belfalls EC | McLennan County EC | Pedernales EC | Bartlett | | |
| BEXAR | 18 | Alamo Area Council of Governments | CPSB | Bandera EC | Karnes EC | | | | | |
| BLANCO | 12 | Capitol Area Planning Council | Pedernales EC | Central Texas EC | | | | | | |
| BORDEN | 9 | Permian Basin Regional Planning Commission | Lyntegar EC | Big Country EC | Cap Rock EC | | | | | |
| BOSQUE | 11 | Heart of Texas Council of Governments | T-NMP | United Coop Services | McLennan County EC | | | | | |
| BOWIE | 5 | Ark-Tex Council of Governments | SWEPCO(AEP) | Bowie-Cass EC | Southwest Arkansas EC | | | | | |
| BRAZORIA | 16 | Houston-Galveston Area Council | RELIANT(CENTER POINT) | T-NMP | Jackson EC | | | | | |
| BRAZOS | 13 | Brazos Valley Council of Governments | BRYAN | College Station | Mid-South EC | Navasota Valley EC | | | | |
| BREWSTER | 8 | Rio Grande Council of Governments | WTU(AEP) | Rio Grande EC | | | | | | |
| BRISCOE | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | WTU(AEP) | Lighthouse EC | Swisher EC | | | | |
| BROOKS | 20 | Coastal Bend Council of Governments | CPL(AEP) | Medina EC | Nueces EC | | | | | |
| BROWN | 7 | West Central Texas Council of Governments | ONCOR | WTU(AEP) | Cap Rock EC | Comanche EC | | | | |
| BURLESON | 13 | Brazos Valley Council of Governments | ENTERGY | BRYAN | Bartlett EC | Bluebonnet EC | | | | |
| BURNET | 12 | Capitol Area Planning Council | ONCOR | Pedernales EC | | | | | | |
| CALDWELL | 12 | Capitol Area Planning Council | CPL(AEP) | Luling | Pedernales EC | Bluebonnet EC | | | | |
| CALHOUN | 17 | Golden Crescent Regional Planning Commission | CPL(AEP) | Victoria EC | Jackson EC | | | | | |
| CALLAHAN | 7 | West Central Texas Council of Governments | WTU(AEP) | Taylor EC | Comanche EC | | | | | |
| CAMERON | 21 | Lower Rio Grande Valley Development Council | CPL(AEP) | Magic Valley EC | Brownsville | | | | | |
| CAMP | 6 | East Texas Council of Governments | SWEPCO(AEP) | Wood County EC | Upshur-Rural EC | | | | | |
| CARSON | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | | | | | | | |
| CASS | 5 | Ark-Tex Council of Governments | SWEPCO(AEP) | Upshur-Rural EC | Bowie-Cass EC | | | | | |
| CASTRO | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Deaf Smith EC | Bailey County EC | Lamb County EC | Swisher EC | | | |
| CHAMBERS | 16 | Houston-Galveston Area Council | RELIANT(CENTER POINT) | ENTERGY | | | | | | |
| CHEROKEE | 6 | East Texas Council of Governments | ONCOR | Cherokee County EC | Houston County EC | | | | | |
| CHILDRESS | 1 | Panhandle Regional Planning Commission | WTU(AEP) | Greenbelt EC | Lighthouse EC | South Plains EC | Harmon EC | | | |
| CLAY | 3 | North Texas Regional Planning Commission | ONCOR | T-NMP | J-A-C EC | Wise EC | | | | |
| COCHRAN | 2 | South Plains Association of Governments | XCEL(SPS) | Bailey County EC | Lamb County EC | Lea County Ec | | | | |
| COKE | 10 | Concho Valley Council of Governments | WTU(AEP) | Concho Valley EC | Taylor EC | | | | | |
| COLEMAN | 7 | West Central Texas Council of Governments | WTU(AEP) | Coleman | Cap Rock EC | Coleman County EC | | | | |
| COLLIN | 4 | North Central Texas Council of Governments | ONCOR | T-NMP | Farmersville | Cap Rock EC | Grayson-Collin EC | CoServ E | FEC Electric | Fannin County EC |
| COLLINGSWORTH | 1 | Panhandle Regional Planning Commission | WTU(AEP) | Greenbelt EC | | | | | | |
| COLORADO | 16 | Houston-Galveston Area Council | CPL(AEP) | Weimar | Fayette EC | Bluebonnet EC | San Benard EC | Wharton County EC | | |
| COMAL | 18 | Alamo Area Council of Governments | CPSB | New Braunfels | Pedernales EC | | | | | |
| COMANCHE | 7 | West Central Texas Council of Governments | ONCOR | T-NMP | Comanche EC | United Coop Services | | | | |
| CONCHO | 10 | Concho Valley Council of Governments | WTU(AEP) | Concho Valley EC | Cap Rock EC | Coleman County EC | Southwest Tx EC | | | |
| COOKE | 22 | Texoma Council of Governments | ONCOR | Cooke County EC | CoServ E | Wise EC | | | | |
| CORYELL | 23 | Central Texas Council of Governments | ONCOR | T-NMP | McLennan County EC | Hamilton County EC | United Coop Services | | | |
| COTTLE | 3 | North Texas Regional Planning Commission | WTU(AEP) | South Plains EC | | | | | | |
| CRANE | 9 | Permian Basin Regional Planning Commission | ONCOR | | | | | | | |
| CROCKETT | 10 | Concho Valley Council of Governments | WTU(AEP) | Rio Grande EC | Southwest Tx EC | | | | | |
| CROSBY | 2 | South Plains Association of Governments | XCEL(SPS) | Crosbyton | Lighthouse EC | South Plains EC | | | | |
| CULBERSON | 8 | Rio Grande Council of Governments | EPEC | Rio Grande EC | | | | | | |
| DALLAM | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Rita Blanca EC | | | | | | |
| DALLAS | 4 | North Central Texas Council of Governments | ONCOR | Garland | FEC Electric | HILCO EC | Trinity Valley EC | | | |
| DAWSON | 9 | Permian Basin Regional Planning Commission | ONCOR | Lyntegar EC | Cap Rock EC | | | | | |
| DEAF SMITH | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Deaf Smith EC | Farmers EC New Mexico | | | | | |
| DELTA | 5 | Ark-Tex Council of Governments | ONCOR | Lamar County EC | FEC Electric | | | | | |
| DENTON | 4 | North Central Texas Council of Governments | ONCOR | T-NMP | Denton | Sanger | Cooke County EC | CoServ E | Wise EC | Tri-County EC |
| DEWITT | 17 | Golden Crescent Regional Planning Commission | CPL(AEP) | Yoakum | Cuero | DeWitt EC | Victoria EC | South Texas EC | | |
| DICKENS | 2 | South Plains Association of Governments | WTU(AEP) | South Plains EC | Lighthouse EC | | | | | |
| DIMMIT | 24 | Middle Rio Grande Development Council | CPL(AEP) | Medina EC | Rio Grande EC | | | | | |
| DONLEY | 1 | Panhandle Regional Planning Commission | WTU(AEP) | Greenbelt EC | Lighthouse EC | | | | | |
| DUVAL | 20 | Coastal Bend Council of Governments | CPL(AEP) | Medina EC | Nueces EC | South Texas EC | | | | |
| EASTLAND | 7 | West Central Texas Council of Governments | ONCOR | WTU(AEP) | Comanche EC | United Coop Services | Taylor EC | | | |
| ECTOR | 9 | Permian Basin Regional Planning Commission | ONCOR | Goldsmith | Cap Rock EC | | | | | |
| EDWARDS | 24 | Middle Rio Grande Development Council | CPL(AEP) | Rio Grande EC | Medina EC | Pedernales EC | Southwest Tx EC | | | |
| EL PASO | 8 | Rio Grande Council of Governments | EPEC | Rio Grande EC | | | | | | |
| ELLIS | 4 | North Central Texas Council of Governments | ONCOR | Navarro County EC | HILCO EC | United Coop Services | | | | |
| ERATH | 4 | North Central Texas Council of Governments | ONCOR | T-NMP | United Coop Services | | | | | |
| FALLS | 11 | Heart of Texas Council of Governments | ONCOR | Belfalls EC | McLennan County EC | Navasota Valley EC | | | | |
| FANNIN | 22 | Texoma Council of Governments | ONCOR | T-NMP | Fannin County EC | Cap Rock EC | FEC Electric | Lamar County EC | | |
| FAYETTE | 12 | Capital Area Planning Council | La Grange | Schulenburg | Flatonia | Fayette EC | Bluebonnet EC | | | |
| FISHER | 7 | West Central Texas Council of Governments | WTU(AEP) | Big Country EC | Cap Rock EC | Taylor EC | | | | |
| FLOYD | 2 | South Plains Association of Governments | XCEL(SPS) | Floydada | Lighthouse EC | South Plains EC | | | | |
| FOARD | 3 | North Texas Regional Planning Commission | WTU(AEP) | Southwest Rural EC | South Plains EC | Tri-County EC | | | | |
| FORT BEND | 16 | Houston-Galveston Area Council | RELIANT(CENTER POINT) | | | | | | | |
| FRANKLIN | 5 | Ark-Tex Council of Governments | SWEPCO(AEP) | FEC Electric | Bowie-Cass EC | Wood County EC | | | | |
| FREESTONE | 11 | Heart of Texas Council of Governments | ONCOR | Navasota Valley EC | Navarro County EC | Houston County EC | | | | |
| FRIO | 18 | Alamo Area Council of Governments | CPL(AEP) | Medina EC | | | | | | |
| GAINES | 9 | Permian Basin Regional Planning Commission | XCEL(SPS) | Lyntegar EC | Lea County Ec | | | | | |
| GALVESTON | 16 | Houston-Galveston Area Council | RELIANT(CENTER POINT) | T-NMP | ENTERGY | | | | | |
| GARZA | 2 | South Plains Association of Governments | XCEL(SPS) | Big Country EC | Lyntegar EC | South Plains EC | | | | |
| GILLESPIE | 18 | Alamo Area Council of Governments | Fredericksburg | Pedernales EC | Central Texas EC | | | | | |
| GLASSCOCK | 9 | Permian Basin Regional Planning Commission | ONCOR | Cap Rock EC | | | | | | |
| GOLIAD | 17 | Golden Crescent Regional Planning Commission | CPL(AEP) | Karnes EC | Victoria EC | San Patricio EC | DeWitt EC | | | |
| GONZALES | 17 | Golden Crescent Regional Planning Commission | CPL(AEP) | Gonzales | Waelder | Guadalupe Valey EC | | | | |
| GRAY | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Greenbelt EC | | | | | | |
| GRAYSON | 22 | Texoma Council of Governments | ONCOR | T-NMP | Whitesboro | Grayson-Collin EC | Fannin County EC | Cooke County EC | CoServ E | |
| GREGG | 6 | East Texas Council of Governments | SWEPCO(AEP) | Rusk County EC | Upshur-Rural EC | | | | | |
| GRIMES | 13 | Brazos Valley Council of Governments | ENTERGY | Mid-South EC | San Benard EC | | | | | |
| GUADALUPE | 18 | Alamo Area Council of Governments | CPSB | Seguin | Guadalupe Valey EC | Bluebonnet EC | Pedernales EC | | | |
| HALE | 2 | South Plains Association of Governments | XCEL(SPS) | Swisher EC | Lamb County EC | Lighthouse EC | South Plains EC | | | |
| HALL | 1 | Panhandle Regional Planning Commission | WTU(AEP) | Lighthouse EC | South Plains EC | | | | | |
| HAMILTON | 23 | Central Texas Council of Governments | T-NMP | United Coop Services | Hamilton County EC | McLennan County EC | | | | |
| HANSFORD | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | T-NMP | North Plains EC | Rita Blanca EC | | | | |
| HARDEMAN | 3 | North Texas Regional Planning Commission | WTU(AEP) | South Plains EC | Southwest Rural EC | Harmon EC | | | | |
| HARDIN | 15 | South East Texas Regional Planning Commission | ENTERGY | RELIANT(CENTER POINT) | Sam Houston EC | | | | | |
| HARRIS | 16 | Houston-Galveston Area Council | RELIANT(CENTER POINT) | ENTERGY | San Benard EC | | | | | |
| HARRISON | 6 | East Texas Council of Governments | SWEPCO(AEP) | Panola-Harrison EC | Upshur-Rural EC | | | | | |
| HARTLEY | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Rita Blanca EC | | | | | | |
| HASKELL | 7 | West Central Texas Council of Governments | WTU(AEP) | Big Country EC | Tri-County EC | | | | | |
| HAYS | 12 | Capitol Area Planning Council | San Marcos | Pedernales EC | Bluebonnet EC | | | | | |
| HEMPHILL | 1 | Panhandle Regional Planning Commission | Canadian | North Plains EC | Greenbelt EC | | | | | |
| HENDERSON | 6 | East Texas Council of Governments | ONCOR | Trinity Valley EC | | | | | | |
| HIDALGO | 21 | Lower Rio Grande Valley Development Council | CPL(AEP) | Magic Valley EC | | | | | | |
| HILL | 11 | Heart of Texas Council of Governments | ONCOR | T-NMP | HILCO EC | Navasota Valley EC | Navarro County EC | | | |
| HOCKLEY | 2 | South Plains Association of Governments | XCEL(SPS) | South Plains EC | Lyntegar EC | Lamb County EC | | | | |
| HOOD | 4 | North Central Texas Council of Governments | ONCOR | T-NMP | Granbury | United Coop Services | Tri-County EC | | | |
| HOPKINS | 5 | Ark-Tex Council of Governments | ONCOR | SWEPCO(AEP) | FEC Electric | Wood County EC | | | | |
| HOUSTON | 14 | Deep East Texas Council of Governments | ONCOR | Houston County EC | | | | | | |
| HOWARD | 9 | Permian Basin Regional Planning Commission | ONCOR | Cap Rock EC | | | | | | |
| HUDSPETH | 8 | Rio Grande Council of Governments | EPEC | Rio Grande EC | | | | | | |
| HUNT | 4 | North Central Texas Council of Governments | ONCOR | T-NMP | Greenville | FEC Electric | Cap Rock EC | Trinity Valley EC | Fannin EC | |
| HUTCHINSON | 1 | Panhandle Regional Planning Committee | XCEL(SPS) | North Plains EC | Rita Blanca EC | | | | | |
| IRION | 10 | Concho Valley Council of Governments | WTU(AEP) | Cap Rock EC | Concho Valley EC | Southwest Texas EC | | | | |
| JACK | 3 | North Central Texas Council of Governments | ONCOR | T-NMP | J-A-C EC | Tri-County EC | Fort Belknap EC | Wise EC | | |

Table 17: PUCT Power Suppliers by County (Obtained from PUCT website, http://www.puc.state.tx.us. November, 2002) (Part A).

| County | Region Number | Region Name | Electric Utilities | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| JACKSON | 17 | Golden Crescent Regional Planning Commission | CPL(AEP) | Jackson EC | Victoria EC | DeWitt EC | | | | | |
| JASPER | 14 | Deep East Texas Council of Governments | ENTERGY | Jasper | Kirbyville | Jasper-Newton EC | Deep East Texas EC | Sam Houston EC | | | |
| JEFF DAVIS | 8 | Rio Grande Council of Governments | WTU(AEP) | Rio Grande EC | | | | | | | |
| JEFFERSON | 15 | South East Texas Regional Planning Commission | ENTERGY | | | | | | | | |
| JIM HOGG | 19 | South Texas Development Council | CPL(AEP) | Medina EC | | | | | | | |
| JIM WELLS | 20 | Coastal Bend Council of Governments | CPL(AEP) | Nueces EC | San Patricio EC | | | | | | |
| JOHNSON | 4 | North Central Texas Council of Governments | ONCOR | T-NMP | United Coop Services | HILCO EC | | | | | |
| JONES | 7 | West Central Texas Council of Governments | WTU(AEP) | Taylor EC | Big Country EC | | | | | | |
| KARNES | 18 | Alamo Area Council of Governments | CPL(AEP) | Floresville | Karnes EC | DeWitt EC | | | | | |
| KAUFMAN | 4 | North Central Texas Council of Governments | ONCOR | Trinity Valley EC | FEC Electric | | | | | | |
| KENDALL | 18 | Alamo Area Council of Governments | Boerne | Central Texas EC | Pedernales EC | Bandera EC | | | | | |
| KENEDY | 20 | Coastal Bend Council of Governments | Nueces EC | Magic Valley EC | | | | | | | |
| KENT | 7 | West Central Texas Council of Governments | WTU(AEP) | South Plains EC | Big Country EC | | | | | | |
| KERR | 18 | Alamo Area Council of Governments | Kerrville | Bandera EC | Central Texas EC | Pedernales EC | | | | | |
| KIMBLE | 10 | Concho Valley Council of Governments | WTU(AEP) | Central Texas EC | Pedernales EC | | | | | | |
| KING | 2 | South Plains Association of Governments | WTU(AEP) | South Plains EC | Tri-County EC | | | | | | |
| KINNEY | 24 | Middle Rio Grande Development Council | CPL(AEP) | Rio Grande EC | Medina EC | Pedernales EC | | | | | |
| KLEBERG | 20 | Coastal Bend Council of Governments | CPL(AEP) | Nueces EC | | | | | | | |
| KNOX | 7 | West Central Texas Council of Governments | WTU(AEP) | Tri-County EC | | | | | | | |
| LA SALLE | 24 | Middle Rio Grande Development Council | CPL(AEP) | Medina EC | | | | | | | |
| LAMAR | 5 | Ark-Tex Council of Governments | ONCOR | T-NMP | Lamar County EC | Fannin County EC | | | | | |
| LAMB | 2 | South Plains Association of Governments | XCEL(SPS) | Lamb County EC | Bailey County EC | South Plains EC | | | | | |
| LAMPASAS | 23 | Central Texas Council of Governments | ONCOR | Lampasas | Hamilton County EC | Pedernales EC | | | | | |
| LAVACA | 17 | Golden Crescent Regional Planning Commission | Schulenburg | Yoakum | Hallettsville | Moulton | Shiner | Sweet Home | DeWitt EC | Guadalupe Valley E | Fayette EC |
| LEE | 12 | Capitol Area Planning Council | Giddings | Lexington | Fayette EC | Bluebonnet EC | | | | | |
| LEON | 13 | Brazos Valley Council of Governments | ONCOR | ENTERGY | Navasota Valley EC | Houston County EC | | | | | |
| LIBERTY | 16 | Houston-Galveston Area Council | ENTERGY | Sam Houston EC | | | | | | | |
| LIMESTONE | 11 | Heart of Texas Council of Governments | ONCOR | ENTERGY | Navasota Valley EC | Navarro County EC | | | | | |
| LIPSCOMB | 1 | Panhandle Regional Planning Commission | T-NMP | North Plains EC | | | | | | | |
| LIVE OAK | 20 | Coastal Bend Council of Governments | CPL(AEP) | San Patricio EC | Karnes EC | Nueces EC | | | | | |
| LLANO | 12 | Capitol Area Planning Council | Llano | Pedernales EC | Central Texas EC | | | | | | |
| LOVING | 9 | Permian Basin Regional Planning Commission | ONCOR | | | | | | | | |
| LUBBOCK | 2 | South Plains Association of Governments | XCEL(SPS) | Lubbock | South Plains EC | | | | | | |
| LYNN | 2 | South Plains Association of Governments | XCEL(SPS) | ONCOR | Lyntegar EC | South Plains EC | | | | | |
| MADISON | 13 | Brazos Valley Council of Governments | ENTERGY | Houston County EC | Mid-South EC | Navasota Valley EC | | | | | |
| MARION | 6 | East Texas Council of Governments | SWEPCO(AEP) | Upshur-Rural EC | | | | | | | |
| MARTIN | 9 | Permian Basin Regional Planning Commission | ONCOR | Cap Rock EC | Lyntegar EC | | | | | | |
| MASON | 10 | Concho Valley Council of Governments | Mason | Cap Rock EC | Central Texas EC | Pedernales EC | | | | | |
| MATAGORDA | 16 | Houston-Galveston Area Council | CPL(AEP) | RELIANT(CENTER POINT) | Jackson EC | Wharton County EC | | | | | |
| MAVERICK | 24 | Middle Rio Grande Development Council | CPL(AEP) | Rio Grande EC | | | | | | | |
| McCULLOCH | 10 | Concho Valley Council of Governments | WTU(AEP) | Brady | Cap Rock EC | Central Texas EC | | | | | |
| McLENNAN | 11 | Heart of Texas Council of Governments | ONCOR | T-NMP | McLennan County EC | HILCO EC | Navasota Valley EC | | | | |
| McMULLEN | 20 | Coastal Bend Council of Governments | CPL(AEP) | Karnes EC | Medina EC | Nueces EC | San Patricio EC | | | | |
| MEDINA | 18 | Alamo Area Council of Governments | CPL(AEP) | CPSB | Castroville | Hondo | Medina EC | Bandera EC | Karnes EC | | |
| MENARD | 10 | Concho Valley Council of Governments | WTU(AEP) | Cap Rock EC | Southwest Texas EC | Pedernales EC | Central Texas EC | | | | |
| MIDLAND | 9 | Permian Basin Regional Planning Commission | ONCOR | Cap Rock EC | | | | | | | |
| MILAM | 23 | Central Texas Council of Governments | ONCOR | ENTERGY | Belfalls EC | Bartlett EC | | | | | |
| MILLS | 23 | Central Texas Council of Governments | Goldwaithe | Cap Rock EC | Hamilton County EC | Comanche EC | | | | | |
| MITCHELL | 7 | West Central Texas Council of Governments | ONCOR | Cap Rock EC | Big Country EC | Concho Valley EC | | | | | |
| MONTAGUE | 3 | North Texas Regional Planning Commission | ONCOR | T-NMP | Bowie | Cooke County EC | Wise EC | J-A-C EC | | | |
| MONTGOMERY | 16 | Houston-Galveston Area Council | ENTERGY | RELIANT(CENTER POINT) | Mid-South EC | Sam Houston EC | San Benard EC | | | | |
| MOORE | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Rita Blanca EC | | | | | | | |
| MORRIS | 5 | Ark-Tex Council of Governments | SWEPCO(AEP) | Bowie-Cass EC | Upshur-Rural EC | | | | | | |
| MOTLEY | 2 | South Plains Association of Governments | WTU(AEP) | Lighthouse EC | South Plains EC | | | | | | |
| NACOGDOCHES | 14 | Deep East Texas Council of Governments | ONCOR | Cherokee County EC | Deep East Texas EC | Rusk County EC | | | | | |
| NAVARRO | 4 | North Central Texas Council of Governments | ONCOR | Navarro County EC | | | | | | | |
| NEWTON | 14 | Deep East Texas Council of Governments | Newton | Jasper-Newton EC | Deep East Texas EC | | | | | | |
| NOLAN | 7 | West Central Texas Council of Governments | WTU(AEP) | ONCOR | Taylor EC | Cap Rock EC | Big Country EC | Concho Valley EC | | | |
| NUECES | 20 | Coastal Bend Council of Governments | CPL(AEP) | Robstown | Nueces EC | San Patricio EC | | | | | |
| OCHILTREE | 1 | Panhandle Regional Planning Commission | T-NMP | North Plains EC | | | | | | | |
| OLDHAM | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Deaf Smith EC | Rita Blanca EC | | | | | | |
| ORANGE | 15 | South East Texas Regional Planning Commission | ENTERGY | Jasper-Newton EC | | | | | | | |
| PALO PINTO | 4 | North Central Texas Council of Governments | ONCOR | T-NMP | Tri-County EC | United Coop Services | | | | | |
| PANOLA | 6 | East Texas Council of Governments | SWEPCO(AEP) | Rusk County EC | Panola-Harrison EC | Deep East Texas EC | | | | | |
| PARKER | 4 | North Central Texas Council of Governments | ONCOR | Weatherford | Wise EC | Tri-County EC | | | | | |
| PARMER | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Deaf Smith EC | Bailey County EC | | | | | | |
| PECOS | 9 | Permian Basin Regional Planning Commission | WTU(AEP) | ONCOR | T-NMP | Rio Grande EC | Southwest Texas EC | | | | |
| POLK | 14 | Deep East Texas Council of Governments | ENTERGY | Livingston | Sam Houston EC | | | | | | |
| POTTER | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Rita Blanca EC | | | | | | | |
| PRESIDIO | 8 | Rio Grande Council of Governments | WTU(AEP) | Rio Grande EC | | | | | | | |
| RAINS | 6 | East Texas Council of Governments | T-NMP | FEC Electric | Wood County EC | | | | | | |
| RANDALL | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Greenbelt EC | Swisher EC | | | | | | |
| REAGAN | 10 | Concho Valley Council of Governments | WTU(AEP) | Cap Rock EC | Concho Valley EC | Southwest Texas EC | | | | | |
| REAL | 24 | Middle Rio Grande Development Council | CPL(AEP) | Bandera EC | Central Texas EC | Medina EC | Pedernales EC | | | | |
| RED RIVER | 5 | Ark-Tex Council of Governments | ONCOR | SWEPCO(AEP) | T-NMP | Lamar County EC | Bowie-Cass EC | | | | |
| REEVES | 9 | Permian Basin Regional Planning Commission | WTU(AEP) | ONCOR | T-NMP | Rio Grande EC | | | | | |
| REFUGIO | 20 | Coastal Bend Council of Governments | CPL(AEP) | San Patricio EC | Victoria EC | | | | | | |
| ROBERTS | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Greenbelt EC | North Plains EC | | | | | | |
| ROBERTSON | 13 | Brazos Valley Council of Governments | ENTERGY | Hearne | Benchely | Wheelock | Navasota Valley EC | | | | |
| ROCKWALL | 4 | North Central Texas Council of Governments | ONCOR | FEC Electric | | | | | | | |
| RUNNELS | 7 | West Central Texas Council of Governments | WTU(AEP) | Coleman County EC | Concho Valley EC | | | | | | |
| RUSK | 6 | East Texas Council of Governments | SWEPCO(AEP) | ONCOR | Rusk County EC | Cherokee County EC | Deep East Texas EC | Upshur-Rural EC | | | |
| SABINE | 14 | Deep East Texas Council of Governments | Hemphill | Pineland | Jasper-Newton EC | Deep East Texas EC | | | | | |
| SAN AUGUSTINE | 14 | Deep East Texas Council of Governments | San Augustine | Deep East Texas EC | | | | | | | |
| SAN JACINTO | 14 | Deep East Texas Council of Governments | ENTERGY | Sam Houston EC | | | | | | | |
| SAN PATRICIO | 20 | Coastal Bend Council of Governments | CPL(AEP) | San Patricio EC | | | | | | | |
| SAN SABA | 23 | Central Texas Council of Governments | San Saba | Central Texas EC | Hamilton County EC | Cap Rock EC | Pedernales EC | | | | |
| SCHLEICHER | 10 | Concho Valley Council of Governments | WTU(AEP) | Pedernales EC | Southwest Texas EC | | | | | | |
| SCURRY | 7 | West Central Texas Council of Governments | ONCOR | Cap Rock EC | Big Country EC | | | | | | |
| SHACKELFORD | 7 | West Central Texas Council of Governments | WTU(AEP) | Fort Belknap EC | Big Country EC | Comanche EC | Taylor EC | | | | |
| SHELBY | 14 | Deep East Texas Council of Governments | SWEPCO(AEP) | Deep East Texas EC | Rusk County EC | | | | | | |
| SHERMAN | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Rita Blanca EC | | | | | | | |
| SMITH | 6 | East Texas Council of Governments | ONCOR | SWEPCO(AEP) | Wood County EC | Cherokee County EC | Upshur-Rural EC | | | | |
| SOMERVELL | 4 | North Central Texas Council of Governments | T-NMP | United Coop Services | | | | | | | |
| STARR | 19 | South Texas Development Council | CPL(AEP) | Medina EC | Magic Valley EC | | | | | | |
| STEPHENS | 7 | West Central Texas Council of Governments | ONCOR | Comanche EC | Fort Belknap EC | United Coop Services | | | | | |
| STERLING | 10 | Concho Valley Council of Governments | WTU(AEP) | Cap Rock EC | Concho Valley EC | | | | | | |
| STONEWALL | 7 | West Central Texas Council of Governments | WTU(AEP) | Big Country EC | South Plains EC | Tri-County EC | | | | | |
| SUTTON | 10 | Concho Valley Council of Governments | WTU(AEP) | Pedernales EC | Southwest Texas EC | | | | | | |
| SWISHER | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | Tulia | Swisher EC | Lighthouse EC | | | | | |
| TARRANT | 4 | North Central Texas Council of Governments | ONCOR | Tri-County EC | CoServ E | United Coop Services | | | | | |
| TAYLOR | 7 | West Central Texas Council of Governments | WTU(AEP) | Taylor EC | | | | | | | |
| TERRELL | 9 | Permian Basin Regional Planning Commission | T-NMP | Rio Grande EC | | | | | | | |
| TERRY | 2 | South Plains Association of Governments | XCEL(SPS) | Brownfield | Lyntegar EC | | | | | | |
| THROCKMORTON | 7 | West Central Texas Council of Governments | WTU(AEP) | Fort Belknap EC | Big Country EC | Tri-County EC | | | | | |
| TITUS | 5 | Ark-Tex Council of Governments | SWEPCO(AEP) | T-NMP | Bowie-Cass EC | Wood County EC | | | | | |
| TOM GREEN | 10 | Concho Valley Council of Governments | WTU(AEP) | Concho Valley EC | Cap Rock EC | Southwest Texas EC | | | | | |
| TRAVIS | 12 | Capitol Area Planning Council | ONCOR | Austin Energy | Pedernales EC | Bluebonnet EC | | | | | |
| TRINITY | 14 | Deep East Texas Council of Governments | ENTERGY | Houston County EC | Sam Houston EC | | | | | | |
| TYLER | 14 | Deep East Texas Council of Governments | ENTERGY | Sam Houston EC | | | | | | | |
| UPSHUR | 6 | East Texas Council of Governments | SWEPCO(AEP) | Upshur-Rural EC | Wood County EC | | | | | | |
| UPTON | 9 | Permian Basin Regional Planning Commission | WTU(AEP) | ONCOR | Cap Rock EC | Southwest Texas EC | | | | | |
| UVALDE | 24 | Middle Rio Grande Development Council | CPL(AEP) | Bandera EC | Medina EC | Rio Grande EC | | | | | |
| VAL VERDE | 24 | Middle Rio Grande Development Council | CPL(AEP) | Rio Grande EC | Southwest Texas EC | | | | | | |
| VAN ZANDT | 6 | East Texas Council of Governments | ONCOR | SWEPCO(AEP) | Wood County EC | Trinity Valley EC | FEC Electric | | | | |
| VICTORIA | 17 | Golden Crescent Regional Planning Commission | CPL(AEP) | Victoria EC | DeWitt EC | | | | | | |
| WALKER | 16 | Houston-Galveston Area Council | ENTERGY | Mid-South EC | Sam Houston EC | Houston County EC | | | | | |
| WALLER | 16 | Houston-Galveston Area Council | RELIANT(CENTER POINT) | Hempstead | Mid-South EC | San Benard EC | | | | | |
| WARD | 9 | Permian Basin Regional Planning Commission | ONCOR | T-NMP | | | | | | | |
| WASHINGTON | 13 | Brazos Valley Council of Governments | ENTERGY | Bluebonnet EC | Fayette EC | | | | | | |
| WEBB | 19 | South Texas Development Council | CPL(AEP) | Rio Grande EC | Medina EC | | | | | | |
| WHARTON | 16 | Houston-Galveston Area Council | RELIANT(CENTER POINT) | CPL(AEP) | Wharton County EC | | | | | | |
| WHEELER | 1 | Panhandle Regional Planning Commission | XCEL(SPS) | WTU(AEP) | Greenbelt EC | North Plains EC | | | | | |
| WICHITA | 3 | North Texas Regional Planning Commission | ONCOR | Electra | Southwest Rural EC | | | | | | |
| WILBARGER | 3 | North Texas Regional Planning Commission | WTU(AEP) | Vernon | Southwest Rural EC | Tri-County EC | | | | | |
| WILLACY | 21 | Lower Rio Grande Valley Development Council | CPL(AEP) | Magic Valley EC | | | | | | | |
| WILLIAMSON | 12 | Capitol Area Planning Council | ONCOR | Austin Energy | Georgetown | Bluebonnet EC | Bartlett EC | Pedernales EC | | | |
| WILSON | 18 | Alamo Area Council of Governments | Floresville | Guadalupe Valley EC | Karnes EC | | | | | | |
| WINKLER | 9 | Permian Basin Regional Planning Commission | ONCOR | T-NMP | | | | | | | |
| WISE | 4 | North Central Texas Council of Governments | ONCOR | Bridgeport | Wise EC | Cooke County | CoServ E | Tri-County EC | | | |
| WOOD | 6 | East Texas Council of Governments | SWEPCO(AEP) | ONCOR | Upshur-Rural EC | Wood County EC | FEC Electric | | | | |
| YOAKUM | 2 | South Plains Association of Governments | XCEL(SPS) | Lyntegar EC | Lea County Ec | | | | | | |
| YOUNG | 3 | North Texas Regional Planning Commission | ONCOR | T-NMP | Fort Belknap EC | United Coop Services | | | | | |
| ZAPATA | 19 | South Texas Development Council | CPL(AEP) | Medina EC | | | | | | | |
| ZAVALA | 24 | Middle Rio Grande Development Council | CPL(AEP) | Medina EC | Rio Grande EC | | | | | | |

Table 18: PUCT Power Suppliers by County (Obtained from PUCT website, http://www.puc.state.tx.us. November, 2002) (Part B).

| | County | Power Control Area[1] | TMY2[2] | Climate Zone[3] | Division (East or West)[4] | No. of projected units[5] | Floor Area (ft2)[6] | 1999 Average Energy Use (KWh)[7] | IECC 2001 Energy Use (KWh)[8] | 1999 Peak Day(KWH /House)[9] | IECC Peak Day(KWH /House)[10] | Savings per house (kWh)[11] | Total Savings (MWh) 1999-IECC w/ 20% T&D Loss[12] | lb-NOx/MWh[13] | Total Savings Tons/Year[14] | Total Savings Tons/Day[15] | Total Savings Peak Tons/Day[16] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Affected County | Bastrop | ERCOT | Austin | 4 | West | 146 | 2,426 | 16,545 | 13,310 | 77.98 | 59.56 | 3,235 | 566.77 | 2.69 | 0.7623 | 0.0021 | 0.0036 |
| | Bexar | San Antonio Public Service Bd | San Antonio | 4 | West | 7,168 | 2,426 | 16,681 | 13,332 | 71.48 | 55.66 | 3,349 | 28,806.76 | 3.24 | 46.6669 | 0.1279 | 0.1837 |
| | Caldwell | ERCOT | Austin | 4 | West | 101 | 2,426 | 16,545 | 13,310 | 77.98 | 59.56 | 3,235 | 392.08 | 2.69 | 0.5274 | 0.0014 | 0.0025 |
| | Comal | ERCOT | San Antonio | 4 | West | 1,111 | 2,426 | 16,681 | 13,332 | 71.48 | 55.66 | 3,349 | 4,464.89 | 2.69 | 6.0053 | 0.0165 | 0.0236 |
| | Ellis | TXU | Fort Worth | 5 | West | 649 | 2,426 | 15,465 | 12,448 | 82.47 | 61.45 | 3,017 | 2,349.64 | 3.34 | 3.9239 | 0.0108 | 0.0228 |
| | Gregg | SWEPCO | Lufkin | 6 | East | 194 | 2,548 | 13,139 | 11,258 | 65.34 | 52.74 | 1,881 | 437.90 | 2.68 | 0.5870 | 0.0016 | 0.0033 |
| | Guadalupe | ERCOT | San Antonio | 4 | West | 478 | 2,426 | 16,681 | 13,332 | 71.48 | 55.66 | 3,349 | 1,920.99 | 2.69 | 2.5837 | 0.0071 | 0.0102 |
| | Harrison | SWEPCO | Lufkin | 6 | East | 33 | 2,548 | 13,139 | 11,258 | 65.34 | 52.74 | 1,881 | 74.49 | 2.68 | 0.0999 | 0.0003 | 0.0006 |
| | Hays | ERCOT | Austin | 5 | West | 737 | 2,426 | 16,662 | 13,160 | 76.83 | 58.28 | 3,502 | 3,097.17 | 2.69 | 4.1657 | 0.0114 | 0.0184 |
| | Johnson | TXU | Fort Worth | 5 | West | 629 | 2,426 | 15,465 | 12,448 | 82.47 | 61.45 | 3,017 | 2,277.23 | 3.34 | 3.8030 | 0.0104 | 0.0221 |
| | Kaufman | TXU | Fort Worth | 6 | West | 218 | 2,426 | 15,725 | 12,419 | 78.10 | 58.40 | 3,306 | 864.85 | 3.34 | 1.4443 | 0.0040 | 0.0072 |
| | Nueces | CRI | Corpus Chrsti | 3 | East | 841 | 2,548 | 14,354 | 12,651 | 63.46 | 56.11 | 1,703 | 1,718.67 | 2.68 | 2.3039 | 0.0063 | 0.0083 |
| | Parker | TXU | Fort Worth | 6 | West | 302 | 2,426 | 15,725 | 12,419 | 78.10 | 58.40 | 3,306 | 1,198.09 | 3.34 | 2.0008 | 0.0055 | 0.0099 |
| | Rockwall | TXU | Fort Worth | 6 | West | 1,111 | 2,426 | 15,725 | 12,419 | 78.10 | 58.40 | 3,306 | 4,407.56 | 3.34 | 7.3606 | 0.0202 | 0.0366 |
| | Rusk | SWEPCO | Lufkin | 5 | East | 17 | 2,548 | 13,139 | 11,253 | 65.34 | 52.97 | 1,886 | 38.47 | 2.68 | 0.0516 | 0.0001 | 0.0003 |
| | San Patricio | CRI | Corpus Chrsti | 3 | East | 218 | 2,548 | 14,354 | 12,651 | 63.46 | 56.11 | 1,703 | 445.50 | 2.68 | 0.5972 | 0.0016 | 0.0021 |
| | Smith | TXU | Lufkin | 5 | East | 465 | 2,548 | 13,139 | 11,253 | 65.34 | 52.97 | 1,886 | 1,052.39 | 3.34 | 1.7575 | 0.0048 | 0.0096 |
| | Travis | Austin Energy | Austin | 5 | West | 5,922 | 2,426 | 16,662 | 13,160 | 76.83 | 58.28 | 3,502 | 24,886.61 | 1.44 | 17.9184 | 0.0491 | 0.0791 |
| | Upshur | SWEPCO | Lufkin | 6 | East | 17 | 2,548 | 13,139 | 11,258 | 65.34 | 52.74 | 1,881 | 38.37 | 2.68 | 0.0514 | 0.0001 | 0.0003 |
| | Victoria | CRI | Victoria | 3 | East | 156 | 2,548 | 13,923 | 12,251 | 67.25 | 60.21 | 1,672 | 313.00 | 2.68 | 0.4196 | 0.0011 | 0.0015 |
| | Williamson | TXU | Austin | 5 | West | 4,111 | 2,426 | 16,662 | 13,160 | 76.83 | 58.28 | 3,502 | 17,276.07 | 2.68 | 23.1586 | 0.0634 | 0.1022 |
| | Wilson | ERCOT | San Antonio | 4 | West | 16 | 2,426 | 16,681 | 13,332 | 71.48 | 55.66 | 3,349 | 64.30 | 2.69 | 0.0865 | 0.0002 | 0.0003 |
| Nonattain-ment County | Brazoria | Reliant Energy HL & P | Houston | 3 | East | 2,008 | 2,548 | 13,740 | 11,859 | 66.52 | 55.568 | 1,881 | 4,532.46 | 1.88 | 4.2605 | 0.0117 | 0.0207 |
| | Chambers | EGS | Port Arthur | 4 | East | 318 | 2,548 | 12,913 | 11,297 | 59.02 | 49.96 | 1,616 | 616.67 | 2.68 | 0.8266 | 0.0023 | 0.0039 |
| | Collin | TXU | Fort Worth | 5 | West | 9,639 | 2,426 | 15,725 | 12,419 | 78.10 | 58.40 | 3,306 | 38,239.84 | 3.34 | 63.8605 | 0.1750 | 0.3172 |
| | Dallas | TXU | Fort Worth | 5 | West | 8,595 | 2,426 | 15,465 | 12,448 | 82.47 | 61.45 | 3,017 | 31,117.34 | 3.34 | 51.9660 | 0.1424 | 0.3017 |
| | Denton | TXU | Fort Worth | 6 | West | 5,338 | 2,426 | 15,725 | 12,419 | 78.10 | 58.40 | 3,306 | 21,176.91 | 3.34 | 35.3654 | 0.0969 | 0.1757 |
| | El Paso | EL PASO Electric Company | El Paso | 6 | West | 3,098 | 2,426 | 16,085 | 12,684 | 76.74 | 56.52 | 3,401 | 12,643.56 | 2.68 | 16.9487 | 0.0464 | 0.0839 |
| | Fort Bend | Reliant Energy HL & P | Houston | 4 | East | 1,049 | 2,548 | 13,093 | 11,467 | 61.75 | 51.80 | 1,626 | 2,046.81 | 1.88 | 1.9240 | 0.0053 | 0.0098 |
| | Galveston | Reliant Energy HL & P | Houston | 3 | East | 2,338 | 2,548 | 13,740 | 11,859 | 66.52 | 55.568 | 1,881 | 5,277.33 | 1.88 | 4.9607 | 0.0136 | 0.0241 |
| | Hardin | EGS | Port Arthur | 4 | East | 19 | 2,548 | 12,913 | 11,297 | 59.02 | 49.96 | 1,616 | 36.84 | 2.68 | 0.0494 | 0.0001 | 0.0002 |
| | Harris | Reliant Energy HL & P | Houston | 4 | East | 19,183 | 2,548 | 13,093 | 11,467 | 61.75 | 51.80 | 1,626 | 37,429.87 | 1.88 | 35.1841 | 0.0964 | 0.1795 |
| | Jefferson | EGS | Port Arthur | 4 | East | 610 | 2,548 | 12,913 | 11,297 | 59.02 | 49.96 | 1,616 | 1,182.91 | 2.68 | 1.5857 | 0.0043 | 0.0074 |
| | Liberty | EGS | Port Arthur | 4 | East | 213 | 2,548 | 12,913 | 11,297 | 59.02 | 49.96 | 1,616 | 413.05 | 2.68 | 0.5537 | 0.0015 | 0.0026 |
| | Montgomery | EGS | Houston | 4 | East | 4,032 | 2,548 | 13,093 | 11,467 | 61.75 | 51.80 | 1,626 | 7,867.24 | 2.68 | 10.5460 | 0.0289 | 0.0538 |
| | Orange | EGS | Port Arthur | 4 | East | 172 | 2,548 | 12,913 | 11,297 | 59.02 | 49.96 | 1,616 | 333.54 | 2.68 | 0.4471 | 0.0012 | 0.0021 |
| | Tarrant | TXU | Fort Worth | 5 | West | 10,358 | 2,426 | 15,465 | 12,448 | 82.47 | 61.45 | 3,017 | 37,500.10 | 3.34 | 62.6252 | 0.1716 | 0.3636 |
| | Waller | Reliant Energy HL & P | Houston | 4 | East | 22 | 2,548 | 13,093 | 11,467 | 61.75 | 51.80 | 2,047 | 54.04 | 1.88 | 0.0508 | 0.0001 | 0.0002 |
| | TOTAL | | | | | | | | | | | 2,517 | 297,160.32 | | 417.4298 | 1.1436 | 2.0947 |

Table 19: ESL 2002 Summary NOx Reductions Table: County-wide NOx Reductions Due to the IECC / IRC (Single Family Residences) Reported September 2002.

| | | | | | | | | | | Energy Use per House | | | | Energy Use for New and All Houses For 2002 | | | | Energy Savings | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | | | | Total Savings | | | Total Savings (PUCT) | | | 2002 Total NOx Emissions from All Single Family Houses | |
| | County | Power Control Area[1] | Primary Electric Utility (From PUCT) | TMY2[2] | CZ[3] | Division (East or West)[4] | Estimated Total Number of Single Family Houses (2002)[5] | Projected Number of Building Permits for Single Family Houses[6] (2002) | Floor Area (ft2)[7] | 1999 Average Annual Energy Use (KWh/ House)[8] | IECC 2001 Annual Energy Use (KWh/ House)[9] | 1999 Peak Day (kWh/ House)[10] | IECC Peak Day(kWh/ House)[11] | 2002 Total Energy Use for New Houses (MWh) | 2002 Total Energy Use for All Houses (MWh) | 2002 Total Peak Day Energy Use for New Houses (MWh) | 2002 Total Peak Day Energy Use for All Houses (MWh) | Annual Savings per house (kWh/ House)[12] | Peak Day Energy Savings (kWh/ House) | Total Enegy Savings (MWh) 1999-IECC w/ 20% T&D Loss[13] | Peak Day Energy Savings for New Houses w/ 20% T&D Loss (MWh) | lb-NOx/MWh[14] | lb-NOx/MWh (PUCT) | Tons/Year[15] | Tons/Day[16] | Peak Tons/Day[17] | Tons/Year | Tons/Day | Peak Tons/Day | Tons/Yr | Peak Tons/Day |
| Affected County | Bastrop | ERCOT | ONCOR | Austin | 4 | West | 16,983 | 146 | 2,426 | 16,545 | 13,310 | 77.98 | 59.56 | 1,943 | 226,037 | 9 | 1,012 | 3,235 | 18.42 | 566.77 | 3.23 | 2.69 | 3.34 | 0.7623 | 0.0021 | 0.0036 | 0.9465 | 0.0026 | 0.0054 | 377.48 | 1.69 |
| | Bexar | San Antonio Public Service Bd | CPSB | San Antonio | 4 | West | 405,355 | 7,168 | 2,426 | 16,681 | 13,332 | 71.48 | 55.66 | 95,564 | 5,404,196 | 399 | 22,563 | 3,349 | 15.82 | 28,806.76 | 136.09 | 3.24 | 3.24 | 46.6669 | 0.1279 | 0.1837 | 46.6669 | 0.1279 | 0.2205 | 8,754.80 | 36.55 |
| | Caldwell | ERCOT | CPL(AEP) | Austin | 4 | West | 9,128 | 101 | 2,426 | 16,545 | 13,310 | 77.98 | 59.56 | 1,344 | 121,490 | 6 | 544 | 3,235 | 18.42 | 392.08 | 2.23 | 2.69 | 2.69 | 0.5274 | 0.0014 | 0.0025 | 0.5274 | 0.0014 | 0.0030 | 163.40 | 0.73 |
| | Comal | ERCOT | CPSB | San Antonio | 4 | West | 26,761 | 1,111 | 2,426 | 16,681 | 13,332 | 71.48 | 55.66 | 14,812 | 356,771 | 62 | 1,490 | 3,349 | 15.82 | 4,464.89 | 21.09 | 2.69 | 3.24 | 6.0053 | 0.0165 | 0.0236 | 7.2331 | 0.0198 | 0.0342 | 577.97 | 2.41 |
| | Ellis | TXU | ONCOR | Fort Worth | 5 | West | 30,601 | 649 | 2,426 | 15,465 | 12,448 | 82.47 | 61.45 | 8,079 | 380,924 | 40 | 1,880 | 3,017 | 21.02 | 2,349.64 | 16.37 | 3.34 | 3.24 | 3.9239 | 0.0108 | 0.0228 | 3.8064 | 0.0104 | 0.0265 | 617.10 | 3.05 |
| | Gregg | SWEPCO | SWEPCO(AEP) | Lufkin | 6 | East | 35,150 | 194 | 2,548 | 13,139 | 11,258 | 65.34 | 52.74 | 2,184 | 395,716 | 10 | 1,854 | 1,881 | 12.61 | 437.90 | 2.93 | 2.68 | 2.69 | 0.5870 | 0.0016 | 0.0033 | 0.5890 | 0.0016 | 0.0039 | 532.24 | 2.49 |
| | Guadalupe | ERCOT | CPSB | San Antonio | 4 | West | 26,145 | 478 | 2,426 | 16,681 | 13,332 | 71.48 | 55.66 | 6,373 | 348,562 | 27 | 1,455 | 3,349 | 15.82 | 1,920.99 | 9.08 | 2.69 | 3.24 | 2.5837 | 0.0071 | 0.0102 | 3.1120 | 0.0085 | 0.0147 | 564.67 | 2.36 |
| | Harrison | SWEPCO | SWEPCO(AEP) | Lufkin | 6 | East | 19,769 | 33 | 2,548 | 13,139 | 11,258 | 65.34 | 52.74 | 372 | 222,562 | 2 | 1,043 | 1,881 | 12.61 | 74.49 | 0.50 | 2.68 | 2.69 | 0.0999 | 0.0003 | 0.0006 | 0.1002 | 0.0003 | 0.0007 | 299.35 | 1.40 |
| | Hays | ERCOT | ERCOT/San Marcos | Austin | 5 | West | 28,206 | 737 | 2,426 | 16,662 | 13,160 | 76.83 | 58.28 | 9,699 | 371,194 | 43 | 1,644 | 3,502 | 18.55 | 3,097.17 | 16.41 | 2.69 | 2.68 | 4.1657 | 0.0114 | 0.0184 | 4.1502 | 0.0114 | 0.0220 | 497.40 | 2.20 |
| | Johnson | TXU | ONCOR | Fort Worth | 5 | West | 35,960 | 629 | 2,426 | 15,465 | 12,448 | 82.47 | 61.45 | 7,830 | 447,627 | 39 | 2,210 | 3,017 | 21.02 | 2,277.23 | 15.87 | 3.34 | 3.34 | 3.8030 | 0.0104 | 0.0221 | 3.8030 | 0.0104 | 0.0265 | 747.54 | 3.69 |
| | Kaufman | TXU | ONCOR | Fort Worth | 6 | West | 20,036 | 218 | 2,426 | 15,725 | 12,419 | 78.10 | 58.40 | 2,707 | 248,824 | 13 | 1,170 | 3,306 | 19.71 | 864.85 | 5.16 | 3.34 | 3.34 | 1.4443 | 0.0040 | 0.0072 | 1.4443 | 0.0040 | 0.0086 | 415.54 | 1.95 |
| | Nueces | CRI | CPL(AEP) | Corpus Chrsti | 3 | East | 93,963 | 841 | 2,548 | 14,354 | 12,651 | 63.46 | 56.11 | 10,639 | 1,188,723 | 47 | 5,272 | 1,703 | 7.35 | 1,718.67 | 7.42 | 2.68 | 2.69 | 2.3039 | 0.0063 | 0.0083 | 2.3116 | 0.0063 | 0.0100 | 1,598.83 | 7.09 |
| | Parker | TXU | ONCOR | Fort Worth | 6 | West | 26,167 | 302 | 2,426 | 15,725 | 12,419 | 78.10 | 58.40 | 3,751 | 324,968 | 18 | 1,528 | 3,306 | 19.71 | 1,198.09 | 7.14 | 3.34 | 3.34 | 2.0008 | 0.0055 | 0.0099 | 2.0008 | 0.0055 | 0.0119 | 542.70 | 2.55 |
| | Rockwall | TXU | ONCOR | Fort Worth | 6 | West | 13,735 | 1,111 | 2,426 | 15,725 | 12,419 | 78.10 | 58.40 | 13,798 | 170,578 | 65 | 802 | 3,306 | 19.71 | 4,407.56 | 26.27 | 3.34 | 3.34 | 7.3606 | 0.0202 | 0.0366 | 7.3606 | 0.0202 | 0.0439 | 284.87 | 1.34 |
| | Rusk | SWEPCO | SWEPCO(AEP) | Lufkin | 5 | East | 14,934 | 17 | 2,548 | 13,139 | 11,253 | 65.34 | 52.97 | 191 | 168,055 | 1 | 791 | 1,886 | 12.37 | 38.47 | 0.25 | 2.68 | 2.69 | 0.0516 | 0.0001 | 0.0003 | 0.0517 | 0.0001 | 0.0003 | 226.03 | 1.06 |
| | San Patricio | CRI | CPL(AEP) | Corpus Chrsti | 3 | East | 19,084 | 218 | 2,548 | 14,354 | 12,651 | 63.46 | 56.11 | 2,758 | 241,432 | 12 | 1,071 | 1,703 | 7.35 | 445.50 | 1.92 | 2.68 | 2.69 | 0.5972 | 0.0016 | 0.0021 | 0.5992 | 0.0016 | 0.0026 | 324.73 | 1.44 |
| | Smith | TXU | ONCOR | Lufkin | 5 | East | 54,706 | 465 | 2,548 | 13,139 | 11,253 | 65.34 | 52.97 | 5,233 | 615,604 | 25 | 2,898 | 1,886 | 12.37 | 1,052.39 | 6.90 | 3.34 | 3.34 | 1.7575 | 0.0048 | 0.0096 | 1.7575 | 0.0048 | 0.0115 | 1,028.06 | 4.84 |
| | Travis | Austin Energy | ONCOR | Austin | 5 | West | 263,755 | 5,922 | 2,426 | 16,662 | 13,160 | 76.83 | 58.28 | 77,934 | 3,471,013 | 345 | 15,371 | 3,502 | 18.55 | 24,886.61 | 131.85 | 1.44 | 3.34 | 17.9184 | 0.0491 | 0.0791 | 41.5606 | 0.1139 | 0.2202 | 5,796.59 | 25.67 |
| | Upshur | SWEPCO | SWEPCO(AEP) | Lufkin | 6 | East | 11,232 | 17 | 2,548 | 13,139 | 11,258 | 65.34 | 52.74 | 191 | 126,444 | 1 | 592 | 1,881 | 12.61 | 38.37 | 0.26 | 2.68 | 2.69 | 0.0514 | 0.0001 | 0.0003 | 0.0516 | 0.0001 | 0.0003 | 170.07 | 0.80 |
| | Victoria | CRI | CPL(AEP) | Victoria | 3 | East | 25,021 | 156 | 2,548 | 13,923 | 12,251 | 67.25 | 60.21 | 1,911 | 306,529 | 9 | 1,507 | 1,672 | 7.04 | 313.00 | 1.32 | 2.68 | 2.69 | 0.4196 | 0.0011 | 0.0015 | 0.4210 | 0.0012 | 0.0018 | 412.28 | 2.03 |
| | Williamson | TXU | ONCOR | Austin | 5 | West | 75,966 | 4,111 | 2,426 | 16,662 | 13,160 | 76.83 | 58.28 | 54,101 | 999,709 | 240 | 4,427 | 3,502 | 18.55 | 17,276.07 | 91.53 | 2.68 | 3.34 | 23.1586 | 0.0634 | 0.1022 | 28.8510 | 0.0790 | 0.1528 | 1,669.51 | 7.39 |
| | Wilson | ERCOT | ERCOT/Floresville | San Antonio | 4 | West | 9,115 | 16 | 2,426 | 16,681 | 13,332 | 71.48 | 55.66 | 213 | 121,515 | 1 | 507 | 3,349 | 15.82 | 64.30 | 0.30 | 2.69 | 2.68 | 0.0865 | 0.0002 | 0.0003 | 0.0862 | 0.0002 | 0.0004 | 162.83 | 0.68 |
| Nonattain-ment County | Brazoria | Reliant Energy HL & P | RELIANT | Houston | 3 | East | 71,987 | 2,008 | 2,548 | 13,740 | 11,859 | 66.52 | 55.568 | 23,813 | 853,694 | 112 | 4,000 | 1,881 | 10.95 | 4,532.46 | 26.39 | 1.88 | 1.88 | 4.2605 | 0.0117 | 0.0207 | 4.2605 | 0.0117 | 0.0248 | 802.47 | 3.76 |
| | Chambers | EGS | RELIANT | Port Arthur | 4 | East | 8,388 | 318 | 2,548 | 12,913 | 11,297 | 59.02 | 49.96 | 3,592 | 94,759 | 16 | 419 | 1,616 | 9.06 | 616.67 | 3.46 | 2.68 | 1.88 | 0.8266 | 0.0023 | 0.0039 | 0.5797 | 0.0016 | 0.0033 | 89.07 | 0.39 |
| | Collin | TXU | ONCOR | Fort Worth | 5 | West | 165,447 | 9,639 | 2,426 | 15,725 | 12,419 | 78.10 | 58.40 | 119,707 | 2,054,686 | 563 | 9,661 | 3,306 | 19.71 | 38,239.84 | 227.95 | 3.34 | 3.34 | 63.8605 | 0.1750 | 0.3172 | 63.8605 | 0.1750 | 0.3807 | 3,431.33 | 16.13 |
| | Dallas | TXU | ONCOR | Fort Worth | 5 | West | 657,779 | 8,595 | 2,426 | 15,465 | 12,448 | 82.47 | 61.45 | 106,991 | 8,188,036 | 528 | 40,421 | 3,017 | 21.02 | 31,117.34 | 216.80 | 3.34 | 3.34 | 51.9660 | 0.1424 | 0.3017 | 51.9660 | 0.1424 | 0.3621 | 13,674.02 | 67.50 |
| | Denton | TXU | ONCOR | Fort Worth | 6 | West | 136,728 | 5,338 | 2,426 | 15,725 | 12,419 | 78.10 | 58.40 | 66,293 | 1,698,022 | 312 | 7,984 | 3,306 | 19.71 | 21,176.91 | 126.24 | 3.34 | 3.34 | 35.3654 | 0.0969 | 0.1757 | 35.3654 | 0.0969 | 0.2108 | 2,835.70 | 13.33 |
| | El Paso | EL PASO Electric Company | EPEC | El Paso | 6 | West | 174,531 | 3,098 | 2,426 | 16,085 | 12,684 | 76.74 | 56.52 | 39,295 | 2,213,754 | 175 | 9,865 | 3,401 | 20.21 | 12,643.56 | 75.15 | 2.68 | 2.63 | 16.9487 | 0.0464 | 0.0839 | 16.6263 | 0.0456 | 0.0988 | 2,911.09 | 12.97 |
| | Fort Bend | Reliant Energy HL & P | RELIANT | Houston | 4 | East | 89,091 | 1,049 | 2,548 | 13,093 | 11,467 | 61.75 | 51.80 | 12,029 | 1,021,609 | 54 | 4,615 | 1,626 | 9.96 | 2,046.81 | 12.53 | 1.88 | 1.88 | 1.9240 | 0.0053 | 0.0098 | 1.9240 | 0.0053 | 0.0118 | 960.31 | 4.34 |
| | Galveston | Reliant Energy HL & P | RELIANT | Houston | 3 | East | 88,476 | 2,338 | 2,548 | 13,740 | 11,859 | 66.52 | 55.568 | 27,726 | 1,049,234 | 130 | 4,916 | 1,881 | 10.95 | 5,277.33 | 30.73 | 1.88 | 1.88 | 4.9607 | 0.0136 | 0.0241 | 4.9607 | 0.0136 | 0.0289 | 986.28 | 4.62 |
| | Hardin | EGS | ENTERGY | Port Arthur | 4 | East | 14,915 | 19 | 2,548 | 12,913 | 11,297 | 59.02 | 49.96 | 215 | 168,495 | 1 | 745 | 1,616 | 9.06 | 36.84 | 0.21 | 2.68 | 2.07 | 0.0494 | 0.0001 | 0.0002 | 0.0381 | 0.0001 | 0.0002 | 174.39 | 0.77 |
| | Harris | Reliant Energy HL & P | RELIANT | Houston | 4 | East | 1,011,964 | 19,183 | 2,548 | 13,093 | 11,467 | 61.75 | 51.80 | 219,971 | 11,604,185 | 994 | 52,417 | 1,626 | 9.96 | 37,429.87 | 229.18 | 1.88 | 1.88 | 35.1841 | 0.0964 | 0.1795 | 35.1841 | 0.0964 | 0.2154 | 10,907.93 | 49.27 |
| | Jefferson | EGS | ENTERGY | Port Arthur | 4 | East | 77,780 | 610 | 2,548 | 12,913 | 11,297 | 59.02 | 49.96 | 6,891 | 878,681 | 30 | 3,886 | 1,616 | 9.06 | 1,182.91 | 6.63 | 2.68 | 2.07 | 1.5857 | 0.0043 | 0.0074 | 1.2243 | 0.0034 | 0.0069 | 909.43 | 4.02 |
| | Liberty | EGS | ENTERGY | Port Arthur | 4 | East | 20,195 | 213 | 2,548 | 12,913 | 11,297 | 59.02 | 49.96 | 2,406 | 228,146 | 11 | 1,009 | 1,616 | 9.06 | 413.05 | 2.32 | 2.68 | 2.07 | 0.5537 | 0.0015 | 0.0026 | 0.4275 | 0.0012 | 0.0024 | 236.13 | 1.04 |
| | Montgomery | EGS | ENTERGY | Houston | 4 | East | 92,642 | 4,032 | 2,548 | 13,093 | 11,467 | 61.75 | 51.80 | 46,235 | 1,062,320 | 209 | 4,799 | 1,626 | 9.96 | 7,867.24 | 48.17 | 2.68 | 2.07 | 10.5460 | 0.0289 | 0.0538 | 8.1426 | 0.0223 | 0.0499 | 1,099.50 | 4.97 |
| | Orange | EGS | ENTERGY | Port Arthur | 4 | East | 26,430 | 172 | 2,548 | 12,913 | 11,297 | 59.02 | 49.96 | 1,943 | 298,577 | 9 | 1,320 | 1,616 | 9.06 | 333.54 | 1.87 | 2.68 | 2.07 | 0.4471 | 0.0012 | 0.0021 | 0.3452 | 0.0009 | 0.0019 | 309.03 | 1.37 |
| | Tarrant | TXU | ONCOR | Fort Worth | 5 | West | 445,089 | 10,358 | 2,426 | 15,465 | 12,448 | 82.47 | 61.45 | 128,936 | 5,540,462 | 637 | 27,351 | 3,017 | 21.02 | 37,500.10 | 261.27 | 3.34 | 3.34 | 62.6252 | 0.1716 | 0.3636 | 62.6252 | 0.1716 | 0.4363 | 9,252.57 | 45.68 |
| | Waller | Reliant Energy HL & P | RELIANT | Houston | 4 | East | 9,010 | 22 | 2,548 | 13,093 | 11,467 | 61.75 | 51.80 | 252 | 103,321 | 1 | 467 | 2,047 | 9.96 | 54.04 | 0.26 | 1.88 | 1.88 | 0.0508 | 0.0001 | 0.0002 | 0.0508 | 0.0001 | 0.0002 | 97.12 | 0.44 |
| | TOTAL | | | | | | 4,352,220 | 91,632 | | | | 2,666 | 2,116 | 1,127,922 | 53,316,454 | 5,192 | 245,505 | 95,631 | 550 | 297,160.32 | 1,773.29 | | | 417.4298 | 1.1436 | 2.0947 | 445.0118 | 1.2192 | 2.6561 | 74,440.36 | 344.04 |

Table 20: Modified Summary Table Using the November 2002 PUCT PCA assignments.

# 7 TECHNOLOGIES FOR REDUCING ENERGY USED IN BUILDINGS (UPDATE TO 2002 REPORT)

Adoption of the IECC / IRC has allowed the state of Texas to define minimum energy performance for new buildings and for existing buildings that are remodeled. In this section of the report the technologies reported in 2002 have been updated to provide a list that can have a substantial impact on delivering above-code building performance for residential, commercial and industrial buildings in Texas Buildings.

In general for residential buildings, the IECC / IRC provides prescriptive measures for each climate zone in Chapters 5 and 6 to assure that new construction meets a minimum, predictable energy use. A residential performance path is provided in Chapter 4. Commercial buildings are addressed by minimum prescriptive measures in Chapter 8 of the IECC / IRC, or by minimum performance measures using ASHRAE Standard 90.1 1999[71], which is referenced by Chapter 7. More stringent design efficiency measures for commercial buildings can be found in programs such as the U.S. Green Building Council's LEED ratings[72].

## 7.1 Building Envelope

Energy efficient technologies for building envelopes include well-known technologies for insulation and newer technologies such as low-E windows, reflective roof coatings, structurally integrated panels (SIPs) and radiative barriers, as indicated in the next section.

### 7.1.1 New Construction

New construction has a many new envelope technologies for contractors and homeowners to choose from, depending upon budget, housing type and climate zone. Examples include improved low-E windows, and ventilated windows (commercial buildings), high albedo, or highly reflective roofs[73], improved shading devices for windows, which can be combined with daylighting features such as lightshelves, improved building sealing techniques such as building wraps, and sealants, reflective barriers in attics and cavities. Some residential builders are now experimenting with reducing thermal loads by reducing the exterior envelope area by using a compact two story designs that also allows for ductwork to be incorporated into the floor trusses, which reduces heat gain when compared to their traditional placement in the hot attic.

### 7.1.2 Existing Construction

Existing homes can also be improved by replacing old, single pane windows with low-E windows, installing reflective roofing, improving building infiltration using blower door testing and duct blasters, retrofitting reflective barriers inside attics to help reduce summertime temperatures, or applying highly reflective roofing when a roof needs replacement.

## 7.2 Lighting/Daylighting

[71] Chapter 7 of the 2000 IECC/IRC, references ASHRAE Standard 90.1, 1989, which is amended to ASHRAE Standard 90.1 1999, (w/o amendments) in the 2001 Supplement (published in March 2001), which is directed by Senate Bill 5's effective date of May 1st, 2001.

[72] The Leadership in Energy and Environmental Design (LEED) Green Building Rating System is the voluntary, consensus-based, market-driven building rating system of the U.S. Green Building Council that is used to evaluate environmental performance from a whole-building perspective over a building's life cycle and to provide a definitive standard for a "green building". Different levels of green building certification are awarded based on the total credits earned. The U.S. Green Building Council (USGBC 2002), founded in 1993, is a non-profit organization that provides knowledge and action on environmental issues for commercial and industrial buildings. The headquarters are located in San Francisco, California. The council has grown to more than 500 leading international organizations. Its goal is to help the building industry develop products that are more environmentally and economically viable and to drive the marketplace forward towards the development of high performance buildings (U.S. Green Building Council 2002).

[73] In the hot and humid south highly reflective roofs usually will require periodic washing to remove dirt, mold and mildew that can reduce the roofs thermal reflectance.

New technologies for reducing the energy use of lighting systems have improved dramatically in recent years. Almost daily, new energy efficient light sources appear on the store shelves for residential and commercial applications, most notably compact fluorescents, T8 and now T5 fluorescent lamps in almost all shapes and sizes. LED lighting and fiber optic lighting are also beginning to appear from commercial lighting vendors.

### 7.2.1 New Construction

Many more architects are becoming comfortable using daylighting systems that reduce lighting energy use by redirecting natural light deep into building interiors without increasing summertime heat gain. Such systems are most effective when combined with automatic dimming systems so building occupants do not have to constantly adjust the lighting levels. New systems have begun to appear that channel solar radiation, captured with sun-catchers, into building interiors using fiber optics. This same technology can provide lighting at night using a central HID source that is then channeled to luminaries through switchable fiber optics. Heat from the central HID source can then be effectively captured and reused or rejected. Lighting systems with combined motion sensors, and automatic dimming features are also becoming popular. Retrofit daylighting systems are also available that include light tubes, and light ducts that collect daylight through a penetration in the roof and channel this down into the house through a reflective channel.

### 7.2.2 Existing Construction

Retrofitting existing T12 fluorescent lamps[74] with either T8 or T5 lamps is a cost effective method for reducing lighting energy use in office buildings, grocery stores, retail stores, and other facilities that currently use T12 fluorescent lighting. Such retrofits reduce the lighting energy use primarily by replacing the older magnetic ballasts[75] with new electronic ballasts that consume a fraction of the electricity use. Increased lamp efficacy is also possible with smaller lamps (i.e., T8 and T5). Such lighting retrofits can also include automatic switching provided by motion sensors, lighting sensors in perimeter lighting applications or a combination of motion and lighting sensors. Reducing the installed lighting load also decreases the required cooling load, with a slight heating penalty for winter months.

### 7.2.3 Increased use of Compact Fluorescent Lamps.

It is recommended that a program be developed to accelerate the purchase and use of compact fluorescent lamps by consumers in non-attainment and affected counties. It is estimated that there will be 8.8 million residences in the non-attainment and affected counties in 2003, which are expected to increase in number by about 2.5% per year. A significant amount of energy used in residences is consumed by incandescent lights, which can easily be replaced by Compact Fluorescent Lamps (CFLs), which consume about 1/6 to 1/5 the electricity and yet produce the same amount of light.

In an average 2,000 ft2 household it is estimated that there are 50 incandescent lamps, of which 33 are suitable for replacement. If 5% of these household could be converted to CFLs each year, it is estimated that 1.3 tons-NOx/day could be saved in 2003. If an additional 5% of the remaining households could be converted each year, 25% of the household could be converted by 2007, resulting in 1.2 ton-NOx/day could be saved in non-attainment and affected counties. One method that has been suggested to motivate conversion to CFLs is to level the initial cost of CFLs by charging an $0.25 Emissions Reduction Fee on each incandescent lamp (252 million lamps expected in 2007), and paying a $1.00 Emissions Incentive for each CFL lamp purchased in the state (26 million lamps expected in 2003).

Exclusions would include incandescent lamps which are less than 10 Watts, decorative holiday lamps sold during the Christmas or Holiday Season during October, November and December. Such a fee would be

[74] The T12 designation refers to the diameter of the fluorescent lamp, where T12 lamps would be 12/8” in diameter, T8 would be 8/8” in diameter, or 1`”, and T5 lamps would be 5/8” in diameter.

[75] Lighting ballasts are necessary for fluorescent lighting to control the flow of electricity once the arc is struck between the electrodes in the lamp, which would otherwise draw an uncontrolled amount of current.

collected at the wholesale level. Sales figures for incandescents and CFLs sold could then be used to track the effectiveness of the program.

The expected benefit for each household that converts to CFLs is estimated to be a 1,375 kWh/year-household reduction, which is $103/year-household (33 lamps replaced) at $0.075 per kWh. Additional benefits included increased lamp life, which will reduce the number of times each year residents are required to change the lamps. Disposal of CFLs could be handled through existing fluorescent lamp collection programs. Replacing incandescent lights with CFLs provides homeowners with a reduction in their electricity bill, and it reduces the frequency of replacing burned-out lamps since the expected life of an incandescent lamp is about 750 hours versus 10,000 hours for a CFL. The cost for replacing incandescent lamps with CFLs would be borne by residents, with an incentive provided by the state.

| | 2007 - 2010 | Tons NOx Saved/yr * | Tons NOx/Peak-Day | Net Tax Revenue Million $ | $/ton-10-yr |
|---|---|---|---|---|---|
| MWh Elec. Saved | 3.3 – 5.7 million | 434- 518 | 1.2 – 1.4 | $37.1 - $20.3 | Negative |

* 38 counties

## 7.3 Appliances

Energy efficient technologies for appliances vary according to application (i.e., residential or commercial) as indicated in the next section.

### 7.3.1 Residential

Significant improvements have been made in developing and delivering energy efficient refrigerators for household use, which represent a sizable portion of household electricity use. Since the mid 1980s refrigerators have made significant advances in reducing thermal losses, and improved refrigeration cycles, without significant prices increases to customers.

Other appliances in the kitchen have made efficiency improvements as well. For example, microwave ovens are in use in many kitchens that are capable of heating food with a fraction of the energy used by traditional electric or gas ovens. Convections ovens also offer some efficiency improvements over conventional ovens, as does induction (i.e., magnetic) stoves.

In the laundry room, significant energy and water savings are available with horizontal axis washing machines. Such clothes washing machines use less water, less detergent and less energy than vertical axis machines and reduce the time needed for drying because of their ability to incorporate a high-speed extraction cycle that removes additional amounts of water, which would have been removed in the dryer. Although such machines carry a premium price tag, reduced prices are expected as additional manufacturers offer competing models. Microwave clothes dryer R&D has also been reported by several manufacturers.

Use of the internet in a home can either increase or decrease energy use, depending several variables. Increases in energy use come from the energy used by the PC continuously connected to the internet, the modem used to connect to the internet (i.e., dial-up, cable or other modem), increased use of A/C or heating where none may have been used before, lighting energy use in the room, etc. Decreases in energy use come from reduced travel by the individual who is now surfing the web, versus cruising the streets in a car, and improvements in efficiency of communication using email, etc.

### 7.3.2 Commercial Buildings

In commercial buildings, steadily increasing internal loads, due in part to the computerization of the office environment, have begun to level-off as LCD computer screens have become competitive with the traditional CRT displays. Increasing use of laptop computers has further reduced computer energy use.

Energy efficiency has also spread to office copiers, printers, and other equipment. Teleconferencing continues to increase in use, which results in travel cost savings. Cell phones and Personal Digital Assistants (PDAs) continue to make office workers more effective workers, which can have an indirect energy savings as companies downsize, and load more clerical and administrative tasks onto their workers.

Use of the internet at work can either increase or decrease energy use, also depending several variables. Increases in energy use come from the energy used by the PC to connected to the internet, the modem used to connect to the internet (i.e., dial-up, cable or other modem), increased use of A/C or heating where none may have been used before, lighting energy use in the room, etc. Some studies have shown that employee productivity can decrease significantly if "personal" internet use at work is not closely monitored, which can indirectly affect energy use. Decreases in energy use come from reduced travel by the individual who is now surfs the web to find information, versus numerous phone calls or trips to find the same information. Use of the email for distribution of sales material, brochures, etc. has also significantly decreased printing costs for many businesses, which can indirectly affect energy use. However, receipt of unsolicited electronic messages (i.e., spam), can decrease the efficiency of workers, which can indirectly increase energy use.

## 7.4 Heating/Cooling Systems

Energy efficient technologies for heating and cooling systems vary according to construction type (i.e., residential, commercial, etc.). Technologies vary as well for new construction and existing construction, as indicated in the next section.

### 7.4.1 Residential: New or Existing Construction

Efficiency improvements in residential heating and cooling systems have also made significant contributions towards reducing household energy use. High efficiency air conditioners are now available from many manufacturers (i.e., SEER 11, 12, and 13), and when properly sized to meet the peak load, can significantly reduce summertime electricity bills. The technologies for accomplishing this vary from one manufacturer to the next, and include such innovations such as dual speed compressors and fans, variable speed systems, improved coil design (i.e., evaporator and condenser coils), and the ever increasing use of microprocessors similar to what has happened in the automotive industry.

Improvements to residential heating and cooling systems have also been accomplished through the introduction (or reintroduction) of new systems. Such systems include mini-splits or ductless air conditioners[76], ground-coupled heat pumps, direct/indirect evaporative cooling (in the hot and dry parts of Texas). New combinations of systems can also deliver improved total performance. For example, air-conditioning systems that use the domestic water heater for space heating instead of a furnace, and systems that supplement domestic water heating with waste heat recovery from the air conditioner's condenser.

Residential furnace efficiencies have also continued to improve as well. One improvement of note for NOx reductions is the replacement of the pilot light with a hot surface ignition system. This eliminates the apx. 500 to 800 Btu/h energy use of the pilot light[77], which contributes to the summertime ozone production if the pilot light is burning during the summertime.

Residential heating/cooling system efficiencies can also improve with the use of programmable thermostats[78]. Residential economizers are also being investigated for those climate zones where cool, dry evening conditions allow for their use[79].

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[76] A mini-split air conditioning system is similar to a window air conditioner, only the unit consists of two parts, an indoor evaporator coil/blower, and an outdoor condensing unit and compressor, connected by refrigeration and control lines. Minisplits are more common in commercial buildings, and have seen wide-spread use in other countries.
[77] 500 to 800 Btu/h is equal to about at 150 to 250 Watt light, and produces considerable NOx since the flame is an open flame.
[78] This is required by the 2000 IECC/IRC for new construction.
[79] One research effort is underway by the California Energy Commission where residential economizers are being investigated for use in low cost housing.

Efficiency improvements have also been reported in the design of residential ductwork. Most notably, increased insulation levels, and improved sealing techniques for ductwork exposed to the severe conditions in the attic, and in several showcase homes, relocation of the ductwork and air-conditioning system inside of the conditioned envelope, usually through the use of a chase located in the ceiling of the hallway, or by using ducts that are threaded between floor trusses. Some researchers have also noted that the use of low-E windows has also reduced the number of diffusers that are needed in a house, since the heat gain/heat loss through the windows has been reduced.

### 7.4.2 Commercial Buildings

#### 7.4.2.1 New Construction

In commercial buildings the list of technology improvement is longer. Many of these improvements rely on new or improved equipment, including: variable-volume dual or single duct systems, which use low static pressure duct distribution system, over-sized, low-head cooling towers, variable-speed chilled/hot water pumping, and high efficiency chillers, pumps, and electric motors. New blowers often utilize advanced air-foil technologies for improved efficiency. Some new systems are also being designed to minimize ductwork[80], which reduces installation costs, and improves efficiency.

Other new technologies include dual-path, pre-conditioning systems, which in the south utilize special cooling coils to efficiently remove humidity from the incoming air[81], water-loop, ground-coupled heat pumps[82], cool ceilings[83], cool beam systems[84], personal heating/cooling systems[85], thermal storage systems, and thermostats that also utilize occupancy sensors.

Significant improvements in efficiency are also being reported from the application of optimum control strategies for cooling/heating systems, most commonly where temperatures and flow rates are reduced to meet only what is required on a minute-by-minute basis. Many architects and engineers are also requiring performance testing of new construction before a building is signed-off to assure that the building meets the design and performance specifications.

#### 7.4.2.2 Existing Construction

Several important studies have shown that building heating/cooling system performance degrades over time. Such degradations decrease the system's ability to deliver comfort conditions, and more importantly to the State's emissions problems, increases the building's energy use. To help improve this problem, the Energy Systems Laboratory developed the Continuous Commissioning® or CC℠ process. Continuous Commissioning® is a process where the Laboratory staff investigates and documents areas where the performance of the mechanical systems can be improved, and working closely with the building operators, makes the changes necessary to improve performance, and documents the savings with hourly measured data. Continuous Commissioning® has produced average savings in the range of 20%, and sometimes saves as much as 40% of a building's heating/cooling energy use. Many retrofit opportunities exist for commercial buildings as well, and include almost all the same measured listed for new construction.

[80] Reducing the ductwork usually means closer coordination of the system layout during the design process. Several new buildings are being designed with ductless, under-floor distribution systems.
[81] These coils are specially made to take 100F outside air and reduce the temperature to 55F, which requires a deeper coil than is normally used in a system.
[82] These are being increasingly used in new K-12 schools.
[83] Cool ceilings have seen greater use in Europe where outside humidity conditions are less. Such systems are similar to radiant ceiling panels, with the difference that chilled water is circulated in the panels to keep the ceiling cool, which cools the adjacent room by radiation and convection. Such systems have improved performance because air-handling units can be downsized to ventilation air requirements (i.e., 10 to 20% of their traditional size).
[84] Cool beam systems are cooling systems where cooling coils are incorporated into the overhead lighting fixtures.
[85] Personal heating/cooling systems are often incorporated into modular office furniture systems that utilize under-floor air distribution. Improved performance is accomplished by allowing for more individualized comfort controls. Such systems also report improved user satisfaction, which is claimed to increase office productivity.

Research is also being performed at the ESL and the U.S. Department of Energy's National Laboratories to develop and test automated fault detection and diagnostics that promise to provide additional benefits from keeping a building tuned.

## 7.5 Low NOx Combustion Technologies for Building Systems

Low NOx combustion technologies for gas consuming systems in buildings vary according to construction type (i.e., residential, commercial, etc.) and include technologies for new construction and existing construction. Gas consumption in residential includes: heating systems, domestic water heating, kitchen appliances (i.e., stoves, ovens, ranges, etc.), and clothes dryers. In commercial buildings, low NOx combustion technologies are most often applied to larger boilers and furnaces that provide buildings with heating. Some progress has been made in this area with the advent of the TCEQ's rule 117, which mandates the application of low NOx technologies to domestic water heaters. Once properly enforced (which would include the elimination of standing pilot lights), this should have a significant impact on NOx reductions since the elimination of the apx. 500 Btu/h of gas consumption used by the pilot light would make a significant contribution to NOx emissions.

In general, low NOx combustion technologies in residential and commercial applications rely on down-sized technology developed by the electric power generation industry, including: low NOx burners and ultra-low NOx burners. Other industrial technologies include less excess air (LEA) technologies, air staging, over fire air, fuel reburning, flue gas recirculation, water and steam rejection, reduced air preheat, combustion optimization, oxygen-enriched combustion, and catalytic combustion. Post combustion technologies include: selective non-catalytic reduction (SNCR), selective catalytic reduction (SCR), low temperature SCRs, catalysts, and other technologies[86]

## 7.6 Industrial

Opportunities for reducing energy use in industrial applications are also significant and include many of the same technologies used in commercial buildings, including: energy efficient electric motors, variable speed drives, computerized control systems, high efficiency chillers, pumps and boilers, and air-foil technologies for improving blower efficiencies. Other energy efficiency improvements have also been reported through the introduction of induction and microwave heating, cogeneration, improved steam systems, and waste heat recovery. Additional information about the numerous energy conservation opportunities for industrial applications in Texas can be found in the proceedings of the Industrial Energy Technology Conference[87].

## 7.7 Other

Significant opportunities exist for reducing energy use in other commercial applications. In the following section, opportunities in restaurants and grocery stores are briefly discussed.

### 7.7.1 Restaurants

Significant energy efficiency improvements have been reported in the restaurant field, including the use of improved grilling equipment[88], refrigerator-freezer combinations that reduce infiltration into freezers by placing the entrance to the freezer inside the cooler, the use of industrialized, pre-prepared foods[89],

[86] For more information about NOx reduction technologies, see the Special Report on NOx Reduction Technologies published by the Texas Institute of Advancement of Chemical Technology (TIACT 2000).
[87] The Industrial Energy Technology Conference, Energy Systems Laboratory, Texas A&M University, College Station, Texas 77843, www-esl.tamu.edu.
[88] For example the use of computerized, double-sided grills at McDonalds.
[89] For example, the use of pre-packaged salads at McDonalds.

convection ovens, microwave cooking, combined air-conditioner/DHW heat recovery, infrared grilling, and optimal start of appliances to reduce peak electric demand[90].

### 7.7.2 Grocery Stores

Reduced energy use in grocery stores has also been reported by the major chains. Efficiency improvements have been reported through the use of refrigerator-freezer combinations, domestic water heat recovery from condensers, desiccant dehumidification from refrigeration heat rejection, rack-mounted, staged-compressors to improve refrigeration performance. Installation of special outside air dehumidification systems. Use of T8, T5 and HID in-store lighting, and the use of daylighting.

## 7.8 Renewables

Renewable energy technologies offer significant opportunities for reducing energy use and include opportunities for solar thermal applications (i.e., active, passive), and photovoltaic (i.e., PV, BIPV).

### 7.8.1 Solar Thermal Systems

Solar thermal systems have most often been applied to new and existing residential and commercial to provide heating of domestic water and space heating. Such systems utilize active and passive delivery systems, where active delivery requires blowers and/or pumps. Passive delivery is usually accomplished without the use of blowers or pumps. The use of solar thermal systems to provide cooling in hot and humid climates is less used. A few installations have also reported the use of active solar systems that provide cooling to buildings using absorption or desiccant refrigeration systems. However, such systems can be expensive and require special maintenance.

### 7.8.2 Solar PV, and BIPV Systems

The use of photovoltaic (PV) solar systems in residential and commercial buildings continues to grow. Installation of systems can be accomplished in new or existing sites. However, although costs have improved considerably in the last few years, the cost of such systems continues to be a restriction for wide-spread applications. Such systems can utilize grid-connected PV, independent PV, or building integrated PV (i.e., BIPV) systems. Recent advances in solar systems also include the development of combined solar thermal/PV systems. Such systems collect electricity and thermal energy from the same solar panel. In Texas, the most current information about available solar systems, and solar system installation contractors can be found by contacting the Texas Renewable Energy Industries[91] Association

## 7.9 Thermal Comfort and Indoor Air Quality

Any discussion about reducing energy use in buildings in hot and humid climates is not complete without a discussion of the needs to maintain proper thermal comfort and indoor air quality. In the United States ASHRAE[92] is the primary organization for developing and promoting standards for proper comfort conditions and indoor air quality[93]. Such standards describe acceptable conditions for thermal comfort, which include temperature and humidity conditions and ventilation requirements. In any building, sources of indoor air pollution should be reduced or placed in a controlled environment. In practice, this can be difficult and expensive to accomplish, requiring extra ducts to provide for exhaust and makeup air, special

[90] Cooking equipment in restaurants draw large amounts of electricity when they are first turned on. In many cases, the peak electric demand for a restaurant can occur in the morning when equipment is first turned-on. Staggering the start of such equipment to avoid simultaneous starting of appliances can reduce the peak monthly electric demand.

[91] The Texas Renewable Energy Industries Association can be reached at P.O. Box 16469, Austin, Texas 78761-6469, 512-345-5446, www.treia.org.

[92] ASHRAE, the American Society of Heating, Refrigerating and Air-conditioning Engineers, 1791 Tullie Cir., NE, Atlanta, GA 30329-2305, Phone: (404) 636-8400 Fax: (404) 321-5478, www.ashrae.org.

[93] Such standards include ASHRAE Standard 62-1999: Ventilation for Acceptable Indoor Air Quality, and ASHRAE Standard 55-1992: Thermal Environmental Conditions for Human Occupancy, Including ANSI/ASHRAE Addendum 55a-1995.

filtration systems (i.e., HEPA/UV systems[94]). In new commercial buildings, CO2 ventilation control is being used to provide the needed fresh air, at minimum outside air levels.

# 8 CALCULATED NOx REDUCTION POTENTIAL FROM IMPLEMENTATION OF THE IECC / IRC

## 8.1 Calculations Required for Analyzing Implementation of IECC / IRC.

A complete reporting of the savings from the implementation of the IECC / IRC requires tracking and analyzing savings to new construction and construction activity to existing buildings that undergoes a building permit. Adoption of the IECC / IRC is expected to impact the following types of buildings:

- single-family residential
- multi-family residential
- commercial buildings
- industrial buildings
- renewables

Adoption of the IECC / IRC is also expected to impact construction activity in existing buildings that undergoes a building permit. Such activity would impact the following types of buildings:

- single-family residential
- multi-family residential
- commercial buildings
- industrial buildings
- renewables

The following sections reports preliminary estimates of the energy savings associated only with new construction activity in single-family and multi-family residences. Calculation of energy savings adoption of the IECC / IRC in commercial building, industrial building and renewables is currently under development at the Laboratory, and will be reported in future reports.

## 8.2 Calculations of 2003 Emissions Reduction From Implementation of the IECC / IRC to New Single-family Residential Construction.

### 8.2.1 2003 Results for New Single-family Residential Construction.

In this section of the report calculations are provided regarding the potential electricity reductions and emissions reduction from the implementation of the IECC / IRC to new single-family residences in the 38 non-attainment and affected counties[95]. The procedures to accomplish this were previously outlined in Section 6 of this report. First, new construction activity by county had to be determined, then energy savings attributable to the IECC / IRC had to be modeled using the code-traceable, DOE-2 simulation that the Laboratory has developed for the TERP, then estimates of the NOx reduction potential from the electricity reductions in each county were calculated using the EPA's eGRID database[96]. The results of the new calculations are reported in Table 25 through Table 31 for new single-family residences, which were estimated to be constructed during 2003.

In Table 25 the 1999 and IECC / IRC code-compliant building characteristics are shown for each county. As previously discussed in Section 6, the 1999 building characteristics reflect those published by the NAHB, ARI and GAMA for Texas. The IECC / IRC code-compliant characteristics are the minimum

[94] HEPA/UV systems remove indoor contaminants using high efficiency filtration (developed by the nuclear industry) and sterilization using ultraviolet light.
[95] The three new counties, Henderson, Hood and Hunt were not included in the 2003 report.
[96] This preliminary analysis does not include actual power transfers on the grid, and assumes transmission and distribution losses of 20%. Counties were assigned to utility service districts as indicated previously.

building code characteristics required by the IECC / IRC for each county for single-family residences (i.e., Type A.1)[97]. In Table 25 the rows are sorted first by the EPA's non-attainment and affected designation, then alphabetically. Next, in the third column, the location of the TMY2 weather file is listed, followed by the NAHB survey classification. The fifth column in Table 25 lists the window area for the average house as defined by the NAHB survey[98]. The sixth, seventh, eighth and ninth columns show the NAHB's average glazing U-value, Solar Heat Gain Coefficient (SHGC), roof insulation and wall insulation, respectively. In columns ten through fourteen of Table 25 the corresponding values from the IECC / IRC code-compliant house are listed for each county (i.e., % area, glazing U-value, SHGC, roof and wall insulation R-value). For each county the identical window %area was used for the 1999 and code-compliant calculation (i.e., window-to-wall area). The IECC / IRC SHGC is 0.4 for all non-attainment and affected counties since they all fall below the 3,500 $HDD_{65}$, as required by the IECC / IRC. All houses were assumed to have an air conditioner efficiency[99] equal to a SEER 11, a furnace efficiency (AFUE) or 0.80, and a domestic water heater efficiency of 76%. The values shown in Table 25 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 1999 and IECC / IRC code-compliant simulation. In cases where the 1999 values were more efficient than the IECC / IRC code-compliant simulation, the 1999 values were used in both simulations, since this indicates that the prevailing practice is already above code. For example, in Brazoriza county, according to the NAHB, the roof insulation is R-27.08, which is already above the code-required insulation of R-19. Therefore, R-27.08 was used in both simulations.

In Table 26 the code-traceable simulation results are shown for each county. In a similar fashion as Table 25, this table is first divided into EPA affected and then non-attainment classifications, followed by an alphabetical listing of counties. In the third column the IECC / IRC climate zone is listed followed by the number of projected new housing units[100] in the fourth and fifth columns. In the sixth and seventh columns the simulated annual energy use for single-family residences with 1999 and IECC / IRC-compliant characteristics is listed. This simulated energy use in column six and seven represent a building with characteristics shown in Table 25 simulated at the climate location shown in column 3. Column 8 is then the annual electricity savings per house from the IECC / IRC code-compliant simulation (kWh/yr), and columns 9 and 10 are the total annual county-wide electricity use from the new housing units, which is the result of the product of the annual electricity use per house times the number of expected housing units for each county. Column 11 is the annual county-wide electricity savings resulting from the implementation of the IECC / IRC, which is followed by column 12, which represents a fixed 1.2 multiplier times column 11 to account for the estimated 20% Transmission and distribution loss (T&D).

In column 13 the peak cooling dates are shown from the TMY2 weather file for each county. These dates represent the DOE-2-chosen peak dates for a particular housing characteristic, which changes as the housing characteristics change. For the 2003 results, the peak dates calculated for the 2002 report were used[101].

Columns 16 through 21 show the peak-day electricity savings for each county, beginning with the peak-day electricity use for each house using 1999 (column 16) and IECC / IRC code-compliant characteristics (column 17), and the savings for each house (column 18), followed by the county-wide peak-day electricity use for 1999 (column 19) and IECC / IRC code-compliant characteristics (column 20), and the county-wide savings (column 21). Column 22 then shows the county-wide savings with the 1.2 multiplier applied to estimate T&D losses.

[97] As modified by the 2001 Supplement.

[98] This value represents the NAHB's reported number of window units times an average window size of 3 x 5 feet, which was determined by surveying local building suppliers. Additional information about the procedures used to determine these values can be found in Im (2003).

[99] The choice of a SEER 11 efficiency for the air conditioner was based on ARI sales numbers for Texas which show an average SEER 11 for houses built in 1999.

[100] The number of projected new housing units uses the published values for the new housing units in 2002. A vacancy rate of 0% was assumed for 2003 calculations, based on information suggested by the Real Estate Center at Texas A&M University.

[101] The 2002 dates were chosen to avoid changes in the results, which are from the choice of peak date only. The non-coincident dates shown were found to represent a realistic coincident peak date. This is because the TMY2 weather tapes are composed of averaged based on a number of years of data for a given site. Hence, dates across TMY2 sites do not correspond to the same calendar date.

In Table 27 the county-wide annual electricity savings were then assigned to each PCA using the first column shown in PUC's PCA assignment tables shown in Table 17 and Table 18. The total value from Table 27 for each PCA was then entered into the bottom row of Table 28, which represents the eGRID utility database for all ERCOT PCAs. The far right column of Table 28 then represents the total annual tons of NOx savings in each county from all the power plants for the PCAs in that county whose electricity use was reduced by new houses that were built to IECC / IRC code compliance. Table 30 contains the 2003 peak-day electricity savings from implementation of the IECC / IRC, which is calculated in a similar fashion as Table 28 using peak-day electricity savings. Finally, Table 31 contains both the 2003, county-wide annual and 2003 peak-day electricity savings from implementation of the IECC / IRC, which represent the values shown in Table 28 and Table 30. Finally, Figure 56 and Figure 57 present the tabulated information previously shown in Table 26 through Table 30. Figure 56 shows the county-wide annual (top), and peak-day (bottom) savings, and Figure 57 shows how the NOx emissions reduction are assigned to the different counties using eGRID.

In Table 32 the annual and peak-day natural gas savings are shown. These savings represent the simulated natural gas reductions due to the implementation of the IECC / IRC, which include reductions in heating energy use due to more efficient insulation, improved windows, and the elimination of the standing pilot light in the furnace that serves the residence[102].

### 8.2.2 Tracing the Savings to Individual Measures: Harris County and Tarrant County.

To better understand which energy conserving features were producing the energy savings a sensitivity study was performed on two houses, one located in Harris County (i.e., Houston area), and one located in Tarrant County (i.e., Dallas/Ft. Worth area). In this analysis, the simulations were repeated with each measure simulated separately and a combined simulation with all measures. Results are shown for the annual and peak-day savings by fuel type and NOx emissions reduction. This analysis is based on the standard house type used for the 2003 simulations for single-family residential as described in Table 25[103].

#### 8.2.2.1 Harris County.

For houses in Harris County (Table 21), which is climate zone 4, the average NAHB characteristics for 1999 include 13.8% window-to-wall area, a glazing U-value of 1.11 Btu/ hr-ft$^2$-°F, a solar heat gain coefficient of 0.71, roof insulation R-value of 27.08 hr-ft$^2$-°F/Btu, a wall insulation of 13.99 hr-ft$^2$-°F/Btu, an air conditioning efficiency of SEER-11, and an AFUE of 0.80. For the IECC / IRC-compliant house in climate zone 4, a house with similar window-to-wall area as the 1999 average house (i.e., 13.8%), is required to have a glazing U-value of 0.75 Btu/ hr-ft$^2$-°F, a solar heat gain coefficient of 0.40, a roof insulation R-value of 26.00 hr-ft$^2$-°F/Btu[104], a wall insulation level of R-13 hr-ft$^2$-°F/Btu, a SEER-11 air conditioning efficiency, and an AFUE of 0.78.

In Table 22, the results of the sensitivity analysis show that the average 1999 house in Harris county consumed 13,900 kWh/year of electricity and 336 therms/year of natural gas, which totaled 81.03 MBtu/year[105], and on a peak summer day consumed 65.74 kWh/day, and 0.53 therm/day of natural gas. When the windows were upgraded to meet the code requirements (i.e., double-pane, low-e windows), the

[102] The elimination of the standing pilot light results in a savings of 500 Btu/hr, which is assumed to operate 24 hours per day, 365 days per year. This feature was identified through conversations with several furnace manufacturers who confirmed that the newer, more efficient furnaces, such as those required to meet the 2000 IECC/IRC, utilize hot surface ignition systems to reach the higher AFUE efficiencies required by the 2000 IECC/IRC. NOx emissions from the elimination of the pilot light were assumed to be 0.248 lbs-NOx/MMBtu, from Ottinger, et al. (1991). Environmental Costs of Electricity, Oceana Publications, Inc., 1991.

[103] The single-family house is a single-story house with slab-on-grade foundation and equal window areas on all four sides of the house. The house has a two-car garage on the west side of the house and no significant shading. It contains an air conditioner (SEER 11), a natural gas-fired furnace (AFUE 80%), and a natural gas-fired domestic water heater.

[104] Whenever the 1999 NAHB characteristics were shown to be above code, the 2000 IECC-code compliant house was simulated with the same characteristics as the NAHB house, which indicated that the current practice in 1999 was already above code and therefore no savings were expected from code-compliance.

[105] This assumes 3,412 Btu/kWh for an electricity to Btu conversion and 100,000 Btu/therm. MBtu = million Btu, or 1 x $10^6$ Btu.

annual electricity was reduced to 12,335 kWh/year (11.26% decrease), and gas use was reduced to 335 therms/year (0.30% decrease), which equaled a total combined energy use of 75.64 MBtu/year (6.65% decrease). Since the average 1999 house already had roof and wall insulation that exceed the code requirement, the house was simulated with insulation levels that were similar to the average 1999 house (i.e., no savings were calculated).

In Table 22 savings are shown for a code-compliant furnace that includes an electronic ignition (i.e., there is no standing pilot light). The type of efficiency upgrade was chosen based on conversations with several residential furnace manufacturers whose current equipment line exclude standing pilot lights to meet the stricter 80% efficiency requirements of the IECC / IRC. When the average 1999 house was resimulated with the pilot light eliminated, the annual gas use dropped to 292 therms/ year (13.10% decrease), which amounts to a total energy use of 76.68 MBtu/year (5.37% decrease). On peak cooling days, the natural gas use is reduced to 0.41 therms/day (22.64% decrease).

When the average 1999 house in Harris county was simulated with both the efficient windows and the electronic ignition the total annual electricity use was reduced to 12,335 kWh/year (11.26% decrease), and gas use was reduced to 292 therms/year (13.10% decrease), with the total annual energy use reduced to 71.29 MBtu/year (12.02% decrease).

| | Area % | Glazing U-value (Btu/ hr-ft$^2$-°F) | SHGC | Roof Insulation (hr-ft$^2$-$^o$F/Btu) | Wall Insulation (hr-ft$^2$-$^o$F/Btu) | SEER | AFUE (%) |
|---|---|---|---|---|---|---|---|
| 1999 Average | 13.8 | 1.11 | 0.71 | 27.08 | 13.99 | 11 | 80 |
| 2000 IECC | 13.8 | 0.75 | 0.40 | 26.00 | 13.00 | 10 | 78 |

Table 21: 1999 Average Vs IECC / IRC Input Values for Specific Measures for Single-family Residential in Harris County.

| Simulated House | Annual Elec. Use | Difference | Annual N.G. Use | Difference | Total Energy Use | Difference |
|---|---|---|---|---|---|---|
| | (kWh/yr) | (%) | (Therm/yr) | (%) | (MBtu/yr) | (%) |
| 1999 Average House | 13,900 | - | 336 | - | 81.03 | - |
| 1999 Average House w/ Low-e windows | 12,335 | 11.26% | 335 | 0.30% | 75.64 | 6.65% |
| 1999 Average House w/o pilot light | 13,900 | 0.00% | 292 | 13.10% | 76.68 | 5.37% |
| 1999 Average House w/ all above | 12,335 | 11.26% | 292 | 13.10% | 71.29 | 12.02% |

| Simulated House | Peak-day | Peak-day Elec. Use | Difference | Peak-day N.G. Use | Difference |
|---|---|---|---|---|---|
| | (2002 report) | (KWh/day) | (%) | (Therm/day) | (%) |
| 1999 Average House | 7/29 | 65.74 | - | 0.53 | - |
| 1999 Average House w/ Low-e windows | | 56.78 | 13.63% | 0.53 | 0.00% |
| 1999 Average House w/o pilot light | | 65.74 | 0.00% | 0.41 | 22.64% |
| 1999 Average House w/ all above | | 56.78 | 13.63% | 0.41 | 22.64% |

Table 22: Annual and Peak-day Savings for Specific Measures for Single-family Residential in Harris County.

8.2.2.2 Tarrant County.

For houses in Tarrant county (Table 23), which is climate zone 5, the average NAHB characteristics for 1999 include 20.6% window-to-wall area, a glazing U-value of 0.87 Btu/ hr-ft$^2$-°F, a solar heat gain coefficient of 0.71, roof insulation R-value of 26.75 hr-ft$^2$-°F/Btu, a wall insulation of 14.18 hr-ft$^2$-°F/Btu, an air conditioning efficiency of SEER-11, and an AFUE of 80%. For the IECC-compliant house in climate zone 5, a house with similar window-to-wall area as the 1999 average house (i.e., 20.6%), is required to have a glazing U-value of 0.50 Btu/ hr-ft$^2$-°F, a solar heat gain coefficient of 0.40, a roof insulation R-value of 38.0 hr-ft$^2$-°F/Btu[106], a wall insulation level of R-13 hr-ft$^2$-°F/Btu, a SEER-11 air conditioning efficiency, and an AFUE of 78%.

In Table 24, the results of the sensitivity analysis show that the average 1999 house in Tarrant county consumed 15,274 kWh/year of electricity and 442 therms/year of natural gas, which totaled 96.32 MBtu/year, and on a peak summer day consumed 84.12 kWh/day, and 0.55 therms/day of natural gas. In difference to Harris county, when only the roof insulation was upgraded, the annual electricity was reduced to 15,098 (1.21% decrease), the natural gas use was reduced to 424 therms/year (4.07% decrease), for a total annual energy use of 93.89 MBtu/year (2.52% decrease). On a peak day electricity use was reduced to 82.10 kWh/day (2.40% decrease), and gas use was unchanged. When only the windows were upgraded to meet the code requirements (i.e., double-pane, low-e windows), the annual electricity was reduced to 13,210 kWh/year (13.51% decrease), and gas use was reduced to 409 therms/year (7.47% decrease), which equaled a total combined energy use of 85.96 MBtu/year (10.76% decrease).

In Table 24 the savings for the code-compliant furnace that includes an electronic ignition show the annual gas use dropped to 399 therms/ year (9.73% decrease), which amounts to a total energy use of 91.99 MBtu/year (4.50% decrease). On peak cooling days, the natural gas use is reduced to 0.43 therms/day (21.82% decrease).

When the average 1999 house in Tarrant county was simulated with efficient windows, improved roof insulation and the electronic ignition the total annual electricity use was reduced to 13,035 kWh/year (14.72% decrease), and gas use was reduced to 347 therms/year (21.49% decrease), with the total annual energy use reduced to 79.12 MBtu/year (17.86% decrease).

| | Area % | Glazing U-value (Btu/ hr-ft$^2$-°F) | SHGC | Roof Insulation (hr-ft$^2$-°F/Btu) | Wall Insulation (hr-ft$^2$-°F/Btu) | SEER | AFUE (%) |
|---|---|---|---|---|---|---|---|
| 1999 Average | 20.6 | 0.87 | 0.66 | 26.75 | 14.18 | 11 | 80 |
| 2000 IECC / IRC | 20.6 | 0.50 | 0.40 | 38.00 | 13.00 | 10 | 78 |

Table 23: 1999 Average Vs IECC Input Values for Specific Measures for Single-family Residential in Tarrant County.

[106] Whenever the 1999 NAHB characteristics were shown to be above code, the 2000 IECC-code compliant house was simulated with the same characteristics as the NAHB 1999 house, which indicated that the current practice in 1999 was already above code and therefore no savings were expected from code-compliance.

| Simulated House | Annual Elec. Use | Difference | Annual N.G. Use | Difference | Total Energy Use | Difference |
|---|---|---|---|---|---|---|
| | (KWh/yr) | (%) | (Therm/yr) | (%) | (MBtu/yr) | (%) |
| 1999 Average House | 15,274 | - | 442 | - | 96.32 | - |
| 1999 Average House w/ roof insulation (R-38) | 15,089 | 1.21% | 424 | 4.07% | 93.89 | 2.52% |
| 1999 Average House w/ Low-e windows | 13,210 | 13.51% | 409 | 7.47% | 85.96 | 10.76% |
| 1999 Average House w/o pilot light | 15,274 | 0.00% | 399 | 9.73% | 91.99 | 4.50% |
| 1999 Average House w/ all above | 13,025 | 14.72% | 347 | 21.49% | 79.12 | 17.86% |

| Simulated House | Peak-day | Peak-day Elec. Use | Difference | Peak-day N.G. Use | Difference |
|---|---|---|---|---|---|
| | (2002 report) | (KWh/day) | (%) | (Therm/day) | (%) |
| 1999 Average House | 7/29 | 84.12 | - | 0.55 | - |
| 1999 Average House w/ roof insulation (R-38) | | 82.10 | 2.40% | 0.55 | 0.00% |
| 1999 Average House w/ Low-e windows | | 70.39 | 16.32% | 0.55 | 0.00% |
| 1999 Average House w/o pilot light | | 84.12 | 0.00% | 0.43 | 21.82% |
| 1999 Average House w/ all above | | 68.33 | 18.77% | 0.43 | 21.82% |

Table 24: Annual and Peak-day Savings for Specific Measures for Single-family Residential in Tarrant County.

### 8.2.3 Summary.

In summary, the implementation of the IECC in the non-attainment and affected counties is calculated to have saved single-family homeowners from 1,602 to 2,583 kWh/house annually (12 to 16% of the annual 1999 household electricity use, which is 0.63 to 1.1 W/ft2), which would be $120 to $194 ($0.047/ft2 to $0.08/ft2 at 0.075 $/kWh). The total annual electricity savings from the implementation of the IECC / IRC for the estimated 96,622 new single-family houses built in the 38 non-attainment and affected counties is 236,965 MWh, for a cost savings of $17.7 million[107]. On peak-days the IECC / IRC reduces single-family household electricity use by 7.86 to 15.79 kWh/day (12.4 to 18.7% of the peak 1999 electricity use), which reduces the total electricity production by 1,452.39 MWh for the 38 non-attainment and affected counties. Using eGRID, the electricity savings from the implementation of the IECC / IRC to single-family houses translate to 340.43 tons of NOx reduction annually. On a peak-day, using eGRID, the electricity reductions translate to 2.13 tons of NOx for all the 38 non-attainment and affected counties.

The natural gas savings from the implementation of the IECC / IRC in the non-attainment and affected counties is calculated to have saved single-family homeowners from 41 to 114 therms/house[108] annually (13 to 26% of the annual 1999 household natural gas use), which would be $25 to $68 (at 0.60 $/therm). The total annual savings from the implementation of the IECC / IRC for the estimated 96,622 new single-family houses built in the 38 non-attainment and affected counties is 7,427,643 therms (742,764 MMBtu)

[107] Calculated at 0.075 $/kWh.
[108] A therm is a measure of the energy content of natural gas, which is equal to 100,000 Btu.

for a cost savings of $4.5 million[109]. On peak-days (i.e., peak cooling days) the IECC / IRC reduces single-family natural gas use by 0.12 therm/day (18 to 25% of the peak 1999 natural gas use), which reduces the total natural gas required on peak days by 11,595 therms (1,159 MMBtu) for the 38 non-attainment and affected counties. When combined with multi-family , this amounts to an annual NOx reduction of 110.1 tons/year (Table 45). On a peak-day in the cooling season, the natural gas reductions translate to 0.1978 tons of NOx for all the 38 non-attainment and affected counties.

[109] Calculated at 0.60 $/therm.

| | County | TMY2 | Division | 1999 Average | | | | | 2000 IECC | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (East or West) | Area % | Glazing U-value (Btu/ hr-ft2-F) | SHGC | Roof Insulation (hr-ft2-F/Btu) | Wall Insulation (hr-ft2-F/Btu) | Area % | Glazing U-value (Btu/ hr-ft2-F) | SHGC | Roof Insulation (hr-ft2-F/Btu) | Wall Insulation (hr-ft2-F/Btu) |
| Non-attainment | Brazoria | Houston | East | 13.8 | 1.11 | 0.71 | 27.08 | 13.99 | 13.8 | 0.75 | 0.40 | 19.00 | 11.00 |
| | Chambers | Port Arthur | East | 13.8 | 1.11 | 0.71 | 27.08 | 13.99 | 13.8 | 0.75 | 0.40 | 26.00 | 13.00 |
| | Collin | Fort Worth | West | 20.6 | 0.87 | 0.66 | 26.75 | 14.18 | 20.6 | 0.46 | 0.40 | 38.00 | 16.00 |
| | Dallas | Fort Worth | West | 20.6 | 0.87 | 0.66 | 26.75 | 14.18 | 20.6 | 0.50 | 0.40 | 38.00 | 13.00 |
| | Denton | Fort Worth | West | 20.6 | 0.87 | 0.66 | 26.75 | 14.18 | 20.6 | 0.46 | 0.40 | 38.00 | 16.00 |
| | El Paso | El Paso | West | 20.6 | 0.87 | 0.66 | 26.75 | 14.18 | 20.6 | 0.46 | 0.40 | 38.00 | 16.00 |
| | Fort Bend | Houston | East | 13.8 | 1.11 | 0.71 | 27.08 | 13.99 | 13.8 | 0.75 | 0.40 | 26.00 | 13.00 |
| | Galveston | Houston | East | 13.8 | 1.11 | 0.71 | 27.08 | 13.99 | 13.8 | 0.75 | 0.40 | 19.00 | 11.00 |
| | Hardin | Port Arthur | East | 13.8 | 1.11 | 0.71 | 27.08 | 13.99 | 13.8 | 0.75 | 0.40 | 26.00 | 13.00 |
| | Harris | Houston | East | 13.8 | 1.11 | 0.71 | 27.08 | 13.99 | 13.8 | 0.75 | 0.40 | 26.00 | 13.00 |
| | Jefferson | Port Arthur | East | 13.8 | 1.11 | 0.71 | 27.08 | 13.99 | 13.8 | 0.75 | 0.40 | 26.00 | 13.00 |
| | Liberty | Port Arthur | East | 13.8 | 1.11 | 0.71 | 27.08 | 13.99 | 13.8 | 0.75 | 0.40 | 26.00 | 13.00 |
| | Montgomery | Houston | East | 13.8 | 1.11 | 0.71 | 27.08 | 13.99 | 13.8 | 0.75 | 0.40 | 26.00 | 13.00 |
| | Orange | Port Arthur | East | 13.8 | 1.11 | 0.71 | 27.08 | 13.99 | 13.8 | 0.75 | 0.40 | 26.00 | 13.00 |
| | Tarrant | Fort Worth | West | 20.6 | 0.87 | 0.66 | 26.75 | 14.18 | 20.6 | 0.50 | 0.40 | 38.00 | 13.00 |
| | Waller | Houston | East | 13.8 | 1.11 | 0.71 | 27.08 | 13.99 | 13.8 | 0.75 | 0.40 | 26.00 | 13.00 |
| Affected | Bastrop | Austin | West | 20.6 | 0.87 | 0.66 | 26.75 | 14.18 | 20.6 | 0.52 | 0.40 | 30.00 | 13.00 |
| | Bexar | San Antonio | West | 20.6 | 0.87 | 0.66 | 26.75 | 14.18 | 20.6 | 0.52 | 0.40 | 30.00 | 13.00 |
| | Caldwell | Austin | West | 20.6 | 0.87 | 0.66 | 26.75 | 14.18 | 20.6 | 0.52 | 0.40 | 30.00 | 13.00 |
| | Comal | San Antonio | West | 20.6 | 0.87 | 0.66 | 26.75 | 14.18 | 20.6 | 0.52 | 0.40 | 30.00 | 13.00 |
| | Ellis | Fort Worth | West | 20.6 | 0.87 | 0.66 | 26.75 | 14.18 | 20.6 | 0.50 | 0.40 | 38.00 | 13.00 |
| | Gregg | Lufkin | East | 13.8 | 1.11 | 0.71 | 27.08 | 13.99 | 13.8 | 0.60 | 0.40 | 30.00 | 13.00 |
| | Guadalupe | San Antonio | West | 20.6 | 0.87 | 0.66 | 26.75 | 14.18 | 20.6 | 0.52 | 0.40 | 30.00 | 13.00 |
| | Harrison | Lufkin | East | 13.8 | 1.11 | 0.71 | 27.08 | 13.99 | 13.8 | 0.60 | 0.40 | 30.00 | 13.00 |
| | Hays | Austin | West | 20.6 | 0.87 | 0.66 | 26.75 | 14.18 | 20.6 | 0.50 | 0.40 | 38.00 | 13.00 |
| | Johnson | Fort Worth | West | 20.6 | 0.87 | 0.66 | 26.75 | 14.18 | 20.6 | 0.50 | 0.40 | 38.00 | 13.00 |
| | Kaufman | Fort Worth | West | 20.6 | 0.87 | 0.66 | 26.75 | 14.18 | 20.6 | 0.46 | 0.40 | 38.00 | 16.00 |
| | Nueces | Corpus Christi | East | 13.8 | 1.11 | 0.71 | 27.08 | 14.18 | 13.8 | 0.75 | 0.40 | 19.00 | 11.00 |
| | Parker | Fort Worth | West | 20.6 | 0.87 | 0.66 | 26.75 | 14.18 | 20.6 | 0.46 | 0.40 | 38.00 | 16.00 |
| | Rockwall | Fort Worth | West | 20.6 | 0.87 | 0.66 | 26.75 | 14.18 | 20.6 | 0.46 | 0.40 | 38.00 | 16.00 |
| | Rusk | Lufkin | East | 13.8 | 1.11 | 0.71 | 27.08 | 13.99 | 13.8 | 0.65 | 0.40 | 30.00 | 13.00 |
| | San Patricio | Corpus Christi | East | 13.8 | 1.11 | 0.71 | 27.08 | 14.18 | 13.8 | 0.75 | 0.40 | 19.00 | 11.00 |
| | Smith | Lufkin | East | 13.8 | 1.11 | 0.71 | 27.08 | 13.99 | 13.8 | 0.65 | 0.40 | 30.00 | 13.00 |
| | Travis | Austin | West | 20.6 | 0.87 | 0.66 | 26.75 | 14.18 | 20.6 | 0.50 | 0.40 | 38.00 | 13.00 |
| | Upshur | Lufkin | East | 13.8 | 1.11 | 0.71 | 27.08 | 13.99 | 13.8 | 0.60 | 0.40 | 30.00 | 13.00 |
| | Victoria | Victoria | East | 20.6 | 1.11 | 0.71 | 27.08 | 14.18 | 20.6 | 0.75 | 0.40 | 19.00 | 11.00 |
| | Williamson | Austin | West | 13.8 | 0.87 | 0.66 | 26.75 | 14.18 | 13.8 | 0.50 | 0.40 | 38.00 | 13.00 |
| | Wilson | San Antonio | West | 20.6 | 0.87 | 0.66 | 26.75 | 14.18 | 20.6 | 0.52 | 0.40 | 30.00 | 13.00 |

Table 25: 1999 and IECC / IRC Code-compliant Building Characteristics Used in the DOE-2 Simulation for Single-family Residential.

**Simulation Results for Single-family Houses**

| | County | Climate Zone | No. of projected units (2003) | No. of projected units (2003) w/ Vacancy Rate | 2000 Annual Electricity Use (kWh/house) *(1999 Average Characteristics)* | 2003 Anuual Electricity Use (kWh/house) *(The 200 IECC Characteristics)* | Annual Electricity Savings per House (kWh/House) | 2000 Total Annual Electricity Use (MWh/County) *(1999 Average Characteristics)* | 2003 Total Anuual Electricity Use (MWh/County) *(The 200 IECC Characteristics)* | Total Annual Electricity Savings per County (MWh/County) | Total Annual Electricity Savings per County w/ 20% T&D Loss (MWh/County) | Peak Date (2002 Report) | 2000 Peak-day Electricity Use (kWh/house) *(1999 Average Characteristics)* | 2003 Peak-day Electricity Use (kWh/house) *(The 200 IECC Characteristics)* | Peak-day Electricity Savings per House (kWh/House) | 2000 Total Peak-day Electricity Use (MWh/County) *(1999 Average Characteristics)* | 2003 Total Peak-day Electricity Use (MWh/County) *(The 200 IECC Characteristics)* | Peak-day Electricity Savings per County (MWh/County) | Peak-day Electricity Savings per County w/ 20% T&D Loss (MWh/County) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Affected County | Bastrop | 4 | 215 | 215 | 16,278 | 13,982 | 2,296 | 3,500 | 3,006 | 494 | 592 | 7/31 | 76.81 | 62.17 | 14.64 | 16.51 | 13.37 | 3.15 | 3.78 |
| | Bexar | 4 | 7,671 | 7,671 | 16,353 | 13,991 | 2,362 | 125,444 | 107,325 | 18,119 | 21,743 | 8/28 | 70.44 | 59.47 | 10.97 | 540.35 | 456.19 | 84.16 | 100.99 |
| | Caldwell | 4 | 129 | 129 | 16,278 | 13,982 | 2,296 | 2,100 | 1,804 | 296 | 355 | 7/31 | 76.81 | 62.17 | 14.64 | 9.91 | 8.02 | 1.89 | 2.27 |
| | Comal | 4 | 1,248 | 1,248 | 16,353 | 13,991 | 2,362 | 20,409 | 17,461 | 2,948 | 3,537 | 8/28 | 70.44 | 59.47 | 10.97 | 87.91 | 74.22 | 13.69 | 16.43 |
| | Ellis | 5 | 707 | 707 | 15,274 | 13,025 | 2,249 | 10,799 | 9,209 | 1,590 | 1,908 | 7/29 | 84.12 | 68.33 | 15.79 | 59.47 | 48.31 | 11.16 | 13.40 |
| | Gregg | 6 | 256 | 256 | 13,505 | 11,903 | 1,602 | 3,457 | 3,047 | 410 | 492 | 7/22 | 68.03 | 57.35 | 10.68 | 17.42 | 14.68 | 2.73 | 3.28 |
| | Guadalupe | 4 | 646 | 646 | 16,353 | 13,991 | 2,362 | 10,564 | 9,038 | 1,526 | 1,831 | 8/28 | 70.44 | 59.47 | 10.97 | 45.50 | 38.42 | 7.09 | 8.50 |
| | Harrison | 6 | 42 | 42 | 13,505 | 11,903 | 1,602 | 567 | 500 | 67 | 81 | 7/22 | 68.03 | 57.35 | 10.68 | 2.86 | 2.41 | 0.45 | 0.54 |
| | Hays | 5 | 919 | 919 | 16,278 | 13,863 | 2,415 | 14,959 | 12,740 | 2,219 | 2,663 | 7/31 | 76.81 | 61.34 | 63.12 | 70.59 | 56.37 | 14.22 | 17.06 |
| | Johnson | 5 | 687 | 687 | 15,274 | 13,025 | 2,249 | 10,493 | 8,948 | 1,545 | 1,854 | 7/29 | 84.12 | 68.33 | 15.79 | 57.79 | 46.94 | 10.85 | 13.02 |
| | Kaufman | 6 | 403 | 403 | 15,274 | 13,003 | 2,271 | 6,155 | 5,240 | 915 | 1,098 | 8/19 | 78.93 | 64.36 | 14.57 | 31.81 | 25.94 | 5.87 | 7.05 |
| | Nueces | 3 | 1,012 | 1,012 | 15,300 | 13,572 | 1,728 | 15,484 | 13,735 | 1,749 | 2,098 | 8/18 | 68.34 | 59.97 | 8.37 | 69.16 | 60.69 | 8.47 | 10.16 |
| | Parker | 6 | 345 | 345 | 15,274 | 13,003 | 2,271 | 5,270 | 4,486 | 783 | 940 | 8/19 | 78.93 | 64.36 | 14.57 | 27.23 | 22.20 | 5.03 | 6.03 |
| | Rockwall | 6 | 1,246 | 1,246 | 15,274 | 13,003 | 2,271 | 19,031 | 16,202 | 2,830 | 3,396 | 8/19 | 78.93 | 64.36 | 14.57 | 98.35 | 80.19 | 18.15 | 21.79 |
| | Rusk | 5 | 16 | 16 | 13,358 | 11,820 | 1,538 | 214 | 189 | 25 | 30 | 7/22 | 67.69 | 57.30 | 10.39 | 1.08 | 0.92 | 0.17 | 0.20 |
| | San Patricio | 3 | 229 | 229 | 15,300 | 13,572 | 1,728 | 3,504 | 3,108 | 396 | 475 | 8/18 | 68.34 | 59.97 | 8.37 | 15.65 | 13.73 | 1.92 | 2.30 |
| | Smith | 5 | 506 | 506 | 13,358 | 11,820 | 1,538 | 6,759 | 5,981 | 778 | 934 | 7/22 | 67.69 | 57.30 | 10.39 | 34.25 | 28.99 | 5.26 | 6.31 |
| | Travis | 5 | 4,820 | 4,820 | 16,278 | 13,863 | 2,415 | 78,460 | 66,820 | 11,640 | 13,968 | 7/31 | 76.81 | 61.34 | 15.47 | 370.22 | 295.66 | 74.57 | 89.48 |
| | Upshur | 6 | 18 | 18 | 13,505 | 11,903 | 1,602 | 243 | 214 | 29 | 35 | 7/22 | 68.03 | 57.35 | 10.68 | 1.22 | 1.03 | 0.19 | 0.23 |
| | Victoria | 3 | 178 | 178 | 14,536 | 12,840 | 1,696 | 2,587 | 2,286 | 302 | 362 | 9/2 | 72.48 | 63.50 | 8.98 | 12.90 | 11.30 | 1.60 | 1.92 |
| | Williamson | 5 | 4,229 | 4,229 | 16,278 | 13,863 | 2,415 | 68,840 | 58,627 | 10,213 | 12,256 | 7/31 | 76.81 | 61.34 | 15.47 | 324.83 | 259.41 | 65.42 | 78.51 |
| | Wilson | 4 | 36 | 36 | 16,353 | 13,991 | 2,362 | 589 | 504 | 85 | 102 | 8/28 | 70.44 | 59.47 | 10.97 | 2.54 | 2.14 | 0.39 | 0.47 |
| Non-attainment County | Brazoria | 3 | 2,349 | 2,349 | 13,900 | 12,335 | 1,565 | 32,651 | 28,975 | 3,676 | 4,411 | 7/29 | 65.74 | 56.78 | 8.96 | 154.42 | 133.38 | 21.05 | 25.26 |
| | Chambers | 4 | 298 | 298 | 13,721 | 12,210 | 1,511 | 4,089 | 3,639 | 450 | 540 | 9/1 | 63.52 | 55.66 | 7.86 | 18.93 | 16.59 | 2.34 | 2.81 |
| | Collin | 5 | 9,671 | 9,671 | 15,274 | 13,003 | 2,271 | 147,715 | 125,752 | 21,963 | 26,355 | 8/19 | 78.93 | 64.36 | 14.57 | 763.33 | 622.43 | 140.91 | 169.09 |
| | Dallas | 5 | 8,170 | 8,170 | 15,274 | 13,025 | 2,249 | 124,789 | 106,414 | 18,374 | 22,049 | 7/29 | 84.12 | 68.33 | 15.79 | 687.26 | 558.26 | 129.00 | 154.81 |
| | Denton | 6 | 4,961 | 4,961 | 15,274 | 13,003 | 2,271 | 75,774 | 64,508 | 11,266 | 13,520 | 8/19 | 78.93 | 64.36 | 14.57 | 391.57 | 319.29 | 72.28 | 86.74 |
| | El Paso | 6 | 3,388 | 3,388 | 15,416 | 12,833 | 2,583 | 52,229 | 43,478 | 8,751 | 10,501 | 7/12 | 73.79 | 58.67 | 15.12 | 250.00 | 198.77 | 51.23 | 61.47 |
| | Fort Bend | 4 | 1,043 | 1,043 | 13,900 | 12,335 | 1,565 | 14,498 | 12,865 | 1,632 | 1,959 | 7/29 | 65.74 | 56.78 | 8.96 | 68.57 | 59.22 | 9.35 | 11.21 |
| | Galveston | 3 | 2,564 | 2,564 | 13,900 | 12,335 | 1,565 | 35,640 | 31,627 | 4,013 | 4,815 | 7/29 | 65.74 | 56.78 | 8.96 | 168.56 | 145.58 | 22.97 | 27.57 |
| | Hardin | 4 | 47 | 47 | 13,721 | 12,210 | 1,511 | 645 | 574 | 71 | 85 | 9/1 | 63.52 | 55.66 | 7.86 | 2.99 | 2.62 | 0.37 | 0.44 |
| | Harris | 4 | 21,587 | 21,587 | 13,900 | 12,335 | 1,565 | 300,059 | 266,276 | 33,784 | 40,540 | 7/29 | 65.74 | 56.78 | 8.96 | 1,419.13 | 1,225.71 | 193.42 | 232.10 |
| | Jefferson | 4 | 595 | 595 | 13,721 | 12,210 | 1,511 | 8,164 | 7,265 | 899 | 1,079 | 9/1 | 63.52 | 55.66 | 7.86 | 37.79 | 33.12 | 4.68 | 5.61 |
| | Liberty | 4 | 224 | 224 | 13,721 | 12,210 | 1,511 | 3,074 | 2,735 | 338 | 406 | 9/1 | 63.52 | 55.66 | 7.86 | 14.23 | 12.47 | 1.76 | 2.11 |
| | Montgomery | 4 | 4,247 | 4,247 | 13,900 | 12,335 | 1,565 | 59,033 | 52,387 | 6,647 | 7,976 | 7/29 | 65.74 | 56.78 | 8.96 | 279.20 | 241.14 | 38.05 | 45.66 |
| | Orange | 4 | 197 | 197 | 13,721 | 12,210 | 1,511 | 2,703 | 2,405 | 298 | 357 | 9/1 | 63.52 | 55.66 | 7.86 | 12.51 | 10.96 | 1.55 | 1.86 |
| | Tarrant | 5 | 11,700 | 11,700 | 15,274 | 13,025 | 2,249 | 178,706 | 152,393 | 26,313 | 31,576 | 7/29 | 84.12 | 68.33 | 15.79 | 984.20 | 799.46 | 184.74 | 221.69 |
| | Waller | 4 | 23 | 23 | 13,900 | 12,335 | 1,565 | 320 | 284 | 36 | 43 | 7/29 | 65.74 | 56.78 | 8.96 | 1.51 | 1.31 | 0.21 | 0.25 |
| | TOTAL | | 96,622 | 96,622 | | | | 1,449,515 | 1,252,044 | 197,471 | **236,965** | | | | | | | **1,210.33** | **1,452.39** |

Table 26: 2003 Annual and Peak-day Electricity Savings From Implementation of the IECC / IRC for Single-family Residences.

| Annual Electricity Use by PCA for Single-family House | | | | | |
|---|---|---|---|---|---|
| Nonattainment and Affected Counties | Electric Retail Service Area | Power Control Area | NERC Region | Total Energy Savings by County (MWh) | Total Energy Savings by PCA (MWh) |
| Travis | Austin Energy | Austin Energy/PCA | ERCOT | 13,968.4 | |
| | | Austin Energy/PCA | | | 13,968.4 |
| Nueces | CRI | American Electric Power West (ERCOT)/PCA | ERCOT | 2,098.5 | |
| San Patricio | CRI | American Electric Power West (ERCOT)/PCA | ERCOT | 474.9 | |
| Victoria | CRI | American Electric Power West (ERCOT)/PCA | ERCOT | 362.3 | |
| | | American Electric Power West (ERCOT)/PCA | | | 2,935.6 |
| Bastrop | | Lower Colorado River Authority/PCA | ERCOT | 592.4 | |
| Caldwell | | Lower Colorado River Authority/PCA | ERCOT | 355.4 | |
| Comal | | Lower Colorado River Authority/PCA | ERCOT | 3,537.3 | |
| Guadalupe | | Lower Colorado River Authority/PCA | ERCOT | 1,831.0 | |
| Hays | | Lower Colorado River Authority/PCA | ERCOT | 2,663.3 | |
| Wilson | | Lower Colorado River Authority/PCA | ERCOT | 102.0 | |
| | | Lower Colorado River Authority/PCA | | | 9,081.4 |
| Brazoria | Reliant Energy HL&P | Reliant Energy HL&P/PCA | ERCOT | 4,411.4 | |
| Fort Bend | Reliant Energy HL&P | Reliant Energy HL&P/PCA | ERCOT | 1,958.8 | |
| Galveston | Reliant Energy HL&P | Reliant Energy HL&P/PCA | ERCOT | 4,815.2 | |
| Harris | Reliant Energy HL&P | Reliant Energy HL&P/PCA | ERCOT | 40,540.4 | |
| Waller | Reliant Energy HL&P | Reliant Energy HL&P/PCA | ERCOT | 43.2 | |
| | | Reliant Energy HL&P/PCA | | | 51,768.9 |
| Bexar | San Antonio Public Service Bd | San Antonio Public Service Bd/PCA | ERCOT | 21,742.7 | |
| | | San Antonio Public Service Bd/PCA | | | 21,742.7 |
| Ellis | TXU | TXU Electric/PCA | ERCOT | 1,908.1 | |
| Johnson | TXU | TXU Electric/PCA | ERCOT | 1,854.1 | |
| Kaufman | TXU | TXU Electric/PCA | ERCOT | 1,098.3 | |
| Parker | TXU | TXU Electric/PCA | ERCOT | 940.2 | |
| Rockwall | TXU | TXU Electric/PCA | ERCOT | 3,395.6 | |
| Smith | TXU | TXU Electric/PCA | ERCOT | 933.9 | |
| Williamson | TXU | TXU Electric/PCA | ERCOT | 12,255.6 | |
| Collin | TXU | TXU Electric/PCA | ERCOT | 26,355.4 | |
| Dallas | TXU | TXU Electric/PCA | ERCOT | 22,049.2 | |
| Denton | TXU | TXU Electric/PCA | ERCOT | 13,519.7 | |
| Tarrant | TXU | TXU Electric/PCA | ERCOT | 31,576.0 | |
| | | TXU Electric/PCA | | | 115,886.0 |
| Chambers | EGS | Entergy Electric System/PCA | SERC | 540.3 | |
| Hardin | EGS | Entergy Electric System/PCA | SERC | 85.2 | |
| Jefferson | EGS | Entergy Electric System/PCA | SERC | 1,078.9 | |
| Liberty | EGS | Entergy Electric System/PCA | SERC | 406.2 | |
| Montgomery | EGS | Entergy Electric System/PCA | SERC | 7,975.9 | |
| Orange | EGS | Entergy Electric System/PCA | SERC | 357.2 | |
| | | Entergy Electric System/PCA | | | 10,443.6 |
| El Paso | EL PASO Electric Company | El Paso Electric Co/PCA | WSCC | 10,501.4 | |
| | | El Paso Electric Co/PCA | | | 10,501.4 |
| Gregg | SWEPCO | Southwestern Public Service Co/PCA | SPP | 492.1 | |
| Harrison | SWEPCO | Southwestern Public Service Co/PCA | SPP | 80.7 | |
| Rusk | SWEPCO | Southwestern Public Service Co/PCA | SPP | 29.5 | |
| Upshur | SWEPCO | Southwestern Public Service Co/PCA | SPP | 34.6 | |
| | | Southwestern Public Service Co/PCA | | | 637.0 |
| Total | | | | | 236,965.1 |

Table 27: 2003 Totalized Annual Electricity Savings From IECC / IRC by PCA for Single-family Residences.

**Annual NOx Emissions Reductions Calculations for Single-family Houses**

| Area | County | American Electric Power - West (ERCOT) /PCA | NOx Reductions (lbs) | Austin Energy/PCA | NOx Reductions (lbs) | Brownsville Public Utils Board/PCA | NOx Reductions (lbs/year) | Lower Colorado River Auhotrity /PCA | NOx Reductions (lbs) | Reliant Energy HL&P/PCA | NOx Reductions (lbs) | San Antonio Public Service Bd/PCA | NOx Reductions (lbs) | South Texas Electric Coop INC/PCA | NOx Reductions (lbs) | Texas Municipal Power Pool/PCA | NOx Reductions (lbs) | Texas-New Mexico Power Co/PCA | NOx Reductions (lbs) | TXU Electric/PCA | NOx Reductions (lbs) | Total Nox Reductions (lbs) | Total Nox Reductions (Tons) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austin-San Antonio Area | BASTROP | 0.01 | 29.36 | 0.20 | 2793.67 | | 0.00 | 0.34 | 3087.69 | | 0.00 | 0.01 | 217.43 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 6128.15 | 3.06 |
| | BEXAR | 0.06 | 176.14 | 0.09 | 1257.15 | 0.04 | 0.00 | 0.16 | 1453.03 | | 0.00 | 2.00 | 43485.36 | 0.08 | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | 46371.68 | 23.19 |
| | TRAVIS | | 0.00 | 0.46 | 6425.45 | | 0.00 | 0.05 | 454.07 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 6879.52 | 3.44 |
| | FAYETTE | 0.02 | 58.71 | 0.86 | 12012.79 | 0.02 | 0.00 | 1.51 | 13712.98 | 0.01 | 517.69 | 0.04 | 869.71 | 0.01 | 0.00 | 0.02 | 0.00 | | 0.00 | 0.02 | 2317.72 | 29489.60 | 14.74 |
| | LLANO | | 0.00 | 0.12 | 1676.20 | | 0.00 | 0.21 | 1907.10 | | 0.00 | 0.01 | 217.43 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 3800.73 | 1.90 |
| | CALDWELL | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | COMAL | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | GUADALUPE | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | HAYS | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | WILLIAMSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | WILSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| Dallas-Fort Worth Area | COLLIN | 0.01 | 29.36 | 0.01 | 139.68 | | 0.00 | 0.02 | 181.63 | 0.01 | 517.69 | | 0.00 | 0.05 | 0.00 | 0.19 | 0.00 | | 0.00 | 0.02 | 2317.72 | 3186.08 | 1.59 |
| | DALLAS | 0.06 | 176.14 | 0.06 | 838.10 | 0.04 | 0.00 | 0.09 | 817.33 | 0.03 | 1553.07 | 0.01 | 217.43 | 0.09 | 0.00 | 0.30 | 0.00 | 0.09 | 0.00 | 0.51 | 59101.85 | 62703.91 | 31.35 |
| | DENTON | | 0.00 | 0.01 | 139.68 | | 0.00 | 0.01 | 90.81 | | 0.00 | | 0.00 | 0.04 | 0.00 | 0.15 | 0.00 | | 0.00 | 0.01 | 1158.86 | 1389.36 | 0.69 |
| | JOHNSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | PARKER | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | CHEROKEE | 0.01 | 29.36 | 0.01 | 139.68 | 0.01 | 0.00 | 0.02 | 181.63 | | 0.00 | | 0.00 | 0.02 | 0.00 | 0.06 | 0.00 | 0.02 | 0.00 | 0.10 | 11588.60 | 11939.27 | 5.97 |
| | COKE | 0.03 | 88.07 | | 0.00 | 0.02 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 88.07 | 0.04 |
| | COLEMAN | 0.02 | 58.71 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 58.71 | 0.03 |
| | FANNIN | 0.02 | 58.71 | 0.02 | 279.37 | 0.01 | 0.00 | 0.03 | 272.44 | 0.01 | 517.69 | | 0.00 | 0.03 | 0.00 | 0.09 | 0.00 | 0.03 | 0.00 | 0.17 | 19700.62 | 20828.83 | 10.41 |
| | FRIO | 0.05 | 146.78 | | 0.00 | 0.04 | 0.00 | 0.01 | 90.81 | | 0.00 | | 0.00 | 1.15 | 0.00 | 0.07 | 0.00 | | 0.00 | | 0.00 | 237.59 | 0.12 |
| | HARDEMAN | 0.01 | 29.36 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 29.36 | 0.01 |
| | HASKELL | 0.16 | 469.70 | | 0.00 | 0.12 | 0.00 | 0.01 | 90.81 | | 0.00 | | 0.00 | 0.03 | 0.00 | 0.01 | 0.00 | | 0.00 | 0.01 | 1158.86 | 1719.37 | 0.86 |
| | HENDERSON | | 0.00 | | 0.00 | | 0.00 | 0.01 | 90.81 | | 0.00 | | 0.00 | | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.03 | 3476.58 | 3567.39 | 1.78 |
| | HOOD | 0.02 | 58.71 | 0.02 | 279.37 | 0.02 | 0.00 | 0.04 | 363.26 | 0.01 | 517.69 | | 0.00 | 0.03 | 0.00 | 0.12 | 0.00 | 0.04 | 0.00 | 0.22 | 25494.91 | 26713.94 | 13.36 |
| | JONES | 0.14 | 410.98 | | 0.00 | 0.11 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | 0.01 | 1158.86 | 1569.84 | 0.78 |
| | LAMAR | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 1158.86 | 1158.86 | 0.58 |
| | LIMESTONE | 0.01 | 29.36 | 0.01 | 139.68 | | 0.00 | | 0.00 | 0.05 | 2588.45 | 0.01 | 217.43 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 2974.91 | 1.49 |
| | MCLENNAN | 0.04 | 117.42 | 0.04 | 558.73 | 0.03 | 0.00 | 0.07 | 635.70 | 0.02 | 1035.38 | 0.01 | 217.43 | 0.06 | 0.00 | 0.22 | 0.00 | 0.07 | 0.00 | 0.40 | 46354.39 | 48919.05 | 24.46 |
| | MITCHELL | 0.04 | 117.42 | 0.04 | 558.73 | 0.03 | 0.00 | 0.07 | 635.70 | 0.02 | 1035.38 | 0.01 | 217.43 | 0.06 | 0.00 | 0.21 | 0.00 | 0.07 | 0.00 | 0.39 | 45195.53 | 47760.20 | 23.88 |
| | NOLAN | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 1158.86 | 1158.86 | 0.58 |
| | PALO PINTO | 0.01 | 29.36 | 0.02 | 279.37 | 0.01 | 0.00 | 0.03 | 272.44 | 0.01 | 517.69 | | 0.00 | 0.09 | 0.00 | 0.36 | 0.00 | | 0.00 | 0.02 | 2317.72 | 3416.58 | 1.71 |
| | RED RIVER | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | 0.02 | 2317.72 | 2317.72 | 1.16 |
| | TAYLOR | 0.01 | 29.36 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 29.36 | 0.01 |
| | TITUS | 0.01 | 29.36 | 0.01 | 139.68 | 0.01 | 0.00 | 0.02 | 181.63 | | 0.00 | | 0.00 | 0.02 | 0.00 | 0.05 | 0.00 | 0.02 | 0.00 | 0.10 | 11588.60 | 11939.27 | 5.97 |
| | YOUNG | 0.02 | 58.71 | 0.02 | 279.37 | 0.01 | 0.00 | 0.03 | 272.44 | 0.01 | 517.69 | | 0.00 | 0.03 | 0.00 | 0.09 | 0.00 | 0.03 | 0.00 | 0.16 | 18541.76 | 19669.97 | 9.83 |
| | TARRANT | 0.04 | 117.42 | 0.04 | 558.73 | 0.03 | 0.00 | 0.06 | 544.89 | 0.02 | 1035.38 | 0.01 | 217.43 | 0.05 | 0.00 | 0.18 | 0.00 | 0.06 | 0.00 | 0.33 | 38242.37 | 40716.22 | 20.36 |
| | ELLIS | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | KAUFMAN | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | ROCKWALL | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| Houston - Galveston Area | BRAZORIA | 0.01 | 29.36 | 0.01 | 139.68 | | 0.00 | | 0.00 | 0.05 | 2588.45 | 0.01 | 217.43 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 2974.91 | 1.49 |
| | BRAZOS | | 0.00 | 0.01 | 139.68 | | 0.00 | 0.01 | 90.81 | | 0.00 | | 0.00 | 0.03 | 0.00 | 0.11 | 0.00 | | 0.00 | 0.01 | 1158.86 | 1389.36 | 0.69 |
| | GRIMES | 0.01 | 29.36 | 0.01 | 139.68 | | 0.00 | 0.02 | 181.63 | 0.01 | 517.69 | | 0.00 | 0.06 | 0.00 | 0.23 | 0.00 | | 0.00 | 0.01 | 1158.86 | 2027.22 | 1.01 |
| | WHARTON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 517.69 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 517.69 | 0.26 |
| | CHAMBERS | 0.05 | 146.78 | 0.06 | 838.10 | 0.03 | 0.00 | 0.02 | 181.63 | 0.35 | 18119.13 | 0.08 | 1739.41 | 0.03 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 | 0.03 | 3476.58 | 24501.64 | 12.25 |
| | FORT BEND | 0.13 | 381.63 | 0.17 | 2374.62 | 0.10 | 0.00 | 0.06 | 544.89 | 1.01 | 52286.64 | 0.23 | 5000.82 | 0.09 | 0.00 | 0.06 | 0.00 | 0.07 | 0.00 | 0.10 | 11588.60 | 72177.19 | 36.09 |
| | GALVESTON | 0.05 | 146.78 | 0.06 | 838.10 | 0.04 | 0.00 | 0.02 | 181.63 | 0.39 | 20189.89 | 0.09 | 1956.84 | 0.04 | 0.00 | 0.03 | 0.00 | 0.42 | 0.00 | 0.04 | 4635.44 | 27948.68 | 13.97 |
| | ROBERTSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 517.69 | | 0.00 | | 0.00 | | 0.00 | 0.40 | 0.00 | 0.01 | 1158.86 | 1676.55 | 0.84 |
| | HARRIS | 0.05 | 146.78 | 0.07 | 977.79 | 0.04 | 0.00 | 0.02 | 181.63 | 0.41 | 21225.27 | 0.09 | 1956.84 | 0.04 | 0.00 | 0.02 | 0.00 | 0.03 | 0.00 | 0.04 | 4635.44 | 29123.74 | 14.56 |
| | HARDIN | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | JEFFERSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | LIBERTY | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | MONTGOMERY | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | ORANGE | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | WALLER | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| El Paso Area | EL PASO | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| OTHER | RUSK | 0.01 | 29.36 | 0.01 | 139.68 | 0.01 | 0.00 | 0.01 | 90.81 | | 0.00 | | 0.00 | 0.01 | 0.00 | 0.04 | 0.00 | 0.01 | 0.00 | 0.07 | 8112.02 | 8371.87 | 4.19 |
| | CROCKETT | 0.14 | 410.98 | | 0.00 | 0.11 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | 0.01 | 1158.86 | 1569.84 | 0.78 |
| | FREESTONE | 0.02 | 58.71 | 0.02 | 279.37 | 0.02 | 0.00 | 0.04 | 363.26 | 0.01 | 517.69 | | 0.00 | 0.03 | 0.00 | 0.12 | 0.00 | 0.04 | 0.00 | 0.22 | 25494.91 | 26713.94 | 13.36 |
| | CALHOUN | 0.19 | 557.76 | | 0.00 | 0.14 | 0.00 | 0.01 | 90.81 | | 0.00 | | 0.00 | 0.04 | 0.00 | 0.01 | 0.00 | | 0.00 | 0.01 | 1158.86 | 1807.44 | 0.90 |
| | HIDALGO | 0.13 | 381.63 | | 0.00 | 0.10 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 381.63 | 0.19 |
| | CAMERON | 0.14 | 410.98 | | 0.00 | 0.20 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | 0.01 | 1158.86 | 1569.84 | 0.78 |
| | WARD | 0.06 | 176.14 | 0.06 | 838.10 | 0.04 | 0.00 | 0.09 | 817.33 | 0.02 | 1035.38 | 0.01 | 217.43 | 0.08 | 0.00 | 0.28 | 0.00 | 0.10 | 0.00 | 0.51 | 59101.85 | 62186.22 | 31.09 |
| | WEBB | 0.06 | 176.14 | | 0.00 | 0.05 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 176.14 | 0.09 |
| | NUECES | 0.74 | 2172.35 | 0.01 | 139.68 | 0.55 | 0.00 | 0.02 | 181.63 | 0.01 | 517.69 | 0.01 | 217.43 | 0.15 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.03 | 3476.58 | 6705.35 | 3.35 |
| | VICTORIA | 0.30 | 880.68 | 0.01 | 139.68 | 0.22 | 0.00 | 0.01 | 90.81 | | 0.00 | | 0.00 | 0.68 | 0.00 | 0.05 | 0.00 | | 0.00 | 0.01 | 1158.86 | 2270.04 | 1.14 |
| | GREGG | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | HARRISON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | SMITH | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | UPSHUR | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | SAN PATRICIO | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | **TOTAL** | **2.89** | | **2.54** | | **2.22** | | **3.12** | | **2.48** | | **2.63** | | **3.27** | | **3.19** | | **1.54** | | **3.65** | | 680851.68 | 340.43 |
| Energy Savings by PCA from ESL (MWh) | | 2935.60 | | 13968.36 | | 0.00 | | 9081.44 | | 51768.95 | | 21742.68 | | 0.00 | | 0.00 | | 0.00 | | 115885.97 | | | |

Table 28: 2003 Annual NOx Reductions From IECC / IRC by PCA for Single-family Residences by County Using eGRID.

**Peak-day Electricity Use by PCA for Single-family House**

| Nonattainment and Affected Counties | Electric Retail Service Area | Power Control Area | NERC Region | Total Energy Savings by County (MWh) | Total Energy Savings by PCA (MWh) |
|---|---|---|---|---|---|
| Travis | Austin Energy | Austin Energy/PCA | ERCOT | 89.5 | |
| | | Austin Energy/PCA | | | 89.5 |
| Nueces | CRI | American Electric Power West (ERCOT)/PCA | ERCOT | 10.2 | |
| San Patricio | CRI | American Electric Power West (ERCOT)/PCA | ERCOT | 2.3 | |
| Victoria | CRI | American Electric Power West (ERCOT)/PCA | ERCOT | 1.9 | |
| | | American Electric Power West (ERCOT)/PCA | | | 14.4 |
| Bastrop | | Lower Colorado River Authority/PCA | ERCOT | 3.8 | |
| Caldwell | | Lower Colorado River Authority/PCA | ERCOT | 2.3 | |
| Comal | | Lower Colorado River Authority/PCA | ERCOT | 16.4 | |
| Guadalupe | | Lower Colorado River Authority/PCA | ERCOT | 8.5 | |
| Hays | | Lower Colorado River Authority/PCA | ERCOT | 17.1 | |
| Wilson | | Lower Colorado River Authority/PCA | ERCOT | 0.5 | |
| | | Lower Colorado River Authority/PCA | | | 48.5 |
| Brazoria | Reliant Energy HL&P | Reliant Energy HL&P/PCA | ERCOT | 25.3 | |
| Fort Bend | Reliant Energy HL&P | Reliant Energy HL&P/PCA | ERCOT | 11.2 | |
| Galveston | Reliant Energy HL&P | Reliant Energy HL&P/PCA | ERCOT | 27.6 | |
| Harris | Reliant Energy HL&P | Reliant Energy HL&P/PCA | ERCOT | 232.1 | |
| Waller | Reliant Energy HL&P | Reliant Energy HL&P/PCA | ERCOT | 0.2 | |
| | | Reliant Energy HL&P/PCA | | | 296.4 |
| Bexar | San Antonio Public Service Bd | San Antonio Public Service Bd/PCA | ERCOT | 101.0 | |
| | | San Antonio Public Service Bd/PCA | | | 101.0 |
| Ellis | TXU | TXU Electric/PCA | ERCOT | 13.4 | |
| Johnson | TXU | TXU Electric/PCA | ERCOT | 13.0 | |
| Kaufman | TXU | TXU Electric/PCA | ERCOT | 7.0 | |
| Parker | TXU | TXU Electric/PCA | ERCOT | 6.0 | |
| Rockwall | TXU | TXU Electric/PCA | ERCOT | 21.8 | |
| Smith | TXU | TXU Electric/PCA | ERCOT | 6.3 | |
| Williamson | TXU | TXU Electric/PCA | ERCOT | 78.5 | |
| Collin | TXU | TXU Electric/PCA | ERCOT | 169.1 | |
| Dallas | TXU | TXU Electric/PCA | ERCOT | 154.8 | |
| Denton | TXU | TXU Electric/PCA | ERCOT | 86.7 | |
| Tarrant | TXU | TXU Electric/PCA | ERCOT | 221.7 | |
| | | TXU Electric/PCA | | | 778.4 |
| Chambers | EGS | Entergy Electric System/PCA | SERC | 2.8 | |
| Hardin | EGS | Entergy Electric System/PCA | SERC | 0.4 | |
| Jefferson | EGS | Entergy Electric System/PCA | SERC | 5.6 | |
| Liberty | EGS | Entergy Electric System/PCA | SERC | 2.1 | |
| Montgomery | EGS | Entergy Electric System/PCA | SERC | 45.7 | |
| Orange | EGS | Entergy Electric System/PCA | SERC | 1.9 | |
| | | Entergy Electric System/PCA | | | 58.5 |
| El Paso | EL PASO Electric Company | El Paso Electric Co/PCA | WSCC | 61.5 | |
| | | El Paso Electric Co/PCA | | | 61.5 |
| Gregg | SWEPCO | Southwestern Public Service Co/PCA | SPP | 3.3 | |
| Harrison | SWEPCO | Southwestern Public Service Co/PCA | SPP | 0.5 | |
| Rusk | SWEPCO | Southwestern Public Service Co/PCA | SPP | 0.2 | |
| Upshur | SWEPCO | Southwestern Public Service Co/PCA | SPP | 0.2 | |
| | | Southwestern Public Service Co/PCA | | | 4.2 |
| Total | | | | | 1,452.4 |

Table 29: 2003 Totalized Peak-day Electricity Savings From IECC / IRC by PCA for Single-family Residences

**Peak-day NOx Emissions Reductions Calculations for Single-family Houses**

| Area | County | American Electric Power - West (ERCOT) /PCA | NOx Reductions (lbs) | Austin Energy/PCA | NOx Reductions (lbs) | Brownsville Public Utils Board/PCA | NOx Reductions (lbs/year) | Lower Colorado River Auhotrity /PCA | NOx Reductions (lbs) | Reliant Energy HL&P/PCA | NOx Reductions (lbs) | San Antonio Public Service Bd/PCA | NOx Reductions (lbs) | South Texas Electric Coop INC/PCA | NOx Reductions (lbs) | Texas Municipal Power Pool/PCA | NOx Reductions (lbs) | Texas-New Mexico Power Co/PCA | NOx Reductions (lbs) | TXU Electric/PCA | NOx Reductions (lbs) | Total Nox Reductions (lbs) | Total Nox Reductions (Tons) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austin-San Antonio Area | BASTROP | 0.01 | 0.14 | 0.20 | 17.90 | | 0.00 | 0.34 | 16.49 | | 0.00 | 0.01 | 1.01 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 35.54 | 0.02 |
| | BEXAR | 0.06 | 0.86 | 0.09 | 8.05 | 0.04 | 0.00 | 0.16 | 7.76 | | 0.00 | 2.00 | 201.98 | 0.08 | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | 218.66 | 0.11 |
| | TRAVIS | | 0.00 | 0.46 | 41.16 | | 0.00 | 0.05 | 2.43 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 43.59 | 0.02 |
| | FAYETTE | 0.02 | 0.29 | 0.86 | 76.95 | 0.02 | 0.00 | 1.51 | 73.25 | 0.01 | 2.96 | 0.04 | 4.04 | 0.01 | 0.00 | 0.02 | 0.00 | | 0.00 | 0.02 | 15.57 | 173.06 | 0.09 |
| | LLANO | | 0.00 | 0.12 | 10.74 | | 0.00 | 0.21 | 10.19 | | 0.00 | 0.01 | 1.01 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 21.93 | 0.01 |
| | CALDWELL | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | COMAL | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | GUADALUPE | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | HAYS | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | WILLIAMSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | WILSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| Dallas-Fort Worth Area | COLLIN | 0.01 | 0.14 | 0.01 | 0.89 | | 0.00 | 0.02 | 0.97 | 0.01 | 2.96 | | 0.00 | 0.05 | 0.00 | 0.19 | 0.00 | | 0.00 | 0.02 | 15.57 | 20.54 | 0.01 |
| | DALLAS | 0.06 | 0.86 | 0.06 | 5.37 | 0.04 | 0.00 | 0.09 | 4.37 | 0.03 | 8.89 | 0.01 | 1.01 | 0.09 | 0.00 | 0.30 | 0.00 | 0.09 | 0.00 | 0.51 | 396.99 | 417.49 | 0.21 |
| | DENTON | | 0.00 | 0.01 | 0.89 | | 0.00 | 0.01 | 0.49 | | 0.00 | | 0.00 | 0.04 | 0.00 | 0.15 | 0.00 | | 0.00 | 0.01 | 7.78 | 9.16 | 0.00 |
| | JOHNSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | PARKER | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | CHEROKEE | 0.01 | 0.14 | 0.01 | 0.89 | 0.01 | 0.00 | 0.02 | 0.97 | | 0.00 | | 0.00 | 0.02 | 0.00 | 0.06 | 0.00 | 0.02 | 0.00 | 0.10 | 77.84 | 79.85 | 0.04 |
| | COKE | 0.03 | 0.43 | | 0.00 | 0.02 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.43 | 0.00 |
| | COLEMAN | 0.02 | 0.29 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.29 | 0.00 |
| | FANNIN | 0.02 | 0.29 | 0.02 | 1.79 | 0.01 | 0.00 | 0.03 | 1.46 | 0.01 | 2.96 | | 0.00 | 0.03 | 0.00 | 0.09 | 0.00 | 0.03 | 0.00 | 0.17 | 132.33 | 138.83 | 0.07 |
| | FRIO | 0.05 | 0.72 | | 0.00 | 0.04 | 0.00 | 0.01 | 0.49 | | 0.00 | | 0.00 | 1.15 | 0.00 | 0.07 | 0.00 | | 0.00 | | 0.00 | 1.20 | 0.00 |
| | HARDEMAN | 0.01 | 0.14 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.14 | 0.00 |
| | HASKELL | 0.16 | 2.30 | | 0.00 | 0.12 | 0.00 | 0.01 | 0.49 | | 0.00 | | 0.00 | 0.03 | 0.00 | 0.01 | 0.00 | | 0.00 | 0.01 | 7.78 | 10.57 | 0.01 |
| | HENDERSON | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.49 | | 0.00 | | 0.00 | | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.03 | 23.35 | 23.84 | 0.01 |
| | HOOD | 0.02 | 0.29 | 0.02 | 1.79 | 0.02 | 0.00 | 0.04 | 1.94 | 0.01 | 2.96 | | 0.00 | 0.03 | 0.00 | 0.12 | 0.00 | 0.04 | 0.00 | 0.22 | 171.25 | 178.23 | 0.09 |
| | JONES | 0.14 | 2.01 | | 0.00 | 0.11 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | 0.01 | 7.78 | 9.80 | 0.00 |
| | LAMAR | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 7.78 | 7.78 | 0.00 |
| | LIMESTONE | 0.01 | 0.14 | 0.01 | 0.89 | | 0.00 | | 0.00 | 0.05 | 14.82 | 0.01 | 1.01 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 16.87 | 0.01 |
| | MCLENNAN | 0.04 | 0.58 | 0.04 | 3.58 | 0.03 | 0.00 | 0.07 | 3.40 | 0.02 | 5.93 | 0.01 | 1.01 | 0.06 | 0.00 | 0.22 | 0.00 | 0.07 | 0.00 | 0.40 | 311.37 | 325.86 | 0.16 |
| | MITCHELL | 0.04 | 0.58 | 0.04 | 3.58 | 0.03 | 0.00 | 0.07 | 3.40 | 0.02 | 5.93 | 0.01 | 1.01 | 0.06 | 0.00 | 0.21 | 0.00 | 0.07 | 0.00 | 0.39 | 303.58 | 318.07 | 0.16 |
| | NOLAN | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 7.78 | 7.78 | 0.00 |
| | PALO PINTO | 0.01 | 0.14 | 0.02 | 1.79 | 0.01 | 0.00 | 0.03 | 1.46 | 0.01 | 2.96 | | 0.00 | 0.09 | 0.00 | 0.36 | 0.00 | | 0.00 | 0.02 | 15.57 | 21.92 | 0.01 |
| | RED RIVER | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | 0.02 | 15.57 | 15.57 | 0.01 |
| | TAYLOR | 0.01 | 0.14 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.14 | 0.00 |
| | TITUS | 0.01 | 0.14 | 0.01 | 0.89 | 0.01 | 0.00 | 0.02 | 0.97 | | 0.00 | | 0.00 | 0.02 | 0.00 | 0.05 | 0.00 | 0.02 | 0.00 | 0.10 | 77.84 | 79.85 | 0.04 |
| | YOUNG | 0.02 | 0.29 | 0.02 | 1.79 | 0.01 | 0.00 | 0.03 | 1.46 | 0.01 | 2.96 | | 0.00 | 0.03 | 0.00 | 0.09 | 0.00 | 0.03 | 0.00 | 0.16 | 124.55 | 131.04 | 0.07 |
| | TARRANT | 0.04 | 0.58 | 0.04 | 3.58 | 0.03 | 0.00 | 0.06 | 2.91 | 0.02 | 5.93 | 0.01 | 1.01 | 0.05 | 0.00 | 0.18 | 0.00 | 0.06 | 0.00 | 0.33 | 256.88 | 270.88 | 0.14 |
| | ELLIS | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | KAUFMAN | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | ROCKWALL | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| Houston - Galveston Area | BRAZORIA | 0.01 | 0.14 | 0.01 | 0.89 | | 0.00 | | 0.00 | 0.05 | 14.82 | 0.01 | 1.01 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 16.87 | 0.01 |
| | BRAZOS | | 0.00 | 0.01 | 0.89 | | 0.00 | 0.01 | 0.49 | | 0.00 | | 0.00 | 0.03 | 0.00 | 0.11 | 0.00 | | 0.00 | 0.01 | 7.78 | 9.16 | 0.00 |
| | GRIMES | 0.01 | 0.14 | 0.01 | 0.89 | | 0.00 | 0.02 | 0.97 | 0.01 | 2.96 | | 0.00 | 0.06 | 0.00 | 0.23 | 0.00 | | 0.00 | 0.01 | 7.78 | 12.76 | 0.01 |
| | WHARTON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 2.96 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 2.96 | 0.00 |
| | CHAMBERS | 0.05 | 0.72 | 0.06 | 5.37 | 0.03 | 0.00 | 0.02 | 0.97 | 0.35 | 103.74 | 0.08 | 8.08 | 0.03 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 | 0.03 | 23.35 | 142.23 | 0.07 |
| | FORT BEND | 0.13 | 1.87 | 0.17 | 15.21 | 0.10 | 0.00 | 0.06 | 2.91 | 1.01 | 299.35 | 0.23 | 23.23 | 0.09 | 0.00 | 0.06 | 0.00 | 0.07 | 0.00 | 0.10 | 77.84 | 420.41 | 0.21 |
| | GALVESTON | 0.05 | 0.72 | 0.06 | 5.37 | 0.04 | 0.00 | 0.02 | 0.97 | 0.39 | 115.59 | 0.09 | 9.09 | 0.04 | 0.00 | 0.03 | 0.00 | 0.42 | 0.00 | 0.04 | 31.14 | 162.88 | 0.08 |
| | ROBERTSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 2.96 | | 0.00 | | 0.00 | | 0.00 | 0.40 | 0.00 | 0.01 | 7.78 | 10.75 | 0.01 |
| | HARRIS | 0.05 | 0.72 | 0.07 | 6.26 | 0.04 | 0.00 | 0.02 | 0.97 | 0.41 | 121.52 | 0.09 | 9.09 | 0.04 | 0.00 | 0.02 | 0.00 | 0.03 | 0.00 | 0.04 | 31.14 | 169.70 | 0.08 |
| | HARDIN | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | JEFFERSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | LIBERTY | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | MONTGOMERY | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | ORANGE | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | WALLER | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| El Paso Area | EL PASO | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| OTHER | RUSK | 0.01 | 0.14 | 0.01 | 0.89 | 0.01 | 0.00 | 0.01 | 0.49 | | 0.00 | | 0.00 | 0.01 | 0.00 | 0.04 | 0.00 | 0.01 | 0.00 | 0.07 | 54.49 | 56.01 | 0.03 |
| | CROCKETT | 0.14 | 2.01 | | 0.00 | 0.11 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | 0.01 | 7.78 | 9.80 | 0.00 |
| | FREESTONE | 0.02 | 0.29 | 0.02 | 1.79 | 0.02 | 0.00 | 0.04 | 1.94 | 0.01 | 2.96 | | 0.00 | 0.03 | 0.00 | 0.12 | 0.00 | 0.04 | 0.00 | 0.22 | 171.25 | 178.23 | 0.09 |
| | CALHOUN | 0.19 | 2.73 | | 0.00 | 0.14 | 0.00 | 0.01 | 0.49 | | 0.00 | | 0.00 | 0.04 | 0.00 | 0.01 | 0.00 | | 0.00 | 0.01 | 7.78 | 11.00 | 0.01 |
| | HIDALGO | 0.13 | 1.87 | | 0.00 | 0.10 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 1.87 | 0.00 |
| | CAMERON | 0.14 | 2.01 | | 0.00 | 0.20 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | 0.01 | 7.78 | 9.80 | 0.00 |
| | WARD | 0.06 | 0.86 | 0.06 | 5.37 | 0.04 | 0.00 | 0.09 | 4.37 | 0.02 | 5.93 | 0.01 | 1.01 | 0.08 | 0.00 | 0.28 | 0.00 | 0.10 | 0.00 | 0.51 | 396.99 | 414.53 | 0.21 |
| | WEBB | 0.06 | 0.86 | | 0.00 | 0.05 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.86 | 0.00 |
| | NUECES | 0.74 | 10.64 | 0.01 | 0.89 | 0.55 | 0.00 | 0.02 | 0.97 | 0.01 | 2.96 | 0.01 | 1.01 | 0.15 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.03 | 23.35 | 39.83 | 0.02 |
| | VICTORIA | 0.30 | 4.31 | 0.01 | 0.89 | 0.22 | 0.00 | 0.01 | 0.49 | | 0.00 | | 0.00 | 0.68 | 0.00 | 0.05 | 0.00 | | 0.00 | 0.01 | 7.78 | 13.48 | 0.01 |
| | GREGG | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | HARRISON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | SMITH | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | UPSHUR | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | SAN PATRICIO | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | **TOTAL** | **2.89** | | **2.54** | | **2.22** | | **3.12** | | **2.48** | | **2.63** | | **3.27** | | **3.19** | | **1.54** | | **3.65** | | 4262.08 | 2.13 |
| Energy Savings by PCA from ESL (MWh) | | 14.38 | | 89.48 | | 0.00 | | 48.51 | | 296.39 | | 100.99 | | 0.00 | | 0.00 | | 0.00 | | 778.42 | | | |

Table 30: 2003 Peak-day NOx Reductions From IECC / IRC by PCA for Single-family Residences by County Using eGRID.

**Annual and Peak-day Electricity and NOx emissions reductions Using eGRID Method (For Single-family Houses)**

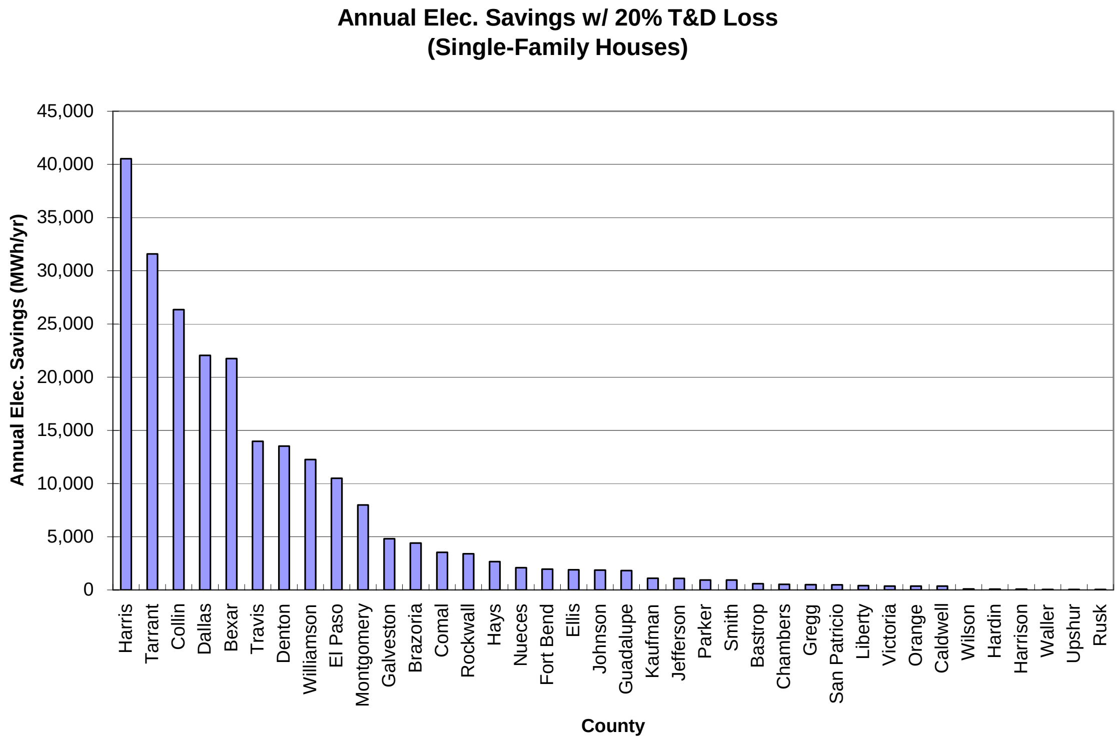
| | County | Total Annual Electricity Savings per County w/ 20% T&D Loss (MWh/County) | Annual Nox Reductions Calculated using eGRID (Tons) | Peak-day Electricity Savings per County w/ 20% T&D Loss (MWh/County) | Peak-day Nox Reductions Calculated Using eGRID (Tons) |
|---|---|---|---|---|---|
| Non-attainment Counties | Bastrop | 592 | 3.06 | 3.78 | 0.0178 |
| | Bexar | 21,743 | 23.19 | 100.99 | 0.1093 |
| | Caldwell | 355 | 0.00 | 2.27 | 0.0000 |
| | Comal | 3,537 | 0.00 | 16.43 | 0.0000 |
| | Ellis | 1,908 | 0.00 | 13.40 | 0.0000 |
| | Gregg | 492 | 0.00 | 3.28 | 0.0000 |
| | Guadalupe | 1,831 | 0.00 | 8.50 | 0.0000 |
| | Harrison | 81 | 0.00 | 0.54 | 0.0000 |
| | Hays | 2,663 | 0.00 | 17.06 | 0.0000 |
| | Johnson | 1,854 | 0.00 | 13.02 | 0.0000 |
| | Kaufman | 1,098 | 0.00 | 7.05 | 0.0000 |
| | Nueces | 2,098 | 3.35 | 10.16 | 0.0199 |
| | Parker | 940 | 0.00 | 6.03 | 0.0000 |
| | Rockwall | 3,396 | 0.00 | 21.79 | 0.0000 |
| | Rusk | 30 | 4.19 | 0.20 | 0.0280 |
| | San Patricio | 475 | 0.00 | 2.30 | 0.0000 |
| | Smith | 934 | 0.00 | 6.31 | 0.0000 |
| | Travis | 13,968 | 3.44 | 89.48 | 0.0218 |
| | Upshur | 35 | 0.00 | 0.23 | 0.0000 |
| | Victoria | 362 | 1.14 | 1.92 | 0.0067 |
| | Williamson | 12,256 | 0.00 | 78.51 | 0.0000 |
| | Wilson | 102 | 0.00 | 0.47 | 0.0000 |
| Affected Counties | Brazoria | 4,411 | 1.49 | 25.26 | 0.0084 |
| | Chambers | 540 | 12.25 | 2.81 | 0.0711 |
| | Collin | 26,355 | 1.59 | 169.09 | 0.0103 |
| | Dallas | 22,049 | 31.35 | 154.81 | 0.2087 |
| | Denton | 13,520 | 0.69 | 86.74 | 0.0046 |
| | El Paso | 10,501 | 0.00 | 61.47 | 0.0000 |
| | Fort Bend | 1,959 | 36.09 | 11.21 | 0.2102 |
| | Galveston | 4,815 | 13.97 | 27.57 | 0.0814 |
| | Hardin | 85 | 0.00 | 0.44 | 0.0000 |
| | Harris | 40,540 | 14.56 | 232.10 | 0.0848 |
| | Jefferson | 1,079 | 0.00 | 5.61 | 0.0000 |
| | Liberty | 406 | 0.00 | 2.11 | 0.0000 |
| | Montgomery | 7,976 | 0.00 | 45.66 | 0.0000 |
| | Orange | 357 | 0.00 | 1.86 | 0.0000 |
| | Tarrant | 31,576 | 20.36 | 221.69 | 0.1354 |
| | Waller | 43 | 0.00 | 0.25 | 0.0000 |
| Other Counties | WARD | | 31.09 | | 0.2073 |
| | MCLENNAN | | 24.46 | | 0.1629 |
| | MITCHELL | | 23.88 | | 0.1590 |
| | FAYETTE | | 14.74 | | 0.0865 |
| | HOOD | | 13.36 | | 0.0891 |
| | FREESTONE | | 13.36 | | 0.0891 |
| | FANNIN | | 10.41 | | 0.0694 |
| | YOUNG | | 9.83 | | 0.0655 |
| | CHEROKEE | | 5.97 | | 0.0399 |
| | TITUS | | 5.97 | | 0.0399 |
| | LLANO | | 1.90 | | 0.0110 |
| | PALO PINTO | | 1.71 | | 0.0110 |
| | HENDERSON | | 1.78 | | 0.0119 |
| | LIMESTONE | | 1.49 | | 0.0084 |
| | RED RIVER | | 1.16 | | 0.0078 |
| | GRIMES | | 1.01 | | 0.0064 |
| | CALHOUN | | 0.90 | | 0.0055 |
| | HASKELL | | 0.86 | | 0.0053 |
| | ROBERTSON | | 0.84 | | 0.0054 |
| | JONES | | 0.78 | | 0.0049 |
| | CROCKETT | | 0.78 | | 0.0049 |
| | CAMERON | | 0.78 | | 0.0049 |
| | BRAZOS | | 0.69 | | 0.0046 |
| | LAMAR | | 0.58 | | 0.0039 |
| | NOLAN | | 0.58 | | 0.0039 |
| | WHARTON | | 0.26 | | 0.0015 |
| | HIDALGO | | 0.19 | | 0.0009 |
| | FRIO | | 0.12 | | 0.0006 |
| | WEBB | | 0.09 | | 0.0004 |
| | COKE | | 0.04 | | 0.0002 |
| | COLEMAN | | 0.03 | | 0.0001 |
| | HARDEMAN | | 0.01 | | 0.0001 |
| | TAYLOR | | 0.01 | | 0.0001 |
| Total | | | 340.43 | | 2.1310 |

Table 31: 2003 Annual and Peak-day NOx Reductions From IECC / IRC by PCA for Single-family Residences by County Using eGRID.

**Simulation Results for Single-family Houses**

| | County | Climate Zone | No. of projected units (2003) | No. of projected units (2003) w/ Vacancy Rate | 2000 Annual Natural Gas Use (Therm/house) *(1999 Average Characteristics)* | 2003 Anuual Natural Gas Use (Therm/house) *(The 2000 IECC Characteristics)* | Annual Natrual Gas Savings per House (Therm/House) | 2000 Total Annual Natural Gas Use (Therm/County) *(1999 Average Characteristics)* | 2003 Total Anuual Natural Gas Use (Therm/County) *(The 200 IECC Characteristics)* | Total Annual Natural Gas Savings per County (Therm/County) | Peak Date (2002 Report) | 2000 Peak-day Natural Gas Use (Therm/house) *(1999 Average Characteristics)* | 2003 Peak-day Natural Gas Use (Therm/house) *(The 2000 IECC Characteristics)* | Peak-day Natural Gas Savings per House (Therm/House) | 2000 Total Peak-day Natural Gas Use (Therm/County) *(1999 Average Characteristics)* | 2003 Total Peak-day Natural Gas Use (Therm/County) *(The 2000 IECC Characteristics)* | Peak-day Natural Gas Savings per County (Therm/County) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Affected County | Bastrop | 4 | 215 | 215 | 362 | 289 | 73 | 77,830 | 62,135 | 15,695 | 7/31 | 0.65 | 0.53 | 0.12 | 139.33 | 113.53 | 25.80 |
| | Bexar | 4 | 7,671 | 7,671 | 340 | 267 | 73 | 2,608,140 | 2,048,157 | 559,983 | 8/28 | 0.51 | 0.39 | 0.12 | 3,920.98 | 3,000.46 | 920.52 |
| | Caldwell | 4 | 129 | 129 | 362 | 289 | 73 | 46,698 | 37,281 | 9,417 | 7/31 | 0.65 | 0.53 | 0.12 | 83.60 | 68.12 | 15.48 |
| | Comal | 4 | 1,248 | 1,248 | 340 | 267 | 73 | 424,320 | 333,216 | 91,104 | 8/28 | 0.51 | 0.39 | 0.12 | 637.91 | 488.15 | 149.76 |
| | Ellis | 5 | 707 | 707 | 442 | 347 | 95 | 312,494 | 245,329 | 67,165 | 7/29 | 0.55 | 0.43 | 0.12 | 387.54 | 302.70 | 84.84 |
| | Gregg | 6 | 256 | 256 | 369 | 302 | 67 | 94,464 | 77,312 | 17,152 | 7/22 | 0.55 | 0.43 | 0.12 | 139.59 | 108.87 | 30.72 |
| | Guadalupe | 4 | 646 | 646 | 340 | 267 | 73 | 219,640 | 172,482 | 47,158 | 8/28 | 0.51 | 0.39 | 0.12 | 330.20 | 252.68 | 77.52 |
| | Harrison | 6 | 42 | 42 | 369 | 302 | 67 | 15,498 | 12,684 | 2,814 | 7/22 | 0.55 | 0.43 | 0.12 | 22.90 | 17.86 | 5.04 |
| | Hays | 5 | 919 | 919 | 362 | 278 | 84 | 332,678 | 255,482 | 77,196 | 7/31 | 0.53 | 0.41 | 0.12 | 485.27 | 374.99 | 110.28 |
| | Johnson | 5 | 687 | 687 | 442 | 347 | 95 | 303,654 | 238,389 | 65,265 | 7/29 | 0.55 | 0.43 | 0.12 | 376.58 | 294.14 | 82.44 |
| | Kaufman | 6 | 403 | 403 | 442 | 328 | 114 | 178,126 | 132,184 | 45,942 | 8/19 | 0.53 | 0.41 | 0.12 | 212.51 | 164.15 | 48.36 |
| | Nueces | 3 | 1,012 | 1,012 | 253 | 208 | 45 | 256,036 | 210,496 | 45,540 | 8/18 | 0.49 | 0.37 | 0.12 | 496.95 | 375.51 | 121.44 |
| | Parker | 6 | 345 | 345 | 442 | 328 | 114 | 152,490 | 113,160 | 39,330 | 8/19 | 0.53 | 0.41 | 0.12 | 181.93 | 140.53 | 41.40 |
| | Rockwall | 6 | 1,246 | 1,246 | 442 | 328 | 114 | 550,732 | 408,688 | 142,044 | 8/19 | 0.53 | 0.41 | 0.12 | 657.06 | 507.54 | 149.52 |
| | Rusk | 5 | 16 | 16 | 329 | 312 | 17 | 5,264 | 4,992 | 272 | 7/22 | 0.55 | 0.43 | 0.12 | 8.72 | 6.80 | 1.92 |
| | San Patricio | 3 | 229 | 229 | 253 | 208 | 45 | 57,937 | 47,632 | 10,305 | 8/18 | 0.49 | 0.37 | 0.12 | 112.45 | 84.97 | 27.48 |
| | Smith | 5 | 506 | 506 | 329 | 312 | 17 | 166,474 | 157,872 | 8,602 | 7/22 | 0.55 | 0.43 | 0.12 | 275.91 | 215.19 | 60.72 |
| | Travis | 5 | 4,820 | 4,820 | 362 | 278 | 84 | 1,744,840 | 1,339,960 | 404,880 | 7/31 | 0.53 | 0.41 | 0.12 | 2,545.15 | 1,966.75 | 578.40 |
| | Upshur | 6 | 18 | 18 | 369 | 302 | 67 | 6,642 | 5,436 | 1,206 | 7/22 | 0.55 | 0.43 | 0.12 | 9.81 | 7.65 | 2.16 |
| | Victoria | 3 | 178 | 178 | 282 | 239 | 43 | 50,196 | 42,542 | 7,654 | 9/2 | 0.50 | 0.38 | 0.12 | 89.81 | 68.45 | 21.36 |
| | Williamson | 5 | 4,229 | 4,229 | 362 | 278 | 84 | 1,530,898 | 1,175,662 | 355,236 | 7/31 | 0.53 | 0.41 | 0.12 | 2,233.07 | 1,725.59 | 507.48 |
| | Wilson | 4 | 36 | 36 | 340 | 267 | 73 | 12,240 | 9,612 | 2,628 | 8/28 | 0.51 | 0.39 | 0.12 | 18.40 | 14.08 | 4.32 |
| Non-attainment County | Brazoria | 3 | 2,349 | 2,349 | 336 | 292 | 44 | 789,264 | 685,908 | 103,356 | 7/29 | 0.53 | 0.41 | 0.12 | 1,245.33 | 963.45 | 281.88 |
| | Chambers | 4 | 298 | 298 | 327 | 286 | 41 | 97,446 | 85,228 | 12,218 | 9/1 | 0.52 | 0.40 | 0.12 | 153.65 | 117.89 | 35.76 |
| | Collin | 5 | 9,671 | 9,671 | 442 | 328 | 114 | 4,274,582 | 3,172,088 | 1,102,494 | 8/19 | 0.53 | 0.41 | 0.12 | 5,099.83 | 3,939.31 | 1,160.52 |
| | Dallas | 5 | 8,170 | 8,170 | 442 | 347 | 95 | 3,611,140 | 2,834,990 | 776,150 | 7/29 | 0.55 | 0.43 | 0.12 | 4,478.41 | 3,498.01 | 980.40 |
| | Denton | 6 | 4,961 | 4,961 | 442 | 328 | 114 | 2,192,762 | 1,627,208 | 565,554 | 8/19 | 0.53 | 0.41 | 0.12 | 2,616.10 | 2,020.78 | 595.32 |
| | El Paso | 6 | 3,388 | 3,388 | 405 | 287 | 118 | 1,372,140 | 972,356 | 399,784 | 7/12 | 0.56 | 0.44 | 0.12 | 1,890.28 | 1,483.72 | 406.56 |
| | Fort Bend | 4 | 1,043 | 1,043 | 336 | 292 | 44 | 350,448 | 304,556 | 45,892 | 7/29 | 0.53 | 0.41 | 0.12 | 552.95 | 427.79 | 125.16 |
| | Galveston | 3 | 2,564 | 2,564 | 336 | 292 | 44 | 861,504 | 748,688 | 112,816 | 7/29 | 0.53 | 0.41 | 0.12 | 1,359.31 | 1,051.63 | 307.68 |
| | Hardin | 4 | 47 | 47 | 327 | 286 | 41 | 15,369 | 13,442 | 1,927 | 9/1 | 0.52 | 0.40 | 0.12 | 24.23 | 18.59 | 5.64 |
| | Harris | 4 | 21,587 | 21,587 | 336 | 292 | 44 | 7,253,232 | 6,303,404 | 949,828 | 7/29 | 0.53 | 0.41 | 0.12 | 11,444.41 | 8,853.97 | 2,590.44 |
| | Jefferson | 4 | 595 | 595 | 327 | 286 | 41 | 194,565 | 170,170 | 24,395 | 9/1 | 0.52 | 0.40 | 0.12 | 306.77 | 235.37 | 71.40 |
| | Liberty | 4 | 224 | 224 | 327 | 286 | 41 | 73,248 | 64,064 | 9,184 | 9/1 | 0.52 | 0.40 | 0.12 | 115.49 | 88.61 | 26.88 |
| | Montgomery | 4 | 4,247 | 4,247 | 336 | 292 | 44 | 1,426,992 | 1,240,124 | 186,868 | 7/29 | 0.53 | 0.41 | 0.12 | 2,251.56 | 1,741.92 | 509.64 |
| | Orange | 4 | 197 | 197 | 327 | 286 | 41 | 64,419 | 56,342 | 8,077 | 9/1 | 0.52 | 0.40 | 0.12 | 101.57 | 77.93 | 23.64 |
| | Tarrant | 5 | 11,700 | 11,700 | 442 | 347 | 95 | 5,171,400 | 4,059,900 | 1,111,500 | 7/29 | 0.55 | 0.43 | 0.12 | 6,413.38 | 5,009.38 | 1,404.00 |
| | Waller | 4 | 23 | 23 | 336 | 292 | 44 | 7,728 | 6,716 | 1,012 | 7/29 | 0.53 | 0.41 | 0.12 | 12.19 | 9.43 | 2.76 |
| | TOTAL | | 96,622 | 96,622 | | | | 36,903,530 | 29,475,887 | 7,427,643 | | | | | 51,431.14 | 39,836.50 | **11,594.64** |

Table 32: 2003 Annual and Peak-day Natural Gas Savings Due to IECC / IRC for Single-family Residences by County.



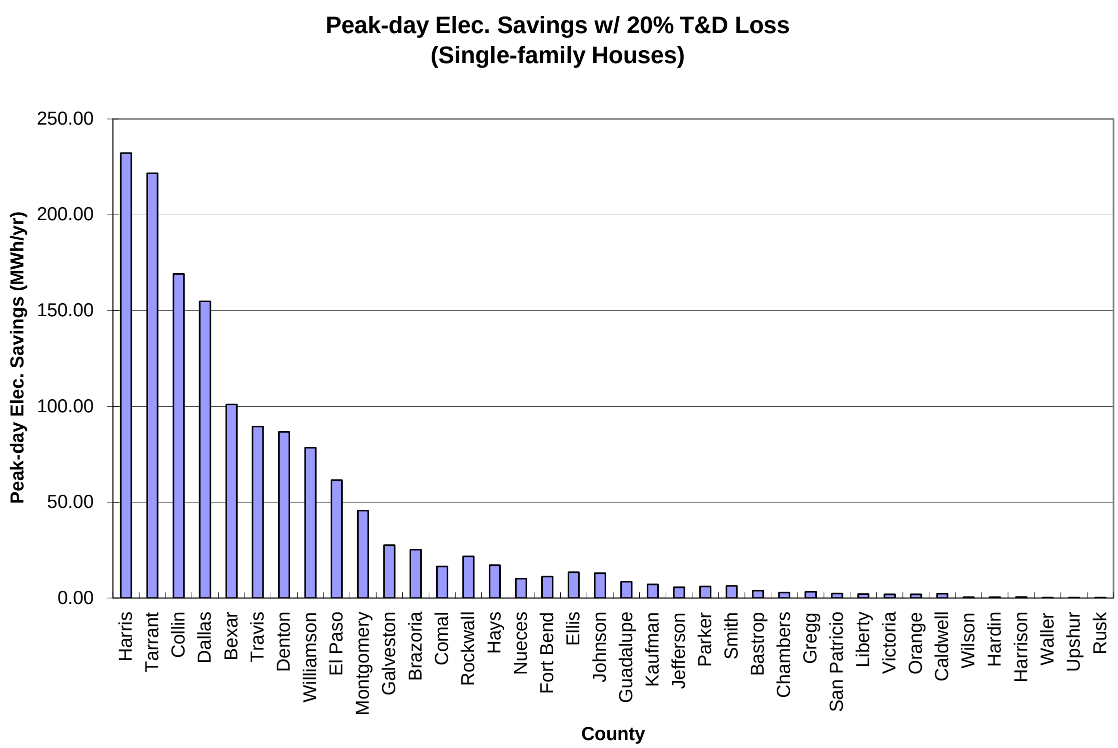
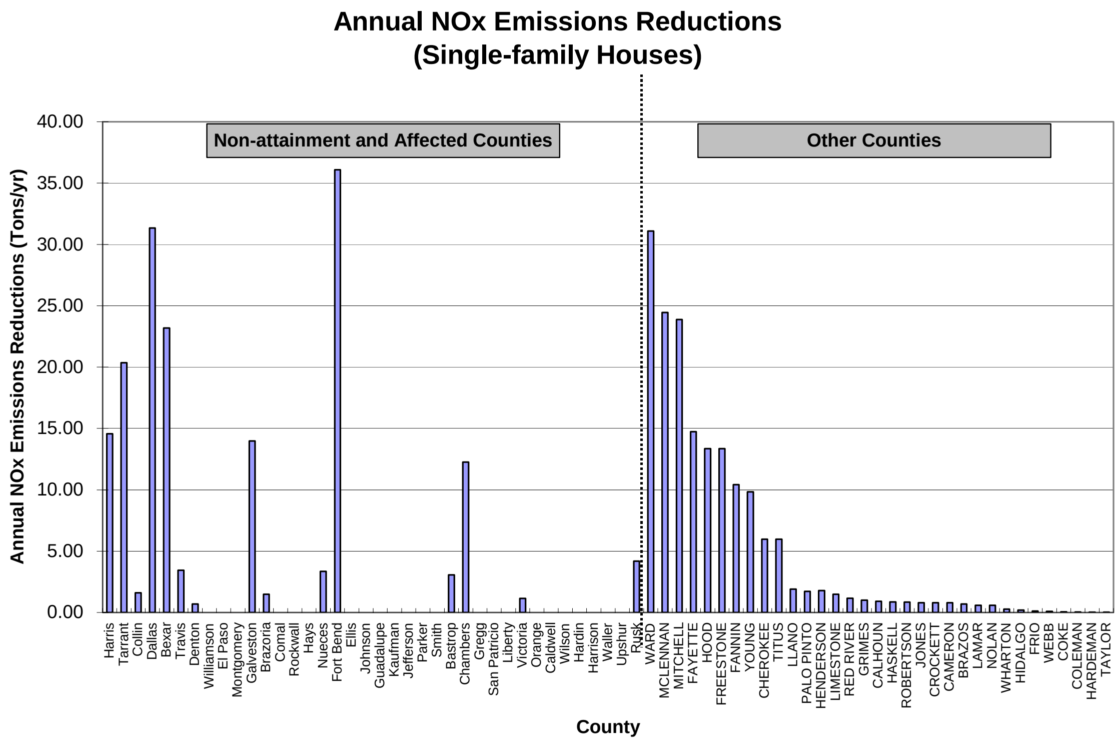




Figure 56: 2003 Annual and Peak-day Electricity Reductions From IECC / IRC by PCA for Single-family Residences by County Using eGRID.



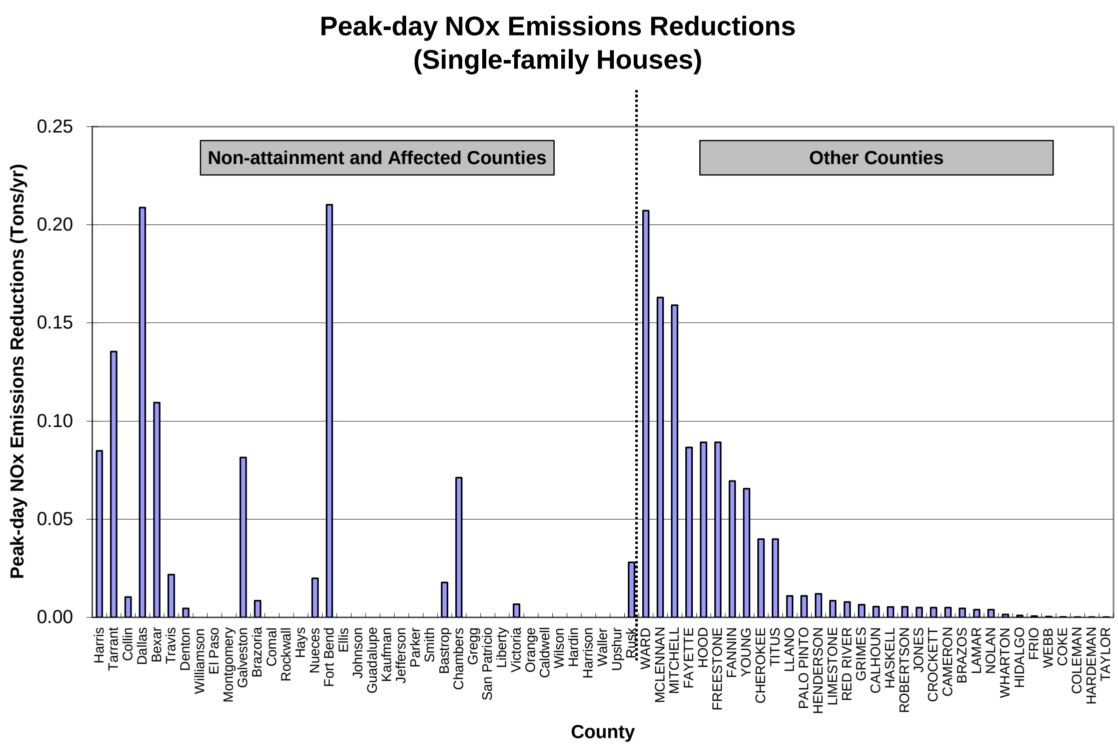




Figure 57: Annual and Peak-day NOx Reductions From IECC / IRC by PCA for Single-family Residences by County Using eGRID.

## 8.3 Calculated 2003 Emissions Reduction From Implementation of IECC / IRC to New Multi-family Construction.

### 8.3.1 2003 Results for New Multi-family Residential Construction.

In this section of the report calculations are provided regarding the potential electricity reductions and emissions reduction from the implementation of the IECC / IRC to new multi-family residences in the 38 non-attainment and affected counties. The procedures to accomplish this were previously outlined in Section 6 of this report, and are the same as the procedures for the single-family calculations. First, new construction activity by county had to be determined, then energy savings attributable to the IECC / IRC had to be modeled using the code-traceable, DOE-2 simulation that the Laboratory has developed for the TERP, then estimates of the NOx reduction potential from the electricity reductions in each county were calculated using the EPA's eGRID database[110].

The results of the new calculations are reported in Table 37 through Table 43 for new multi-family residences, which were estimated to be constructed during 2003. In Table 37 the 1999 and IECC / IRC code-compliant building characteristics are shown for each county for multi-family residential (i.e., Type A.2). As previously discussed in Section 6, the 1999 building characteristics reflect those published by the NAHB, ARI and GAMA for Texas. The IECC / IRC code-compliant characteristics are the minimum building code characteristics required by the IECC / IRC for each county[111]. In a similar fashion as single-family residential, in Table 37 the rows are sorted first by the EPA's non-attainment and affected designation, then alphabetically. Next, in the third column, the IECC / IRC climate zone is listed for each county, followed by the location of the TMY2 weather file, which was used in the simulation.

In difference to the single-family NAHB classifications of East and West, the NAHB survey for multi-family construction practice in Texas is one classification for all of Texas[112]. Therefore, the fifth column in Table 37 lists the average window area for all new multi-family construction in Texas, as defined by the NAHB survey for 1999[113]. The sixth through ninth columns show the NAHB's average glazing U-value, Solar Heat Gain Coefficient (SHGC), roof insulation and wall insulation, respectively. In columns ten through fourteen of Table 37 the corresponding values from the IECC / IRC code-compliant house are listed for each county (i.e., % area, glazing U-value, SHGC, roof and wall insulation R-value). For each county the identical window % area was used for the 1999 and IECC / IRC code-compliant calculation (i.e., window-to-wall area). The IECC / IRC SHGC is 0.4 for all non-attainment and affected counties since they all fall below the 3,500 $HDD_{65}$, as required by the IECC / IRC. All houses were assumed to have an air conditioner efficiency[114] of SEER 11, a gas furnace efficiency (AFUE) of 0.80, and a domestic water heater efficiency of 0.76. The values shown in Table 37 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 1999 and IECC / IRC code compliant simulation[115]. In a similar fashion as the single-family houses, in cases where the 1999 values were more efficient than the IECC / IRC code-compliant simulation, the 1999 values were used in both simulations, since this indicates that the prevailing practice is already above code. For example, in Brazoriza county, according to the NAHB, the roof insulation is R-36.08, which is already above the code-required insulation of R-19. Therefore, R-36.08 was used in both simulations.

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[110] In a similar fashion as the single-family calculations, this analysis does not include actual power transfers on the grid, and assumes transmission and distribution losses of 20%. Counties were assigned to utility service districts as indicated previously.

[111] As modified by the 2001 Supplement.

[112] Therefore the "east" and "west" classifications are omitted from Table 37.

[113] In a similar fashion as single-family residential, this value represents the NAHB's reported number of window units times an average window size of 3 x 5 feet, which was determined by surveying local building suppliers. Additional information about the procedures used to determine these values can be found in Im (2003).

[114] The choice of a SEER 11 efficiency for the air conditioner was based on ARI sales numbers for Texas which show an average SEER 11 for houses built in 1999.

[115] For detailed listing of all variables, see Im (2003). For the results shown in this 2003 report a house shape similar to that shown in Figure 21 was used with a floor area that was representative of the NAHB's survey data for multi-family housing. Preliminary results of simulations with multi-family housing with two or more stories indicates similar results. Therefore, for purposes of reporting the 2003 values only, a simplified structure was used as shown in Figure 21. Future reports will include multifamily structures that are more representative of typical multifamily structures such as those shown in Figure 23.

In Table 38 the code-traceable simulation results are shown for each county. In a similar fashion as Table 37, this table is first divided into EPA affected and then non-attainment classifications, followed by an alphabetical listing of counties. In the third column the IECC / IRC climate zone is listed followed by the number of projected new multi-family housing units[116] in the fourth column. In the fifth and sixth columns the simulated annual electricity use for multi-family residences with 1999 and IECC-compliant characteristics is listed. This simulated electricity use in column five and six represent a multi-family dwelling with characteristics shown in Table 37 simulated at the climate location shown in column 3. Columns 7 and 8 are then the annual electricity savings per multi-family unit from the IECC code-compliant simulation[117], and columns 9 and 10 are the total annual county-wide electricity use from the new multi-family housing units, which is the result of the product of the annual electricity use per unit times the number of expected housing units for each county. Column 11 is the annual county-wide electricity savings resulting from the implementation of the IECC / IRC, which is followed by column 12, which represents a fixed 1.2 multiplier times column 11 to account for the estimated 20% Transmission and distribution loss (T&D).

In column 13 is the peak date of the TMY2 weather data that was used for the peak-day calculation, which represents the same peak date that was used for the Laboratory's 2002 report for single-family residential NOx reductions[118].

Columns 14 and 15 show the 1999 and IECC code-compliant peak-day electricity use for each multi-family unit, respectively. Column 16 shows the peak day electricity savings per multi-family unit. Columns 17 and 18 show the 1999 and IECC code-compliant peak-day county-wide electricity use for all new multi-family units in each county, respectively. Column 19 shows the peak day county-wide electricity savings for all new multi-family units, and column 20 shows the peak day county-wide electricity savings for all new multi-family units with the 1.2 multiplier applied to estimate T&D losses.

In Table 39 the county-wide annual electricity savings were then assigned to each PCA using the first column shown in PUC's PCA assignment tables shown in Table 17 and Table 18. The total value from Table 39 for each PCA was then entered into the bottom row of Table 40, which represents the eGRID utility database for all ERCOT PCAs. The far right column of Table 40 then represents the total annual tons of NOx savings in each county from all the power plants for the PCAs in that county whose electricity use was reduced by new multi-family units that were built to IECC code compliance. Table 41 contains the 2003 peak-day electricity savings from implementation of the IECC / IRC for each PCA, which is calculated in a similar fashion as Table 39 using peak-day electricity savings. Table 42 contains the 2003 peak-day electricity savings from implementation of the IECC / IRC for each county, which is calculated in a similar fashion as Table 40 using peak-day electricity savings Finally, Table 43 contains both the 2003, county-wide annual and 2003 peak-day electricity savings from implementation of the IECC / IRC.

Finally, Figure 58 and Figure 59 present the tabulated information previously shown in Table 37 through Table 43. Figure 58 shows the county-wide annual (top), and peak-day (bottom) savings, and Figure 59 shows how the NOx emissions reduction are assigned to the different counties using eGRID.

In Table 44 the annual and peak-day natural gas savings are shown. These savings represent the simulated natural gas reductions due to the implementation of the IECC / IRC, which include reductions in heating energy use due to more efficient insulation, improved windows, and the elimination of the standing pilot light in the furnace that serves the residence.

[116] The number of projected new housing units uses the published values for the new multi-family housing units in 2002. A vacancy rate of 0% was assumed for 2003 calculations, based on information suggested by the Real Estate Center at Texas A&M University.

[117] Column 7 is expresses savings as a percentage of the total annual electricity use for each house. Column 8 shows the savings as kWh/year for each multi-family unit.

[118] This date is actually calculated by DOE-2 for each simulation, and can change from simulation to simulation. Therefore, for continuity, the peak date has been fixed to be the date that was used for the Laboratory's 2002 Annual Report to the TNRCC (Haberl et al. 2002).

### 8.3.2 Tracing the Savings to Individual Measures: Dallas County and Tarrant County.

In a similar fashion as the single-family housing, a sensitivity study was performed on two multi-family units, one located in Harris County (i.e., Houston area), and one located in Tarrant County (i.e., Dallas/Ft. Worth area). In this analysis, the simulations were repeated with each measure simulated separately and a combined simulation with all measures. Results are shown for the annual and peak-day savings by fuel type and NOx emissions reduction. This analysis is based on the standard house type used for the 2003 simulations for single-family residential as described[119] in Table 37.

#### 8.3.2.1 Harris County.

For multi-family units in Harris County (Table 33), which is climate zone 4, the average NAHB characteristics for 1999 include 7.5% window-to-wall area, a glazing U-value of 0.75 Btu/ hr-ft$^2$-°F, a solar heat gain coefficient of 0.61, roof insulation of R-36.08 hr-ft$^2$-°F/Btu, a wall insulation of R-21.41 hr-ft$^2$-°F/Btu, an air conditioning efficiency of SEER-11, and an AFUE of 80%. For the IECC-compliant house in climate zone 4, a multi-family unit (i.e., Type A.2) with similar window-to-wall area as the 1999 average house (i.e., 7.5%), is required to have a glazing U-value of 0.85 Btu/ hr-ft$^2$-°F, a solar heat gain coefficient of 0.40, a roof insulation R-value of 19.00 hr-ft$^2$-°F/Btu[120], a wall insulation level of R-11 hr-ft$^2$-°F/Btu, a SEER-11 air conditioning efficiency, and an AFUE of 78%.

In Table 34, the results of the sensitivity analysis show that the average 1999 multi-family unit in Harris county consumed 10,625 kWh/year of electricity and 220 therms/year of natural gas, which totaled 58.31 MBtu/year[121], and on a peak summer day consumed 39.26 kWh/day, and 0.53 therms/day of natural gas. When the windows were upgraded to meet the code requirements (i.e., double-pane, low-e windows[122]), the annual electricity was reduced to 10,275 kWh/year (3.29% decrease), and gas use was increased to 223 therms/year (1.36% increase), which equaled a total combined energy use of 57.39 MBtu/year (1.58% decrease). Since the average 1999 multi-family already had roof and wall insulation that exceed the code requirement, the house was simulated with insulation levels that were similar to the average 1999 house (i.e., no savings were calculated).

In Table 34 savings are shown for a code-compliant furnace that includes an electronic ignition (i.e., there is no standing pilot light). In a similar fashion as single-family housing, this type of efficiency upgrade was chosen based on conversations with several residential furnace manufacturers whose current equipment line exclude standing pilot lights to meet the stricter 80% efficiency requirements of the IECC / IRC. When resimulated with the pilot light eliminated, the annual gas use dropped to 177 therms/ year (19.55% decrease), which amounts to a total energy use of 53.94 MBtu/year (7.49% decrease). Also, in a similar fashion as single-family residential, on peak cooling days, the natural gas use is reduced to 0.41 therms/day (22.64% decrease).

When the average 1999 multi-family unit in Harris county was simulated with both the efficient windows and the electronic ignition the total annual electricity use was reduced to 10,275 kWh/year (3.29% decrease), and gas use was reduced to 180 therms/year (18.18% decrease), with the total annual energy use reduced to 53.02 MBtu/year (9.07% decrease).

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[119] The multi-family house is a 1,000 ft2, single-story house with slab-on-grade foundation and equal window areas on all four sides of the house. The house has a two-car garage on the west side of the house and no significant shading. It contains an air conditioner (SEER 11), a natural gas-fired furnace (AFUE 80%), and a natural gas-fired domestic water heater.

[120] Whenever the 1999 NAHB characteristics were shown to be above code, the 2000 IECC-code compliant house was simulated with the same characteristics as the NAHB 1999 house, which indicated that the current practice in 1999 was already above code and therefore no savings were expected from code-compliance.

[121] This assumes 3,412 Btu/kWh for an electricity to Btu conversion and 100,000 Btu/therm. MBtu = million Btu, or 1 x $10^6$ Btu.

[122] In the case of the multi-family housing in Harris county, the glazing U-value remained at 0.75, and the SHGC was reduced from 0.61 to 0.40.

| | Area % | Glazing U-value (Btu/ hr-ft$^2$-°F) | SHGC | Roof Insulation (hr-ft$^2$-°F/Btu) | Wall Insulation (hr-ft$^2$-°F/Btu) | SEER | AFUE (%) |
|---|---|---|---|---|---|---|---|
| 1999 Average | 7.5 | 0.75 | 0.61 | 36.08 | 21.41 | 11 | 80 |
| 2000 IECC | 7.5 | 0.85 | 0.40 | 19.00 | 11.00 | 10 | 78 |

Table 33: 1999 Average Vs IECC / IRC Input Values for Specific Measures for Multi-family Residential in Harris County.

| Simulated House | Annual Elec. Use | Difference | Annual N.G. Use | Difference | Total Energy Use | Difference |
|---|---|---|---|---|---|---|
| | (KWh/yr) | (%) | (Therm/yr) | (%) | (MBtu/yr) | (%) |
| 1999 Average House | 10,625 | - | 220 | - | 58.31 | - |
| 1999 Average House w/ Low-e windows | 10,275 | 3.29% | 223 | -1.36% | 57.39 | 1.58% |
| 1999 Average House w/o pilot light | 10,625 | 0.00% | 177 | 19.55% | 53.94 | 7.49% |
| 1999 Average House w/ all above | 10,275 | 3.29% | 180 | 18.18% | 53.02 | 9.07% |

| Simulated House | Peak-day | Peak-day Elec. Use | Difference | Peak-day N.G. Use | Difference |
|---|---|---|---|---|---|
| | (2002 report) | (KWh/day) | (%) | (Therm/day) | (%) |
| 1999 Average House | 7/29 | 39.26 | - | 0.53 | - |
| 1999 Average House w/ Low-e windows | | 37.62 | 4.18% | 0.53 | 0.00% |
| 1999 Average House w/o pilot light | | 39.26 | 0.00% | 0.41 | 22.64% |
| 1999 Average House w/ all above | | 37.62 | 4.18% | 0.41 | 22.64% |

Table 34: Annual and Peak-day Savings for Specific Measures for Multi-family Residential in Harris County.

#### 8.3.2.2 Tarrant County.

For multi-family units in Tarrant county (Table 33), which is climate zone 5, the average NAHB characteristics for a 1999 multi-family unit include 7.5% window-to-wall area, a glazing U-value of 0.75 Btu/ hr-ft$^2$-°F, a solar heat gain coefficient of 0.61, roof insulation R-value of 36.08 hr-ft$^2$-°F/Btu, a wall insulation of 21.41 hr-ft$^2$-°F/Btu, an air conditioning efficiency of SEER-11, and an AFUE of 80%. For the IECC-compliant multi-family unit in climate zone 5, a house with similar window-to-wall area as the 1999 average multi-family (i.e., 7.5%), is required to have a glazing U-value of 0.70 Btu/ hr-ft$^2$-°F, a solar heat gain coefficient of 0.40, a roof insulation R-value of 19.0 hr-ft$^2$-°F/Btu[123], a wall insulation level of R-11 hr-ft$^2$-°F/Btu, a SEER-11 air conditioning efficiency, and an AFUE of 78%.

[123] Whenever the 1999 NAHB characteristics were shown to be above code, the 2000 IECC-code compliant house was simulated with the same characteristics as the NAHB multi-family 1999 unit, which indicated that the current practice in 1999 was already above code and therefore no savings were expected from code-compliance.

In Table 36, the results of the sensitivity analysis show that the average 1999 multi-family house in Tarrant county consumed 10,322 kWh/year of electricity and 251 therms/year of natural gas, which totaled 60.34 MBtu/year, and on a peak summer day consumed 41.79 kWh/day, and 0.55 therms/day of natural gas. When only the windows were upgraded to meet the code requirements (i.e., double-pane, low-e windows), the annual electricity was reduced to 9,988 kWh/year (3.24% decrease), and gas use was increased to 256 therms/year (1.99% increase), which equaled a total combined energy use of 59.69 MBtu/year (1.08% decrease).

In Table 36 the savings for the code-compliant furnace that includes an electronic ignition show the annual gas use dropped to 208 therms/ year (17.13% decrease), which amounts to a total energy use of 55.98 MBtu/year (7.23% decrease). On peak cooling days, the natural gas use is reduced to 0.43 therms/day (21.82% decrease).

When the average 1999 house in Tarrant county was simulated with efficient windows, improved roof insulation and the electronic ignition the total annual electricity use was reduced to 9,988 kWh/year (3.24% decrease), and gas use was reduced to 212 therms/year (15.54% decrease), with the total annual energy use reduced to 55.33 MBtu/year (8.30% decrease).

| | Area % | Glazing U-value (Btu/ hr-ft$^2$-°F) | SHGC | Roof Insulation (hr-ft$^2$-°F/Btu) | Wall Insulation (hr-ft$^2$-°F/Btu) | SEER | AFUE (%) |
|---|---|---|---|---|---|---|---|
| 1999 Average | 7.5 | 0.75 | 0.61 | 36.08 | 21.41 | 11 | 80 |
| 2000 IECC | 7.5 | 0.70 | 0.40 | 19.00 | 11.00 | 10 | 78 |

Table 35: 1999 Average Vs IECC / IRC Input Values for Specific Measures for Multi-family Residential in Tarrant County.

| Simulated House | Annual Elec. Use | Difference | Annual N.G. Use | Difference | Total Energy Use | Difference |
|---|---|---|---|---|---|---|
| | (KWh/yr) | (%) | (Therm/yr) | (%) | (MBtu/yr) | (%) |
| 1999 Average House | 10,322 | - | 251 | - | 60.34 | - |
| 1999 Average House w/ Low-e windows | 9,988 | 3.24% | 256 | -1.99% | 59.69 | 1.08% |
| 1999 Average House w/o pilot light | 10,322 | 0.00% | 208 | 17.13% | 55.98 | 7.23% |
| 1999 Average House w/ all above | 9,988 | 3.24% | 212 | 15.54% | 55.33 | 8.30% |

| Simulated House | Peak-day | Peak-day Elec. Use | Difference | Peak-day N.G. Use | Difference |
|---|---|---|---|---|---|
| | (2002 report) | (KWh/day) | (%) | (Therm/day) | (%) |
| 1999 Average House | 7/29 | 41.79 | - | 0.55 | - |
| 1999 Average House w/ Low-e windows | | 39.95 | 4.40% | 0.55 | 0.00% |
| 1999 Average House w/o pilot light | | 41.79 | 0.00% | 0.43 | 21.82% |
| 1999 Average House w/ all above | | 39.95 | 4.40% | 0.43 | 21.82% |

Table 36: Annual and Peak-day Savings for Specific Measures for Multi-family Residential in Tarrant County.

### 8.3.3 Summary.

In summary, the implementation of the IECC / IRC in the non-attainment and affected counties is calculated to have saved multi-family households from 321 to 390 kWh/unit annually (3.1 to 3.5% of annual 1999 household electricity use), which would be $24 to $29 at 0.075 $/kWh. The total annual electricity savings from the implementation of the IECC / IRC for the estimated 36,323 new multi-family units built in the 38 non-attainment and affected counties is 15,273 MWh, for a cost savings of $1.1 million[124]. On peak-days the IECC / IRC reduces multi-family household electricity use by 1.44 to 1.90 kWh/day (3.7 to 4.8% of 1999 peak day electric use), which reduces the total electricity production by 73.73 MWh for the 38 non-attainment and affected counties. Using eGRID, the electricity savings from the implementation of the IECC / IRC translate to 22.18 tons of NOx reduction annually. On a peak-day, using eGRID, the electricity reductions translate to 0.11 tons of NOx for all the 38 non-attainment and affected counties.

The natural gas savings from the implementation of the IECC / IRC in the non-attainment and affected counties is calculated to have saved multi-family homeowners from 39 to 45 therms/unit annually (16 to 20% of the annual 1999 household natural gas use), which would be $23 to $27 (at 0.60 $/therm). The total annual savings from the implementation of the IECC / IRC for the estimated 36,323 new multi-family units built in the 38 non-attainment and affected counties is 1,448,051 therms (144,805 MMBtu) for a cost savings of $0.86 million. On peak-days (i.e, peak cooling days) the IECC / IRC reduces multi-family natural gas use by 0.12 therm/day (19 to 24% of the peak 1999 natural gas use), which reduces the total natural gas required on peak days by 4,358 therms (435 MMBtu) for the 38 non-attainment and affected counties. When combined with single-family, this amounts to an annual NOx reduction of 110.1 tons/year (Table 45). On a peak-day in the cooling season, the natural gas reductions translate to 0.1978 tons of NOx for all the 38 non-attainment and affected counties.

[124] Calculated at 0.075 $/kWh.

| | County | Climate Zone | TMY2 | 1999 Average | | | | | 2000 IECC | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Area % | Glazing U-value (Btu/ hr-ft2-F) | SHGC | Roof Insulation (hr-ft2-F/Btu) | Wall Insulation (hr-ft2-F/Btu) | Area % | Glazing U-value (Btu/ hr-ft2-F) | SHGC | Roof Insulation (hr-ft2-F/Btu) | Wall Insulation (hr-ft2-F/Btu) |
| Non-attainment | **Brazoria** | 3 | Houston | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | any | 0.40 | 19.00 | 11.00 |
| | **Chambers** | 4 | Port Arthur | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.85 | 0.40 | 19.00 | 11.00 |
| | **Collin** | 5 | Fort Worth | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.70 | 0.40 | 19.00 | 11.00 |
| | **Dallas** | 5 | Fort Worth | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.70 | 0.40 | 19.00 | 11.00 |
| | **Denton** | 6 | Fort Worth | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.55 | 0.40 | 30.00 | 13.00 |
| | **El Paso** | 6 | El Paso | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.55 | 0.40 | 30.00 | 13.00 |
| | **Fort Bend** | 4 | Houston | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.85 | 0.40 | 19.00 | 11.00 |
| | **Galveston** | 3 | Houston | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | any | 0.40 | 19.00 | 11.00 |
| | **Hardin** | 4 | Port Arthur | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.85 | 0.40 | 19.00 | 11.00 |
| | **Harris** | 4 | Houston | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.85 | 0.40 | 19.00 | 11.00 |
| | **Jefferson** | 4 | Port Arthur | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.85 | 0.40 | 19.00 | 11.00 |
| | **Liberty** | 4 | Port Arthur | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.85 | 0.40 | 19.00 | 11.00 |
| | **Montgomery** | 4 | Houston | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.85 | 0.40 | 19.00 | 11.00 |
| | **Orange** | 4 | Port Arthur | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.85 | 0.40 | 19.00 | 11.00 |
| | **Tarrant** | 5 | Fort Worth | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.70 | 0.40 | 19.00 | 11.00 |
| | **Waller** | 4 | Houston | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.85 | 0.40 | 19.00 | 11.00 |
| Affected | **Bastrop** | 4 | Austin | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.85 | 0.40 | 19.00 | 11.00 |
| | **Bexar** | 4 | San Antonio | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.85 | 0.40 | 19.00 | 11.00 |
| | **Caldwell** | 4 | Austin | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.85 | 0.40 | 19.00 | 11.00 |
| | **Comal** | 4 | San Antonio | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.85 | 0.40 | 19.00 | 11.00 |
| | **Ellis** | 5 | Fort Worth | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.70 | 0.40 | 19.00 | 11.00 |
| | **Gregg** | 6 | Lufkin | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.55 | 0.40 | 30.00 | 13.00 |
| | **Guadalupe** | 4 | San Antonio | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.85 | 0.40 | 19.00 | 11.00 |
| | **Harrison** | 6 | Lufkin | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.55 | 0.40 | 30.00 | 13.00 |
| | **Hays** | 5 | Austin | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.70 | 0.40 | 19.00 | 11.00 |
| | **Johnson** | 5 | Fort Worth | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.70 | 0.40 | 19.00 | 11.00 |
| | **Kaufman** | 6 | Fort Worth | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.55 | 0.40 | 30.00 | 13.00 |
| | **Nueces** | 3 | Corpus Christi | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | any | 0.40 | 19.00 | 11.00 |
| | **Parker** | 6 | Fort Worth | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.55 | 0.40 | 30.00 | 13.00 |
| | **Rockwall** | 6 | Fort Worth | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.55 | 0.40 | 30.00 | 13.00 |
| | **Rusk** | 5 | Lufkin | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.70 | 0.40 | 19.00 | 11.00 |
| | **San Patricio** | 3 | Corpus Christi | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | any | 0.40 | 19.00 | 11.00 |
| | **Smith** | 5 | Lufkin | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.70 | 0.40 | 19.00 | 11.00 |
| | **Travis** | 5 | Austin | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.70 | 0.40 | 19.00 | 11.00 |
| | **Upshur** | 6 | Lufkin | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.55 | 0.40 | 30.00 | 13.00 |
| | **Victoria** | 3 | Victoria | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | any | 0.40 | 19.00 | 11.00 |
| | **Williamson** | 5 | Austin | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.70 | 0.40 | 19.00 | 11.00 |
| | **Wilson** | 4 | San Antonio | 7.5% | 0.75 | 0.61 | 36.08 | 21.41 | 7.5% | 0.85 | 0.40 | 19.00 | 11.00 |

Table 37: 1999 and IECC / IRC Code-compliant Building Characteristics Used in the DOE-2 Simulation for Multi-family Residential.

**Simulation Results for Multifamily Houses**

| | County | Climate Zone | No. of projected units (2003) | 2000 Annual Electricity Use (kWh/house) *(1999 Average Characteristics)* | 2003 Anuual Electricity Use (kWh/house) *(The 200 IECC Characteristics)* | Electricity Use Reductions from Code Adoption | Annual Electricity Savings per House (kWh/House) | 2000 Total Annual Electricity Use (MWh/County) *(1999 Average Characteristics)* | 2003 Total Anuual Electricity Use (MWh/County) *(The 200 IECC Characteristics)* | Total Annual Electricity Savings per County (MWh/County) | Total Annual Electricity Savings per County w/ 20% T&D Loss (MWh/County) | Peak Date (2002 report for single family house) | 2000 Peak-day Electricity Use (kWh/house) *(1999 Average Characteristics)* | 2003 Peak-day Electricity Use (kWh/house) *(The 200 IECC Characteristics)* | Peak-day Electricity Savings per House (kWh/House) | 2000 Total Peak-day Electricity Use (MWh/County) *(1999 Average Characteristics)* | 2003 Total Peak-day Electricity Use (MWh/County) *(The 200 IECC Characteristics)* | Peak-day Electricity Savings per County (MWh/County) | Peak-day Electricity Savings per County w/ 20% T&D Loss (MWh/County) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Affected County | Bastrop | 4 | 88 | 10,779 | 10,406 | 3.46% | 373 | 949 | 916 | 33 | 39 | 7/31 | 40.23 | 38.62 | 1.61 | 3.54 | 3.40 | 0.14 | 0.17 |
| | Bexar | 4 | 2,552 | 10,785 | 10,396 | 3.61% | 389 | 27,523 | 26,531 | 993 | 1,191 | 8/28 | 38.76 | 37.18 | 1.58 | 98.92 | 94.88 | 4.04 | 4.84 |
| | Caldwell | 4 | 0 | 10,779 | 10,406 | 3.46% | 373 | 0 | 0 | 0 | 0 | 7/31 | 40.23 | 38.62 | 1.61 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Comal | 4 | 169 | 10,785 | 10,396 | 3.61% | 389 | 1,823 | 1,757 | 66 | 79 | 8/28 | 38.76 | 37.18 | 1.58 | 6.55 | 6.28 | 0.27 | 0.32 |
| | Ellis | 5 | 838 | 10,322 | 9,988 | 3.24% | 334 | 8,650 | 8,370 | 280 | 336 | 7/29 | 41.79 | 39.95 | 1.84 | 35.02 | 33.48 | 1.54 | 1.85 |
| | Gregg | 6 | 0 | 10,362 | 10,041 | 3.10% | 321 | 0 | 0 | 0 | 0 | 7/22 | 39.78 | 37.89 | 1.90 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Guadalupe | 4 | 0 | 10,785 | 10,396 | 3.61% | 389 | 0 | 0 | 0 | 0 | 8/28 | 38.76 | 37.18 | 1.58 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Harrison | 6 | 0 | 10,362 | 10,041 | 3.10% | 321 | 0 | 0 | 0 | 0 | 7/22 | 39.78 | 37.89 | 1.90 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Hays | 5 | 411 | 10,779 | 10,411 | 3.41% | 368 | 4,430 | 4,279 | 151 | 181 | 7/31 | 40.23 | 38.57 | 1.66 | 16.53 | 15.85 | 0.68 | 0.82 |
| | Johnson | 5 | 17 | 10,322 | 9,988 | 3.24% | 334 | 175 | 170 | 6 | 7 | 7/29 | 41.79 | 39.95 | 1.84 | 0.71 | 0.68 | 0.03 | 0.04 |
| | Kaufman | 6 | 2 | 10,322 | 9,988 | 3.24% | 334 | 21 | 20 | 1 | 1 | 8/19 | 40.94 | 39.21 | 1.73 | 0.08 | 0.08 | 0.00 | 0.00 |
| | Nueces | 3 | 253 | 11,265 | 10,875 | 3.46% | 390 | 2,850 | 2,751 | 99 | 118 | 8/18 | 40.98 | 39.47 | 1.51 | 10.37 | 9.98 | 0.38 | 0.46 |
| | Parker | 6 | 4 | 10,322 | 9,988 | 3.24% | 334 | 41 | 40 | 1 | 2 | 8/19 | 40.94 | 39.21 | 1.73 | 0.16 | 0.16 | 0.01 | 0.01 |
| | Rockwall | 6 | 0 | 10,322 | 9,988 | 3.24% | 334 | 0 | 0 | 0 | 0 | 8/19 | 40.94 | 39.21 | 1.73 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Rusk | 5 | 2 | 10,323 | 9,991 | 3.22% | 332 | 21 | 20 | 1 | 1 | 7/22 | 39.68 | 37.95 | 1.73 | 0.08 | 0.08 | 0.00 | 0.00 |
| | San Patricio | 3 | 306 | 11,265 | 10,875 | 3.46% | 390 | 3,447 | 3,328 | 119 | 143 | 8/18 | 40.98 | 39.47 | 1.51 | 12.54 | 12.08 | 0.46 | 0.55 |
| | Smith | 5 | 83 | 10,323 | 9,991 | 3.22% | 332 | 857 | 829 | 28 | 33 | 7/22 | 39.68 | 37.95 | 1.73 | 3.29 | 3.15 | 0.14 | 0.17 |
| | Travis | 5 | 5,349 | 10,779 | 10,411 | 3.41% | 368 | 57,657 | 55,688 | 1,968 | 2,362 | 7/31 | 40.23 | 38.57 | 1.66 | 215.19 | 206.33 | 8.86 | 10.63 |
| | Upshur | 6 | 0 | 10,362 | 10,041 | 3.10% | 321 | 0 | 0 | 0 | 0 | 7/22 | 39.78 | 37.89 | 1.90 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Victoria | 3 | 0 | 10,890 | 10,501 | 3.57% | 389 | 0 | 0 | 0 | 0 | 9/2 | 42.12 | 40.54 | 1.57 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Williamson | 5 | 312 | 10,779 | 10,411 | 3.41% | 368 | 3,363 | 3,248 | 115 | 138 | 7/31 | 40.23 | 38.57 | 1.66 | 12.55 | 12.04 | 0.52 | 0.62 |
| | Wilson | 4 | 0 | 10,785 | 10,396 | 3.61% | 389 | 0 | 0 | 0 | 0 | 8/28 | 38.76 | 37.18 | 1.58 | 0.00 | 0.00 | 0.00 | 0.00 |
| Non-attainment County | Brazoria | 3 | 343 | 10,625 | 10,275 | 3.29% | 350 | 3,644 | 3,524 | 120 | 144 | 7/29 | 39.26 | 37.62 | 1.64 | 13.47 | 12.91 | 0.56 | 0.67 |
| | Chambers | 4 | 0 | 10,524 | 10,171 | 3.35% | 353 | 0 | 0 | 0 | 0 | 9/1 | 39.14 | 37.70 | 1.44 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Collin | 5 | 732 | 10,322 | 9,988 | 3.24% | 334 | 7,556 | 7,311 | 244 | 293 | 8/19 | 40.94 | 39.21 | 1.73 | 29.96 | 28.70 | 1.26 | 1.52 |
| | Dallas | 5 | 7,324 | 10,322 | 9,988 | 3.24% | 334 | 75,598 | 73,152 | 2,446 | 2,935 | 7/29 | 41.79 | 39.95 | 1.84 | 306.08 | 292.59 | 13.48 | 16.18 |
| | Denton | 6 | 1,406 | 10,322 | 9,988 | 3.24% | 334 | 14,513 | 14,043 | 470 | 564 | 8/19 | 40.94 | 39.21 | 1.73 | 57.55 | 55.13 | 2.43 | 2.92 |
| | El Paso | 6 | 251 | 10,186 | 9,834 | 3.46% | 352 | 2,557 | 2,468 | 88 | 106 | 7/12 | 38.48 | 36.63 | 1.84 | 9.66 | 9.20 | 0.46 | 0.56 |
| | Fort Bend | 4 | 0 | 10,625 | 10,275 | 3.29% | 350 | 0 | 0 | 0 | 0 | 7/29 | 39.26 | 37.67 | 1.59 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Galveston | 3 | 52 | 10,625 | 10,275 | 3.29% | 350 | 553 | 534 | 18 | 22 | 7/29 | 39.26 | 37.62 | 1.64 | 2.04 | 1.96 | 0.09 | 0.10 |
| | Hardin | 4 | 0 | 10,524 | 10,171 | 3.35% | 353 | 0 | 0 | 0 | 0 | 9/1 | 39.14 | 37.70 | 1.44 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Harris | 4 | 11,287 | 10,625 | 10,275 | 3.29% | 350 | 119,924 | 115,974 | 3,950 | 4,741 | 7/29 | 39.26 | 37.67 | 1.59 | 443.16 | 425.23 | 17.94 | 21.52 |
| | Jefferson | 4 | 94 | 10,524 | 10,171 | 3.35% | 353 | 989 | 956 | 33 | 40 | 9/1 | 39.14 | 37.70 | 1.44 | 3.68 | 3.54 | 0.13 | 0.16 |
| | Liberty | 4 | 0 | 10,524 | 10,171 | 3.35% | 353 | 0 | 0 | 0 | 0 | 9/1 | 39.14 | 37.70 | 1.44 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Montgomery | 4 | 536 | 10,625 | 10,275 | 3.29% | 350 | 5,695 | 5,507 | 188 | 225 | 7/29 | 39.26 | 37.67 | 1.59 | 21.04 | 20.19 | 0.85 | 1.02 |
| | Orange | 4 | 0 | 10,524 | 10,171 | 3.35% | 353 | 0 | 0 | 0 | 0 | 9/1 | 39.14 | 37.70 | 1.44 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Tarrant | 5 | 3,729 | 10,322 | 9,988 | 3.24% | 334 | 38,491 | 37,245 | 1,245 | 1,495 | 7/29 | 41.79 | 39.95 | 1.84 | 155.84 | 148.97 | 6.87 | 8.24 |
| | Waller | 4 | 183 | 10,625 | 10,275 | 3.29% | 350 | 1,944 | 1,880 | 64 | 77 | 7/29 | 39.26 | 37.67 | 1.59 | 7.19 | 6.89 | 0.29 | 0.35 |
| | TOTAL | | 36,323 | | | | | 383,271 | 370,543 | 12,727 | **15,273** | | | | | 1,465.21 | 1,403.77 | 61.44 | **73.73** |

Table 38: 2003 Annual and Peak-day Electricity Savings From Implementation of the IECC / IRC for Multi-family Residences.

## Annual Electricity Use by PCA for Multifamily House

| Nonattainment and Affected Counties | Electric Retail Service Area | Power Control Area | NERC Region | Total Energy Savings by County (MWh) | Total Energy Savings by PCA (MWh) |
|---|---|---|---|---|---|
| Travis | Austin Energy | Austin Energy/PCA | ERCOT | 2,362.1 | |
| | | Austin Energy/PCA | | | 2,362.1 |
| Nueces | CRI | American Electric Power West (ERCOT)/PCA | ERCOT | 118.4 | |
| San Patricio | CRI | American Electric Power West (ERCOT)/PCA | ERCOT | 143.2 | |
| Victoria | CRI | American Electric Power West (ERCOT)/PCA | ERCOT | 0.0 | |
| | | American Electric Power West (ERCOT)/PCA | | | 261.6 |
| Bastrop | | Lower Colorado River Authority/PCA | ERCOT | 39.4 | |
| Caldwell | | Lower Colorado River Authority/PCA | ERCOT | 0.0 | |
| Comal | | Lower Colorado River Authority/PCA | ERCOT | 78.9 | |
| Guadalupe | | Lower Colorado River Authority/PCA | ERCOT | 0.0 | |
| Hays | | Lower Colorado River Authority/PCA | ERCOT | 181.5 | |
| Wilson | | Lower Colorado River Authority/PCA | ERCOT | 0.0 | |
| | | Lower Colorado River Authority/PCA | | | 299.8 |
| Brazoria | Reliant Energy HL&P | Reliant Energy HL&P/PCA | ERCOT | 144.1 | |
| Fort Bend | Reliant Energy HL&P | Reliant Energy HL&P/PCA | ERCOT | 0.0 | |
| Galveston | Reliant Energy HL&P | Reliant Energy HL&P/PCA | ERCOT | 21.8 | |
| Harris | Reliant Energy HL&P | Reliant Energy HL&P/PCA | ERCOT | 4,740.5 | |
| Waller | Reliant Energy HL&P | Reliant Energy HL&P/PCA | ERCOT | 76.9 | |
| | | Reliant Energy HL&P/PCA | | | 4,983.3 |
| Bexar | San Antonio Public Service Bd | San Antonio Public Service Bd/PCA | ERCOT | 1,191.3 | |
| | | San Antonio Public Service Bd/PCA | | | 1,191.3 |
| Ellis | TXU | TXU Electric/PCA | ERCOT | 335.9 | |
| Johnson | TXU | TXU Electric/PCA | ERCOT | 6.8 | |
| Kaufman | TXU | TXU Electric/PCA | ERCOT | 0.8 | |
| Parker | TXU | TXU Electric/PCA | ERCOT | 1.6 | |
| Rockwall | TXU | TXU Electric/PCA | ERCOT | 0.0 | |
| Smith | TXU | TXU Electric/PCA | ERCOT | 33.1 | |
| Williamson | TXU | TXU Electric/PCA | ERCOT | 137.8 | |
| Collin | TXU | TXU Electric/PCA | ERCOT | 293.4 | |
| Dallas | TXU | TXU Electric/PCA | ERCOT | 2,935.5 | |
| Denton | TXU | TXU Electric/PCA | ERCOT | 563.5 | |
| Tarrant | TXU | TXU Electric/PCA | ERCOT | 1,494.6 | |
| | | TXU Electric/PCA | | | 5,802.9 |
| Chambers | EGS | Entergy Electric System/PCA | SERC | 0.0 | |
| Hardin | EGS | Entergy Electric System/PCA | SERC | 0.0 | |
| Jefferson | EGS | Entergy Electric System/PCA | SERC | 39.8 | |
| Liberty | EGS | Entergy Electric System/PCA | SERC | 0.0 | |
| Montgomery | EGS | Entergy Electric System/PCA | SERC | 225.1 | |
| Orange | EGS | Entergy Electric System/PCA | SERC | 0.0 | |
| | | Entergy Electric System/PCA | | | 264.9 |
| El Paso | EL PASO Electric Company | El Paso Electric Co/PCA | WSCC | 106.0 | |
| | | El Paso Electric Co/PCA | | | 106.0 |
| Gregg | SWEPCO | Southwestern Public Service Co/PCA | SPP | 0.0 | |

Table 39: 2003 Totalized Annual Electricity Savings From IECC / IRC by PCA for Multi-family Residences.

**Annual NOx Emissions Reductions Calculations for Multifamily Houses**

| Area | County | American Electric Power - West (ERCOT) /PCA | NOx Reductions (lbs) | Austin Energy/PCA | NOx Reductions (lbs) | Brownsville Public Utils Board/PCA | NOx Reductions (lbs/year) | Lower Colorado River Auhotrity /PCA | NOx Reductions (lbs) | Reliant Energy HL&P/PCA | NOx Reductions (lbs) | San Antonio Public Service Bd/PCA | NOx Reductions (lbs) | South Texas Electric Coop INC/PCA | NOx Reductions (lbs) | Texas Municipal Power Pool/PCA | NOx Reductions (lbs) | Texas-New Mexico Power Co/PCA | NOx Reductions (lbs) | TXU Electric/PCA | NOx Reductions (lbs) | Total Nox Reductions (lbs) | Total Nox Reductions (Tons) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austin-San Antonio Area | BASTROP | 0.01 | 2.62 | 0.20 | 472.42 | | 0.00 | 0.34 | 101.92 | | 0.00 | 0.01 | 11.91 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 588.88 | 0.29 |
| | BEXAR | 0.06 | 15.70 | 0.09 | 212.59 | 0.04 | 0.00 | 0.16 | 47.96 | | 0.00 | 2.00 | 2382.55 | 0.08 | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | 2658.80 | 1.33 |
| | TRAVIS | | 0.00 | 0.46 | 1086.57 | | 0.00 | 0.05 | 14.99 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 1101.56 | 0.55 |
| | FAYETTE | 0.02 | 5.23 | 0.86 | 2031.42 | 0.02 | 0.00 | 1.51 | 452.66 | 0.01 | 49.83 | 0.04 | 47.65 | 0.01 | 0.00 | 0.02 | 0.00 | | 0.00 | 0.02 | 116.06 | 2702.86 | 1.35 |
| | LLANO | | 0.00 | 0.12 | 283.45 | | 0.00 | 0.21 | 62.95 | | 0.00 | 0.01 | 11.91 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 358.32 | 0.18 |
| | CALDWELL | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | COMAL | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | GUADALUPE | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | HAYS | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | WILLIAMSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | WILSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| Dallas-Fort Worth Area | COLLIN | 0.01 | 2.62 | 0.01 | 23.62 | | 0.00 | 0.02 | 6.00 | 0.01 | 49.83 | | 0.00 | 0.05 | 0.00 | 0.19 | 0.00 | | 0.00 | 0.02 | 116.06 | 198.12 | 0.10 |
| | DALLAS | 0.06 | 15.70 | 0.06 | 141.73 | 0.04 | 0.00 | 0.09 | 26.98 | 0.03 | 149.50 | 0.01 | 11.91 | 0.09 | 0.00 | 0.30 | 0.00 | 0.09 | 0.00 | 0.51 | 2959.47 | 3305.29 | 1.65 |
| | DENTON | | 0.00 | 0.01 | 23.62 | | 0.00 | 0.01 | 3.00 | | 0.00 | | 0.00 | 0.04 | 0.00 | 0.15 | 0.00 | | 0.00 | 0.01 | 58.03 | 84.65 | 0.04 |
| | JOHNSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | PARKER | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | CHEROKEE | 0.01 | 2.62 | 0.01 | 23.62 | 0.01 | 0.00 | 0.02 | 6.00 | | 0.00 | | 0.00 | 0.02 | 0.00 | 0.06 | 0.00 | 0.02 | 0.00 | 0.10 | 580.29 | 612.52 | 0.31 |
| | COKE | 0.03 | 7.85 | | 0.00 | 0.02 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 7.85 | 0.00 |
| | COLEMAN | 0.02 | 5.23 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 5.23 | 0.00 |
| | FANNIN | 0.02 | 5.23 | 0.02 | 47.24 | 0.01 | 0.00 | 0.03 | 8.99 | 0.01 | 49.83 | | 0.00 | 0.03 | 0.00 | 0.09 | 0.00 | 0.03 | 0.00 | 0.17 | 986.49 | 1097.79 | 0.55 |
| | FRIO | 0.05 | 13.08 | | 0.00 | 0.04 | 0.00 | 0.01 | 3.00 | | 0.00 | | 0.00 | 1.15 | 0.00 | 0.07 | 0.00 | | 0.00 | | 0.00 | 16.08 | 0.01 |
| | HARDEMAN | 0.01 | 2.62 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 2.62 | 0.00 |
| | HASKELL | 0.16 | 41.86 | | 0.00 | 0.12 | 0.00 | 0.01 | 3.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | 0.01 | 0.00 | | 0.00 | 0.01 | 58.03 | 102.88 | 0.05 |
| | HENDERSON | | 0.00 | | 0.00 | | 0.00 | 0.01 | 3.00 | | 0.00 | | 0.00 | | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.03 | 174.09 | 177.08 | 0.09 |
| | HOOD | 0.02 | 5.23 | 0.02 | 47.24 | 0.02 | 0.00 | 0.04 | 11.99 | 0.01 | 49.83 | | 0.00 | 0.03 | 0.00 | 0.12 | 0.00 | 0.04 | 0.00 | 0.22 | 1276.64 | 1390.93 | 0.70 |
| | JONES | 0.14 | 36.63 | | 0.00 | 0.11 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | 0.01 | 58.03 | 94.65 | 0.05 |
| | LAMAR | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 58.03 | 58.03 | 0.03 |
| | LIMESTONE | 0.01 | 2.62 | 0.01 | 23.62 | | 0.00 | | 0.00 | 0.05 | 249.17 | 0.01 | 11.91 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 287.32 | 0.14 |
| | MCLENNAN | 0.04 | 10.46 | 0.04 | 94.48 | 0.03 | 0.00 | 0.07 | 20.98 | 0.02 | 99.67 | 0.01 | 11.91 | 0.06 | 0.00 | 0.22 | 0.00 | 0.07 | 0.00 | 0.40 | 2321.16 | 2558.67 | 1.28 |
| | MITCHELL | 0.04 | 10.46 | 0.04 | 94.48 | 0.03 | 0.00 | 0.07 | 20.98 | 0.02 | 99.67 | 0.01 | 11.91 | 0.06 | 0.00 | 0.21 | 0.00 | 0.07 | 0.00 | 0.39 | 2263.13 | 2500.64 | 1.25 |
| | NOLAN | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 58.03 | 58.03 | 0.03 |
| | PALO PINTO | 0.01 | 2.62 | 0.02 | 47.24 | 0.01 | 0.00 | 0.03 | 8.99 | 0.01 | 49.83 | | 0.00 | 0.09 | 0.00 | 0.36 | 0.00 | | 0.00 | 0.02 | 116.06 | 224.74 | 0.11 |
| | RED RIVER | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | 0.02 | 116.06 | 116.06 | 0.06 |
| | TAYLOR | 0.01 | 2.62 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 2.62 | 0.00 |
| | TITUS | 0.01 | 2.62 | 0.01 | 23.62 | 0.01 | 0.00 | 0.02 | 6.00 | | 0.00 | | 0.00 | 0.02 | 0.00 | 0.05 | 0.00 | 0.02 | 0.00 | 0.10 | 580.29 | 612.52 | 0.31 |
| | YOUNG | 0.02 | 5.23 | 0.02 | 47.24 | 0.01 | 0.00 | 0.03 | 8.99 | 0.01 | 49.83 | | 0.00 | 0.03 | 0.00 | 0.09 | 0.00 | 0.03 | 0.00 | 0.16 | 928.46 | 1039.76 | 0.52 |
| | TARRANT | 0.04 | 10.46 | 0.04 | 94.48 | 0.03 | 0.00 | 0.06 | 17.99 | 0.02 | 99.67 | 0.01 | 11.91 | 0.05 | 0.00 | 0.18 | 0.00 | 0.06 | 0.00 | 0.33 | 1914.95 | 2149.47 | 1.07 |
| | ELLIS | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | KAUFMAN | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | ROCKWALL | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| Houston - Galveston Area | BRAZORIA | 0.01 | 2.62 | 0.01 | 23.62 | | 0.00 | | 0.00 | 0.05 | 249.17 | 0.01 | 11.91 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 287.32 | 0.14 |
| | BRAZOS | | 0.00 | 0.01 | 23.62 | | 0.00 | 0.01 | 3.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | 0.11 | 0.00 | | 0.00 | 0.01 | 58.03 | 84.65 | 0.04 |
| | GRIMES | 0.01 | 2.62 | 0.01 | 23.62 | | 0.00 | 0.02 | 6.00 | 0.01 | 49.83 | | 0.00 | 0.06 | 0.00 | 0.23 | 0.00 | | 0.00 | 0.01 | 58.03 | 140.09 | 0.07 |
| | WHARTON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 49.83 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 49.83 | 0.02 |
| | CHAMBERS | 0.05 | 13.08 | 0.06 | 141.73 | 0.03 | 0.00 | 0.02 | 6.00 | 0.35 | 1744.16 | 0.08 | 95.30 | 0.03 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 | 0.03 | 174.09 | 2174.35 | 1.09 |
| | FORT BEND | 0.13 | 34.01 | 0.17 | 401.56 | 0.10 | 0.00 | 0.06 | 17.99 | 1.01 | 5033.13 | 0.23 | 273.99 | 0.09 | 0.00 | 0.06 | 0.00 | 0.07 | 0.00 | 0.10 | 580.29 | 6340.97 | 3.17 |
| | GALVESTON | 0.05 | 13.08 | 0.06 | 141.73 | 0.04 | 0.00 | 0.02 | 6.00 | 0.39 | 1943.49 | 0.09 | 107.21 | 0.04 | 0.00 | 0.03 | 0.00 | 0.42 | 0.00 | 0.04 | 232.12 | 2443.62 | 1.22 |
| | ROBERTSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 49.83 | | 0.00 | | 0.00 | | 0.00 | 0.40 | 0.00 | 0.01 | 58.03 | 107.86 | 0.05 |
| | HARRIS | 0.05 | 13.08 | 0.07 | 165.35 | 0.04 | 0.00 | 0.02 | 6.00 | 0.41 | 2043.15 | 0.09 | 107.21 | 0.04 | 0.00 | 0.02 | 0.00 | 0.03 | 0.00 | 0.04 | 232.12 | 2566.91 | 1.28 |
| | HARDIN | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | JEFFERSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | LIBERTY | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | MONTGOMERY | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | ORANGE | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | WALLER | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| El Paso Area | EL PASO | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| OTHER | RUSK | 0.01 | 2.62 | 0.01 | 23.62 | 0.01 | 0.00 | 0.01 | 3.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | 0.04 | 0.00 | 0.01 | 0.00 | 0.07 | 406.20 | 435.44 | 0.22 |
| | CROCKETT | 0.14 | 36.63 | | 0.00 | 0.11 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | 0.01 | 58.03 | 94.65 | 0.05 |
| | FREESTONE | 0.02 | 5.23 | 0.02 | 47.24 | 0.02 | 0.00 | 0.04 | 11.99 | 0.01 | 49.83 | | 0.00 | 0.03 | 0.00 | 0.12 | 0.00 | 0.04 | 0.00 | 0.22 | 1276.64 | 1390.93 | 0.70 |
| | CALHOUN | 0.19 | 49.71 | | 0.00 | 0.14 | 0.00 | 0.01 | 3.00 | | 0.00 | | 0.00 | 0.04 | 0.00 | 0.01 | 0.00 | | 0.00 | 0.01 | 58.03 | 110.73 | 0.06 |
| | HIDALGO | 0.13 | 34.01 | | 0.00 | 0.10 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 34.01 | 0.02 |
| | CAMERON | 0.14 | 36.63 | | 0.00 | 0.20 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | 0.01 | 58.03 | 94.65 | 0.05 |
| | WARD | 0.06 | 15.70 | 0.06 | 141.73 | 0.04 | 0.00 | 0.09 | 26.98 | 0.02 | 99.67 | 0.01 | 11.91 | 0.08 | 0.00 | 0.28 | 0.00 | 0.10 | 0.00 | 0.51 | 2959.47 | 3255.46 | 1.63 |
| | WEBB | 0.06 | 15.70 | | 0.00 | 0.05 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 15.70 | 0.01 |
| | NUECES | 0.74 | 193.59 | 0.01 | 23.62 | 0.55 | 0.00 | 0.02 | 6.00 | 0.01 | 49.83 | 0.01 | 11.91 | 0.15 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.03 | 174.09 | 459.04 | 0.23 |
| | VICTORIA | 0.30 | 78.48 | 0.01 | 23.62 | 0.22 | 0.00 | 0.01 | 3.00 | | 0.00 | | 0.00 | 0.68 | 0.00 | 0.05 | 0.00 | | 0.00 | 0.01 | 58.03 | 163.13 | 0.08 |
| | GREGG | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | HARRISON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | SMITH | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | UPSHUR | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | SAN PATRICIO | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | **TOTAL** | **2.89** | | **2.54** | | **2.22** | | **3.12** | | **2.48** | | **2.63** | | **3.27** | | **3.19** | | **1.54** | | **3.65** | | 44363.31 | 22.18 |
| Energy Savings by PCA from ESL (MWh) | | 261.61 | | 2362.12 | | 0.00 | | 299.78 | | 4983.30 | | 1191.27 | | 0.00 | | 0.00 | | 0.00 | | 5802.89 | | | |

Table 40: 2003 Annual NOx Reductions From IECC / IRC by PCA for Multi-family Residences by County Using eGRID.

**Peak-day Electricity Use by PCA for Multifamily House**

| Nonattainment and Affected Counties | Electric Retail Service Area | Power Control Area | NERC Region | Total Energy Savings by County (MWh) | Total Energy Savings by PCA (MWh) |
|---|---|---|---|---|---|
| **Travis** | Austin Energy | Austin Energy/PCA | ERCOT | 10.6 | |
| | | Austin Energy/PCA | | | 10.6 |
| **Nueces** | CRI | American Electric Power West (ERCOT)/PCA | ERCOT | 0.5 | |
| **San Patricio** | CRI | American Electric Power West (ERCOT)/PCA | ERCOT | 0.6 | |
| **Victoria** | CRI | American Electric Power West (ERCOT)/PCA | ERCOT | 0.0 | |
| | | American Electric Power West (ERCOT)/PCA | | | 1.0 |
| **Bastrop** | | Lower Colorado River Authority/PCA | ERCOT | 0.2 | |
| **Caldwell** | | Lower Colorado River Authority/PCA | ERCOT | 0.0 | |
| **Comal** | | Lower Colorado River Authority/PCA | ERCOT | 0.3 | |
| **Guadalupe** | | Lower Colorado River Authority/PCA | ERCOT | 0.0 | |
| **Hays** | | Lower Colorado River Authority/PCA | ERCOT | 0.8 | |
| **Wilson** | | Lower Colorado River Authority/PCA | ERCOT | 0.0 | |
| | | Lower Colorado River Authority/PCA | | | 1.3 |
| **Brazoria** | Reliant Energy HL&P | Reliant Energy HL&P/PCA | ERCOT | 0.7 | |
| **Fort Bend** | Reliant Energy HL&P | Reliant Energy HL&P/PCA | ERCOT | 0.0 | |
| **Galveston** | Reliant Energy HL&P | Reliant Energy HL&P/PCA | ERCOT | 0.1 | |
| **Harris** | Reliant Energy HL&P | Reliant Energy HL&P/PCA | ERCOT | 21.5 | |
| **Waller** | Reliant Energy HL&P | Reliant Energy HL&P/PCA | ERCOT | 0.3 | |
| | | Reliant Energy HL&P/PCA | | | 22.6 |
| **Bexar** | San Antonio Public Service Bd | San Antonio Public Service Bd/PCA | ERCOT | 4.8 | |
| | | San Antonio Public Service Bd/PCA | | | 4.8 |
| **Ellis** | TXU | TXU Electric/PCA | ERCOT | 1.9 | |
| **Johnson** | TXU | TXU Electric/PCA | ERCOT | 0.0 | |
| **Kaufman** | TXU | TXU Electric/PCA | ERCOT | 0.0 | |
| **Parker** | TXU | TXU Electric/PCA | ERCOT | 0.0 | |
| **Rockwall** | TXU | TXU Electric/PCA | ERCOT | 0.0 | |
| **Smith** | TXU | TXU Electric/PCA | ERCOT | 0.2 | |
| **Williamson** | TXU | TXU Electric/PCA | ERCOT | 0.6 | |
| **Collin** | TXU | TXU Electric/PCA | ERCOT | 1.5 | |
| **Dallas** | TXU | TXU Electric/PCA | ERCOT | 16.2 | |
| **Denton** | TXU | TXU Electric/PCA | ERCOT | 2.9 | |
| **Tarrant** | TXU | TXU Electric/PCA | ERCOT | 8.2 | |
| | | TXU Electric/PCA | | | 31.5 |
| **Chambers** | EGS | Entergy Electric System/PCA | SERC | 0.0 | |
| **Hardin** | EGS | Entergy Electric System/PCA | SERC | 0.0 | |
| **Jefferson** | EGS | Entergy Electric System/PCA | SERC | 0.2 | |
| **Liberty** | EGS | Entergy Electric System/PCA | SERC | 0.0 | |
| **Montgomery** | EGS | Entergy Electric System/PCA | SERC | 1.0 | |
| **Orange** | EGS | Entergy Electric System/PCA | SERC | 0.0 | |
| | | Entergy Electric System/PCA | | | 1.2 |
| **El Paso** | EL PASO Electric Company | El Paso Electric Co/PCA | WSCC | 0.6 | |
| | | El Paso Electric Co/PCA | | | 0.6 |
| **Gregg** | SWEPCO | Southwestern Public Service Co/PCA | SPP | 0.0 | |

Table 41: 2003 Totalized Peak-day Electricity Savings From IECC / IRC by PCA for Multi-family Residences

**Peak-day NOx Emissions Reductions Calculations for Multifamily Houses**

| Area | County | American Electric Power - West (ERCOT) /PCA | NOx Reductions (lbs) | Austin Energy/PCA | NOx Reductions (lbs) | Brownsville Public Utils Board/PCA | NOx Reductions (lbs/year) | Lower Colorado River Auhotrity /PCA | NOx Reductions (lbs) | Reliant Energy HL&P/PCA | NOx Reductions (lbs) | San Antonio Public Service Bd/PCA | NOx Reductions (lbs) | South Texas Electric Coop INC/PCA | NOx Reductions (lbs) | Texas Municipal Power Pool/PCA | NOx Reductions (lbs) | Texas-New Mexico Power Co/PCA | NOx Reductions (lbs) | TXU Electric/PCA | NOx Reductions (lbs) | Total Nox Reductions (lbs) | Total Nox Reductions (Tons) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austin-San Antonio Area | BASTROP | 0.01 | 0.01 | 0.20 | 2.13 | | 0.00 | 0.34 | 0.44 | | 0.00 | 0.01 | 0.05 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 2.63 | 0.00 |
| | BEXAR | 0.06 | 0.06 | 0.09 | 0.96 | 0.04 | 0.00 | 0.16 | 0.21 | | 0.00 | 2.00 | 9.69 | 0.08 | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | 10.92 | 0.01 |
| | TRAVIS | | 0.00 | 0.46 | 4.89 | | 0.00 | 0.05 | 0.07 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 4.95 | 0.00 |
| | FAYETTE | 0.02 | 0.02 | 0.86 | 9.14 | 0.02 | 0.00 | 1.51 | 1.97 | 0.01 | 0.23 | 0.04 | 0.19 | 0.01 | 0.00 | 0.02 | 0.00 | | 0.00 | 0.02 | 0.63 | 12.19 | 0.01 |
| | LLANO | | 0.00 | 0.12 | 1.28 | | 0.00 | 0.21 | 0.27 | | 0.00 | 0.01 | 0.05 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 1.60 | 0.00 |
| | CALDWELL | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | COMAL | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | GUADALUPE | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | HAYS | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | WILLIAMSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | WILSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| Dallas-Fort Worth Area | COLLIN | 0.01 | 0.01 | 0.01 | 0.11 | | 0.00 | 0.02 | 0.03 | 0.01 | 0.23 | | 0.00 | 0.05 | 0.00 | 0.19 | 0.00 | | 0.00 | 0.02 | 0.63 | 1.00 | 0.00 |
| | DALLAS | 0.06 | 0.06 | 0.06 | 0.64 | 0.04 | 0.00 | 0.09 | 0.12 | 0.03 | 0.68 | 0.01 | 0.05 | 0.09 | 0.00 | 0.30 | 0.00 | 0.09 | 0.00 | 0.51 | 16.09 | 17.63 | 0.01 |
| | DENTON | | 0.00 | 0.01 | 0.11 | | 0.00 | 0.01 | 0.01 | | 0.00 | | 0.00 | 0.04 | 0.00 | 0.15 | 0.00 | | 0.00 | 0.01 | 0.32 | 0.43 | 0.00 |
| | JOHNSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | PARKER | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | CHEROKEE | 0.01 | 0.01 | 0.01 | 0.11 | 0.01 | 0.00 | 0.02 | 0.03 | | 0.00 | | 0.00 | 0.02 | 0.00 | 0.06 | 0.00 | 0.02 | 0.00 | 0.10 | 3.15 | 3.30 | 0.00 |
| | COKE | 0.03 | 0.03 | | 0.00 | 0.02 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 |
| | COLEMAN | 0.02 | 0.02 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.02 | 0.00 |
| | FANNIN | 0.02 | 0.02 | 0.02 | 0.21 | 0.01 | 0.00 | 0.03 | 0.04 | 0.01 | 0.23 | | 0.00 | 0.03 | 0.00 | 0.09 | 0.00 | 0.03 | 0.00 | 0.17 | 5.36 | 5.86 | 0.00 |
| | FRIO | 0.05 | 0.05 | | 0.00 | 0.04 | 0.00 | 0.01 | 0.01 | | 0.00 | | 0.00 | 1.15 | 0.00 | 0.07 | 0.00 | | 0.00 | | 0.00 | 0.06 | 0.00 |
| | HARDEMAN | 0.01 | 0.01 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 |
| | HASKELL | 0.16 | 0.16 | | 0.00 | 0.12 | 0.00 | 0.01 | 0.01 | | 0.00 | | 0.00 | 0.03 | 0.00 | 0.01 | 0.00 | | 0.00 | 0.01 | 0.32 | 0.49 | 0.00 |
| | HENDERSON | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.01 | | 0.00 | | 0.00 | | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.03 | 0.95 | 0.96 | 0.00 |
| | HOOD | 0.02 | 0.02 | 0.02 | 0.21 | 0.02 | 0.00 | 0.04 | 0.05 | 0.01 | 0.23 | | 0.00 | 0.03 | 0.00 | 0.12 | 0.00 | 0.04 | 0.00 | 0.22 | 6.94 | 7.45 | 0.00 |
| | JONES | 0.14 | 0.14 | | 0.00 | 0.11 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.32 | 0.46 | 0.00 |
| | LAMAR | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.32 | 0.32 | 0.00 |
| | LIMESTONE | 0.01 | 0.01 | 0.01 | 0.11 | | 0.00 | | 0.00 | 0.05 | 1.13 | 0.01 | 0.05 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 1.30 | 0.00 |
| | MCLENNAN | 0.04 | 0.04 | 0.04 | 0.43 | 0.03 | 0.00 | 0.07 | 0.09 | 0.02 | 0.45 | 0.01 | 0.05 | 0.06 | 0.00 | 0.22 | 0.00 | 0.07 | 0.00 | 0.40 | 12.62 | 13.68 | 0.01 |
| | MITCHELL | 0.04 | 0.04 | 0.04 | 0.43 | 0.03 | 0.00 | 0.07 | 0.09 | 0.02 | 0.45 | 0.01 | 0.05 | 0.06 | 0.00 | 0.21 | 0.00 | 0.07 | 0.00 | 0.39 | 12.30 | 13.36 | 0.01 |
| | NOLAN | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.32 | 0.32 | 0.00 |
| | PALO PINTO | 0.01 | 0.01 | 0.02 | 0.21 | 0.01 | 0.00 | 0.03 | 0.04 | 0.01 | 0.23 | | 0.00 | 0.09 | 0.00 | 0.36 | 0.00 | | 0.00 | 0.02 | 0.63 | 1.12 | 0.00 |
| | RED RIVER | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | 0.02 | 0.63 | 0.63 | 0.00 |
| | TAYLOR | 0.01 | 0.01 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 |
| | TITUS | 0.01 | 0.01 | 0.01 | 0.11 | 0.01 | 0.00 | 0.02 | 0.03 | | 0.00 | | 0.00 | 0.02 | 0.00 | 0.05 | 0.00 | 0.02 | 0.00 | 0.10 | 3.15 | 3.30 | 0.00 |
| | YOUNG | 0.02 | 0.02 | 0.02 | 0.21 | 0.01 | 0.00 | 0.03 | 0.04 | 0.01 | 0.23 | | 0.00 | 0.03 | 0.00 | 0.09 | 0.00 | 0.03 | 0.00 | 0.16 | 5.05 | 5.55 | 0.00 |
| | TARRANT | 0.04 | 0.04 | 0.04 | 0.43 | 0.03 | 0.00 | 0.06 | 0.08 | 0.02 | 0.45 | 0.01 | 0.05 | 0.05 | 0.00 | 0.18 | 0.00 | 0.06 | 0.00 | 0.33 | 10.41 | 11.46 | 0.01 |
| | ELLIS | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | KAUFMAN | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | ROCKWALL | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| Houston - Galveston Area | BRAZORIA | 0.01 | 0.01 | 0.01 | 0.11 | | 0.00 | | 0.00 | 0.05 | 1.13 | 0.01 | 0.05 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 1.30 | 0.00 |
| | BRAZOS | | 0.00 | 0.01 | 0.11 | | 0.00 | 0.01 | 0.01 | | 0.00 | | 0.00 | 0.03 | 0.00 | 0.11 | 0.00 | | 0.00 | 0.01 | 0.32 | 0.43 | 0.00 |
| | GRIMES | 0.01 | 0.01 | 0.01 | 0.11 | | 0.00 | 0.02 | 0.03 | 0.01 | 0.23 | | 0.00 | 0.06 | 0.00 | 0.23 | 0.00 | | 0.00 | 0.01 | 0.32 | 0.68 | 0.00 |
| | WHARTON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.23 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.23 | 0.00 |
| | CHAMBERS | 0.05 | 0.05 | 0.06 | 0.64 | 0.03 | 0.00 | 0.02 | 0.03 | 0.35 | 7.93 | 0.08 | 0.39 | 0.03 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 | 0.03 | 0.95 | 9.98 | 0.00 |
| | FORT BEND | 0.13 | 0.13 | 0.17 | 1.81 | 0.10 | 0.00 | 0.06 | 0.08 | 1.01 | 22.87 | 0.23 | 1.11 | 0.09 | 0.00 | 0.06 | 0.00 | 0.07 | 0.00 | 0.10 | 3.15 | 29.16 | 0.01 |
| | GALVESTON | 0.05 | 0.05 | 0.06 | 0.64 | 0.04 | 0.00 | 0.02 | 0.03 | 0.39 | 8.83 | 0.09 | 0.44 | 0.04 | 0.00 | 0.03 | 0.00 | 0.42 | 0.00 | 0.04 | 1.26 | 11.25 | 0.01 |
| | ROBERTSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.23 | | 0.00 | | 0.00 | | 0.00 | 0.40 | 0.00 | 0.01 | 0.32 | 0.54 | 0.00 |
| | HARRIS | 0.05 | 0.05 | 0.07 | 0.74 | 0.04 | 0.00 | 0.02 | 0.03 | 0.41 | 9.29 | 0.09 | 0.44 | 0.04 | 0.00 | 0.02 | 0.00 | 0.03 | 0.00 | 0.04 | 1.26 | 11.80 | 0.01 |
| | HARDIN | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | JEFFERSON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | LIBERTY | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | MONTGOMERY | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | ORANGE | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | WALLER | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| El Paso Area | EL PASO | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| OTHER | RUSK | 0.01 | 0.01 | 0.01 | 0.11 | 0.01 | 0.00 | 0.01 | 0.01 | | 0.00 | | 0.00 | 0.01 | 0.00 | 0.04 | 0.00 | 0.01 | 0.00 | 0.07 | 2.21 | 2.34 | 0.00 |
| | CROCKETT | 0.14 | 0.14 | | 0.00 | 0.11 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.32 | 0.48 | 0.00 |
| | FREESTONE | 0.02 | 0.02 | 0.02 | 0.21 | 0.02 | 0.00 | 0.04 | 0.05 | 0.01 | 0.23 | | 0.00 | 0.03 | 0.00 | 0.12 | 0.00 | 0.04 | 0.00 | 0.22 | 6.94 | 7.45 | 0.00 |
| | CALHOUN | 0.19 | 0.19 | | 0.00 | 0.14 | 0.00 | 0.01 | 0.01 | | 0.00 | | 0.00 | 0.04 | 0.00 | 0.01 | 0.00 | | 0.00 | 0.01 | 0.32 | 0.52 | 0.00 |
| | HIDALGO | 0.13 | 0.13 | | 0.00 | 0.10 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.13 | 0.00 |
| | CAMERON | 0.14 | 0.14 | | 0.00 | 0.20 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.03 | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.32 | 0.46 | 0.00 |
| | WARD | 0.06 | 0.06 | 0.06 | 0.64 | 0.04 | 0.00 | 0.09 | 0.12 | 0.02 | 0.45 | 0.01 | 0.05 | 0.08 | 0.00 | 0.28 | 0.00 | 0.10 | 0.00 | 0.51 | 16.09 | 17.41 | 0.01 |
| | WEBB | 0.06 | 0.06 | | 0.00 | 0.05 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.01 | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.06 | 0.00 |
| | NUECES | 0.74 | 0.75 | 0.01 | 0.11 | 0.55 | 0.00 | 0.02 | 0.03 | 0.01 | 0.23 | 0.01 | 0.05 | 0.15 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.03 | 0.95 | 2.10 | 0.00 |
| | VICTORIA | 0.30 | 0.30 | 0.01 | 0.11 | 0.22 | 0.00 | 0.01 | 0.01 | | 0.00 | | 0.00 | 0.68 | 0.00 | 0.05 | 0.00 | | 0.00 | 0.01 | 0.32 | 0.74 | 0.00 |
| | GREGG | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | HARRISON | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | SMITH | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | UPSHUR | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | SAN PATRICIO | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.00 |
| | **TOTAL** | **2.89** | | **2.54** | | **2.22** | | **3.12** | | **2.48** | | **2.63** | | **3.27** | | **3.19** | | **1.54** | | **3.65** | | 218.05 | 0.11 |
| Energy Savings by PCA from ESL (MWh) | | 1.01 | | 10.63 | | 0.00 | | 1.31 | | 22.65 | | 4.84 | | 0.00 | | 0.00 | | 0.00 | | 31.55 | | | |

Table 42: 2003 Peak-day NOx Reductions From IECC / IRC by PCA for Multi-family Residences by County Using eGRID.

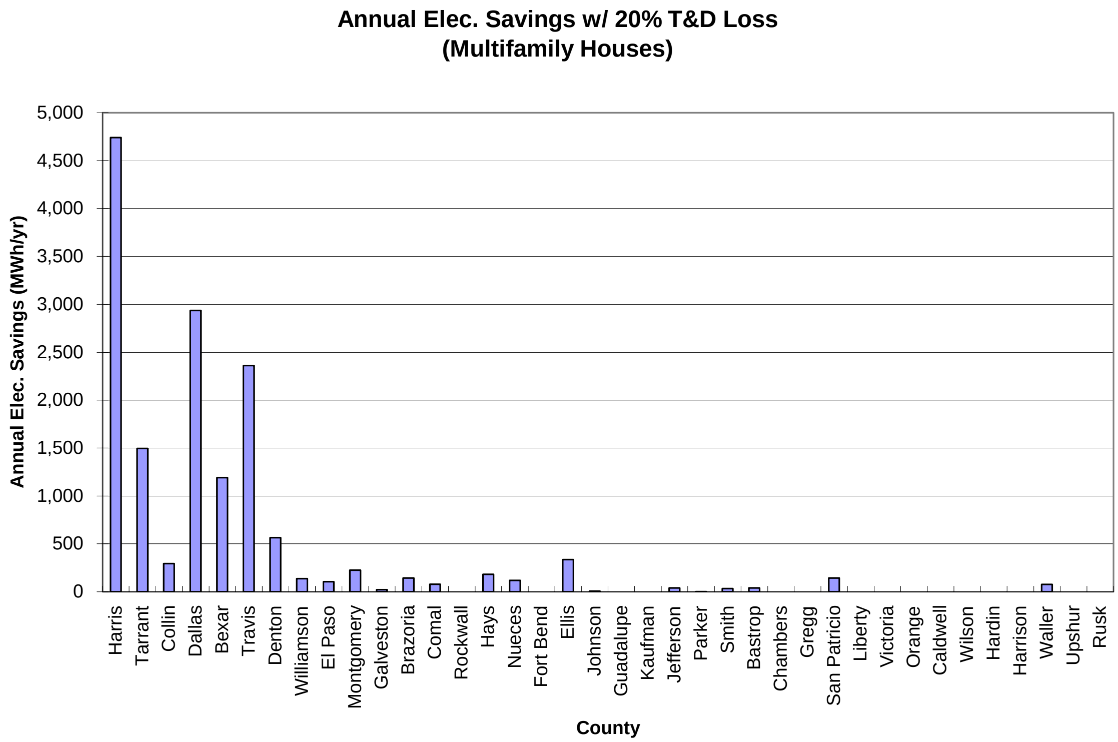
| Annual and Peak-day Electricity and NOx emissions reductions Using eGRID Method (For Multifamily Houses) | | | | | |
|---|---|---|---|---|---|
| | County | Total Annual Electricity Savings per County w/ 20% T&D Loss (MWh/County) | Annual Nox Reductions Calculated using eGRID (Tons) | Peak-day Electricity Savings per County w/ 20% T&D Loss (MWh/County) | Peak-day Nox Reductions Calculated Using eGRID (Tons) |
| Non-attainment Counties | Bastrop | 39 | 0.29 | 0.17 | 0.0013 |
| | Bexar | 1,191 | 1.33 | 4.84 | 0.0055 |
| | Caldwell | 0 | 0.00 | 0.00 | 0.0000 |
| | Comal | 79 | 0.00 | 0.32 | 0.0000 |
| | Ellis | 336 | 0.00 | 1.85 | 0.0000 |
| | Gregg | 0 | 0.00 | 0.00 | 0.0000 |
| | Guadalupe | 0 | 0.00 | 0.00 | 0.0000 |
| | Harrison | 0 | 0.00 | 0.00 | 0.0000 |
| | Hays | 181 | 0.00 | 0.82 | 0.0000 |
| | Johnson | 7 | 0.00 | 0.04 | 0.0000 |
| | Kaufman | 1 | 0.00 | 0.00 | 0.0000 |
| | Nueces | 118 | 0.23 | 0.46 | 0.0011 |
| | Parker | 2 | 0.00 | 0.01 | 0.0000 |
| | Rockwall | 0 | 0.00 | 0.00 | 0.0000 |
| | Rusk | 1 | 0.22 | 0.00 | 0.0012 |
| | San Patricio | 143 | 0.00 | 0.55 | 0.0000 |
| | Smith | 33 | 0.00 | 0.17 | 0.0000 |
| | Travis | 2,362 | 0.55 | 10.63 | 0.0025 |
| | Upshur | 0 | 0.00 | 0.00 | 0.0000 |
| | Victoria | 0 | 0.08 | 0.00 | 0.0004 |
| | Williamson | 138 | 0.00 | 0.62 | 0.0000 |
| | Wilson | 0 | 0.00 | 0.00 | 0.0000 |
| Affected Counties | Brazoria | 144 | 0.14 | 0.67 | 0.0006 |
| | Chambers | 0 | 1.09 | 0.00 | 0.0050 |
| | Collin | 293 | 0.10 | 1.52 | 0.0005 |
| | Dallas | 2,935 | 1.65 | 16.18 | 0.0088 |
| | Denton | 564 | 0.04 | 2.92 | 0.0002 |
| | El Paso | 106 | 0.00 | 0.56 | 0.0000 |
| | Fort Bend | 0 | 3.17 | 0.00 | 0.0146 |
| | Galveston | 22 | 1.22 | 0.10 | 0.0056 |
| | Hardin | 0 | 0.00 | 0.00 | 0.0000 |
| | Harris | 4,741 | 1.28 | 21.52 | 0.0059 |
| | Jefferson | 40 | 0.00 | 0.16 | 0.0000 |
| | Liberty | 0 | 0.00 | 0.00 | 0.0000 |
| | Montgomery | 225 | 0.00 | 1.02 | 0.0000 |
| | Orange | 0 | 0.00 | 0.00 | 0.0000 |
| | Tarrant | 1,495 | 1.07 | 8.24 | 0.0057 |
| | Waller | 77 | 0.00 | 0.35 | 0.0000 |
| Other Counties | WARD | | 1.63 | | 0.0087 |
| | MCLENNAN | | 1.28 | | 0.0068 |
| | MITCHELL | | 1.25 | | 0.0067 |
| | FAYETTE | | 1.35 | | 0.0061 |
| | HOOD | | 0.70 | | 0.0037 |
| | FREESTONE | | 0.70 | | 0.0037 |
| | FANNIN | | 0.55 | | 0.0029 |
| | YOUNG | | 0.52 | | 0.0028 |
| | CHEROKEE | | 0.31 | | 0.0016 |
| | TITUS | | 0.31 | | 0.0016 |
| | LLANO | | 0.18 | | 0.0008 |
| | PALO PINTO | | 0.11 | | 0.0006 |
| | HENDERSON | | 0.09 | | 0.0005 |
| | LIMESTONE | | 0.14 | | 0.0006 |
| | RED RIVER | | 0.06 | | 0.0003 |
| | GRIMES | | 0.07 | | 0.0003 |
| | CALHOUN | | 0.06 | | 0.0003 |
| | HASKELL | | 0.05 | | 0.0002 |
| | ROBERTSON | | 0.05 | | 0.0003 |
| | JONES | | 0.05 | | 0.0002 |
| | CROCKETT | | 0.05 | | 0.0002 |
| | CAMERON | | 0.05 | | 0.0002 |
| | BRAZOS | | 0.04 | | 0.0002 |
| | LAMAR | | 0.03 | | 0.0002 |
| | NOLAN | | 0.03 | | 0.0002 |
| | WHARTON | | 0.02 | | 0.0001 |
| | HIDALGO | | 0.02 | | 0.0001 |
| | FRIO | | 0.01 | | 0.0000 |
| | WEBB | | 0.01 | | 0.0000 |
| | COKE | | 0.00 | | 0.0000 |
| | COLEMAN | | 0.00 | | 0.0000 |
| | HARDEMAN | | 0.00 | | 0.0000 |
| | TAYLOR | | 0.00 | | 0.0000 |
| Total | | | 22.18 | | 0.1090 |

Table 43: 2003 Annual and Peak-day NOx Reductions From IECC / IRC by PCA for Multi-family Residences by County Using eGRID.

**Simulation Results for Multifamily Houses**

| | County | Climate Zone | No. of projected units (2003) | 2000 Annual Natural Gas Use (Therm/house) *(1999 Average Characteristics)* | 2003 Anuual Natural Gas Use (Therm/house) *(The 200 IECC Characteristics)* | Annual Natrual Gas Savings per House (Therm/House) | 2000 Total Annual Natural Gas Use (Therm/County) *(1999 Average Characteristics)* | 2003 Total Anuual Natural Gas Use (Therm/County) *(The 200 IECC Characteristics)* | Total Annual Natural Gas Savings per County (Therm/County) | Peak Date (2002 Report) | 2000 Peak-day Natural Gas Use (Therm/house) *(1999 Average Characteristics)* | 2003 Peak-day Natural Gas Use (Therm/house) *(The 2000 IECC Characteristics)* | Peak-day Natural Gas Savings per House (Therm/House) | 2000 Total Peak-day Natural Gas Use (Therm/County) *(1999 Average Characteristics)* | 2003 Total Peak-day Natural Gas Use (Therm/County) *(The 2000 IECC Characteristics)* | Peak-day Natural Gas Savings per County (MWh/County) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Affected County | Bastrop | 4 | 88 | 228 | 188 | 40 | 20,064 | 16,544 | 3,520 | 7/31 | 0.53 | 0.41 | 0.12 | 46.47 | 35.91 | 10.56 |
| | Bexar | 4 | 2,552 | 220 | 180 | 40 | 561,440 | 459,360 | 102,080 | 8/28 | 0.51 | 0.39 | 0.12 | 1,304.44 | 998.20 | 306.24 |
| | Caldwell | 4 | 0 | 228 | 188 | 40 | 0 | 0 | 0 | 7/31 | 0.53 | 0.41 | 0.12 | 0.00 | 0.00 | 0.00 |
| | Comal | 4 | 169 | 220 | 180 | 40 | 37,180 | 30,420 | 6,760 | 8/28 | 0.51 | 0.39 | 0.12 | 86.38 | 66.10 | 20.28 |
| | Ellis | 5 | 838 | 251 | 212 | 39 | 210,338 | 177,656 | 32,682 | 7/29 | 0.55 | 0.43 | 0.12 | 459.35 | 358.79 | 100.56 |
| | Gregg | 6 | 0 | 230 | 185 | 45 | 0 | 0 | 0 | 7/22 | 0.55 | 0.43 | 0.12 | 0.00 | 0.00 | 0.00 |
| | Guadalupe | 4 | 0 | 220 | 180 | 40 | 0 | 0 | 0 | 8/28 | 0.51 | 0.39 | 0.12 | 0.00 | 0.00 | 0.00 |
| | Harrison | 6 | 0 | 230 | 185 | 45 | 0 | 0 | 0 | 7/22 | 0.55 | 0.43 | 0.12 | 0.00 | 0.00 | 0.00 |
| | Hays | 5 | 411 | 228 | 187 | 41 | 93,708 | 76,857 | 16,851 | 7/31 | 0.53 | 0.41 | 0.12 | 217.02 | 167.70 | 49.32 |
| | Johnson | 5 | 17 | 251 | 212 | 39 | 4,267 | 3,604 | 663 | 7/29 | 0.55 | 0.43 | 0.12 | 9.32 | 7.28 | 2.04 |
| | Kaufman | 6 | 2 | 251 | 212 | 39 | 502 | 424 | 78 | 8/19 | 0.53 | 0.41 | 0.12 | 1.05 | 0.81 | 0.24 |
| | Nueces | 3 | 253 | 200 | 157 | 43 | 50,600 | 39,721 | 10,879 | 8/18 | 0.51 | 0.39 | 0.12 | 128.02 | 97.66 | 30.36 |
| | Parker | 6 | 4 | 251 | 212 | 39 | 1,004 | 848 | 156 | 8/19 | 0.53 | 0.41 | 0.12 | 2.11 | 1.63 | 0.48 |
| | Rockwall | 6 | 0 | 251 | 212 | 39 | 0 | 0 | 0 | 8/19 | 0.53 | 0.41 | 0.12 | 0.00 | 0.00 | 0.00 |
| | Rusk | 5 | 2 | 230 | 189 | 41 | 460 | 378 | 82 | 7/22 | 0.55 | 0.43 | 0.12 | 1.09 | 0.85 | 0.24 |
| | San Patricio | 3 | 306 | 200 | 157 | 43 | 61,200 | 48,042 | 13,158 | 8/18 | 0.51 | 0.39 | 0.12 | 154.84 | 118.12 | 36.72 |
| | Smith | 5 | 83 | 230 | 189 | 41 | 19,090 | 15,687 | 3,403 | 7/22 | 0.55 | 0.43 | 0.12 | 45.26 | 35.30 | 9.96 |
| | Travis | 5 | 5,349 | 228 | 187 | 41 | 1,219,572 | 1,000,263 | 219,309 | 7/31 | 0.53 | 0.41 | 0.12 | 2,824.48 | 2,182.60 | 641.88 |
| | Upshur | 6 | 0 | 230 | 185 | 45 | 0 | 0 | 0 | 7/22 | 0.55 | 0.43 | 0.12 | 0.00 | 0.00 | 0.00 |
| | Victoria | 3 | 0 | 209 | 167 | 42 | 0 | 0 | 0 | 9/2 | 0.50 | 0.38 | 0.12 | 0.00 | 0.00 | 0.00 |
| | Williamson | 5 | 312 | 228 | 187 | 41 | 71,136 | 58,344 | 12,792 | 7/31 | 0.53 | 0.41 | 0.12 | 164.75 | 127.31 | 37.44 |
| | Wilson | 4 | 0 | 220 | 180 | 40 | 0 | 0 | 0 | 8/28 | 0.51 | 0.39 | 0.12 | 0.00 | 0.00 | 0.00 |
| Non-attainment County | Brazoria | 3 | 343 | 220 | 180 | 40 | 75,460 | 61,740 | 13,720 | 7/29 | 0.53 | 0.41 | 0.12 | 181.84 | 140.68 | 41.16 |
| | Chambers | 4 | 0 | 219 | 178 | 41 | 0 | 0 | 0 | 9/1 | 0.52 | 0.40 | 0.12 | 0.00 | 0.00 | 0.00 |
| | Collin | 5 | 732 | 251 | 212 | 39 | 183,732 | 155,184 | 28,548 | 8/19 | 0.53 | 0.41 | 0.12 | 386.01 | 298.17 | 87.84 |
| | Dallas | 5 | 7,324 | 251 | 212 | 39 | 1,838,324 | 1,552,688 | 285,636 | 7/29 | 0.55 | 0.43 | 0.12 | 4,014.67 | 3,135.79 | 878.88 |
| | Denton | 6 | 1,406 | 251 | 212 | 39 | 352,906 | 298,072 | 54,834 | 8/19 | 0.53 | 0.41 | 0.12 | 741.43 | 572.71 | 168.72 |
| | El Paso | 6 | 251 | 244 | 199 | 45 | 61,244 | 49,949 | 11,295 | 7/12 | 0.61 | 0.49 | 0.12 | 152.59 | 122.47 | 30.12 |
| | Fort Bend | 4 | 0 | 220 | 180 | 40 | 0 | 0 | 0 | 7/29 | 0.53 | 0.41 | 0.12 | 0.00 | 0.00 | 0.00 |
| | Galveston | 3 | 52 | 220 | 180 | 40 | 11,440 | 9,360 | 2,080 | 7/29 | 0.53 | 0.41 | 0.12 | 27.57 | 21.33 | 6.24 |
| | Hardin | 4 | 0 | 219 | 178 | 41 | 0 | 0 | 0 | 9/1 | 0.52 | 0.40 | 0.12 | 0.00 | 0.00 | 0.00 |
| | Harris | 4 | 11,287 | 220 | 180 | 40 | 2,483,140 | 2,031,660 | 451,480 | 7/29 | 0.53 | 0.41 | 0.12 | 5,983.84 | 4,629.40 | 1,354.44 |
| | Jefferson | 4 | 94 | 219 | 178 | 41 | 20,586 | 16,732 | 3,854 | 9/1 | 0.52 | 0.40 | 0.12 | 48.47 | 37.19 | 11.28 |
| | Liberty | 4 | 0 | 219 | 178 | 41 | 0 | 0 | 0 | 9/1 | 0.52 | 0.40 | 0.12 | 0.00 | 0.00 | 0.00 |
| | Montgomery | 4 | 536 | 220 | 180 | 40 | 117,920 | 96,480 | 21,440 | 7/29 | 0.53 | 0.41 | 0.12 | 284.16 | 219.84 | 64.32 |
| | Orange | 4 | 0 | 219 | 178 | 41 | 0 | 0 | 0 | 9/1 | 0.52 | 0.40 | 0.12 | 0.00 | 0.00 | 0.00 |
| | Tarrant | 5 | 3,729 | 251 | 212 | 39 | 935,979 | 790,548 | 145,431 | 7/29 | 0.55 | 0.43 | 0.12 | 2,044.06 | 1,596.58 | 447.48 |
| | Waller | 4 | 183 | 220 | 180 | 40 | 40,260 | 32,940 | 7,320 | 7/29 | 0.53 | 0.41 | 0.12 | 97.02 | 75.06 | 21.96 |
| | TOTAL | | 36,323 | | | | 8,471,552 | 7,023,501 | 1,448,051 | | | | | 19,406.24 | 15,047.48 | **4,358.76** |

Table 44: 2003 Annual and Peak-day Natural Gas Savings Due to IECC / IRC for Multi-family Residences by County.



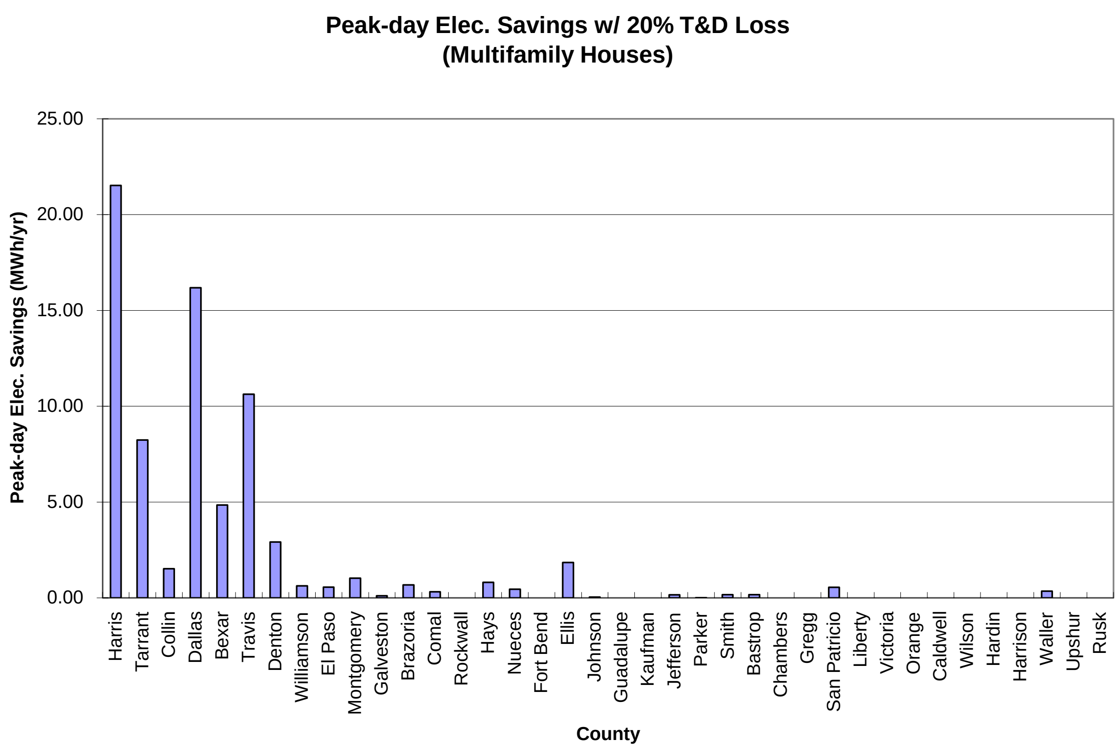
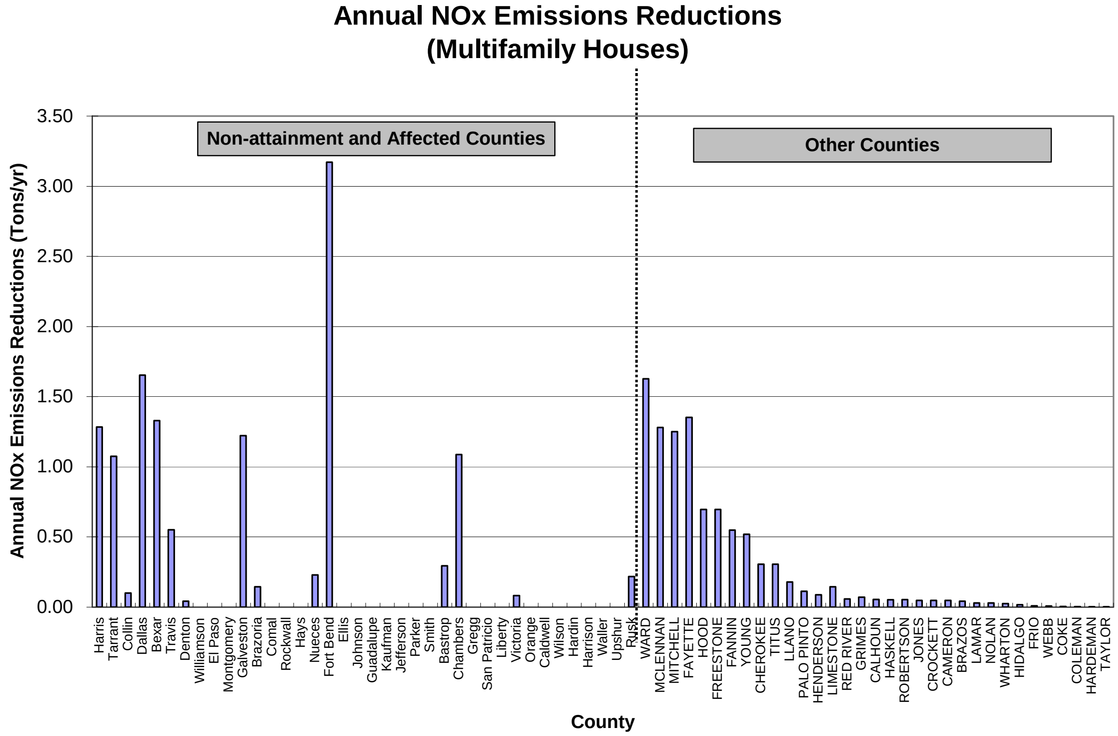




Figure 58: 2003 Annual and Peak-day Electricity Reductions From IECC / IRC by PCA for Multi-family Residences by County Using eGRID.



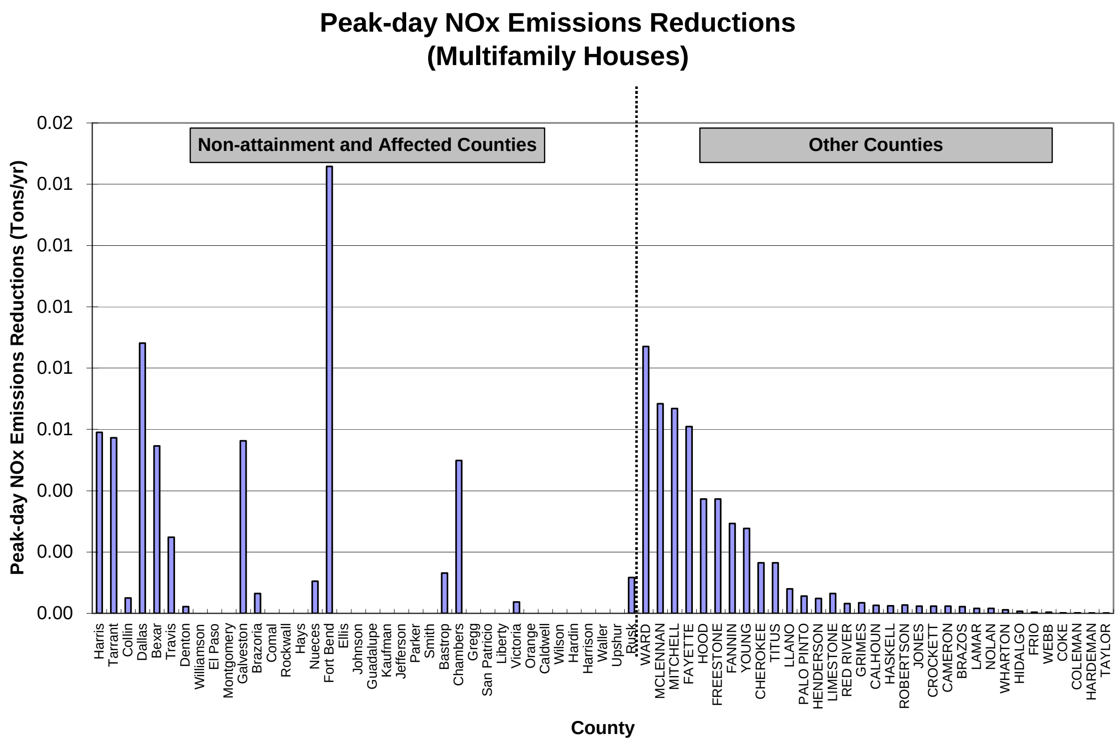




Figure 59: Annual and Peak-day NOx Reductions From IECC / IRC by PCA for Multi-family Residences by County Using eGRID.

## 8.4 Calculated 2003 Emissions Reduction From Electricity and Natural Gas Savings Due to the Implementation of the IECC / IRC to New Residential Construction (Single-family and Multi-family).

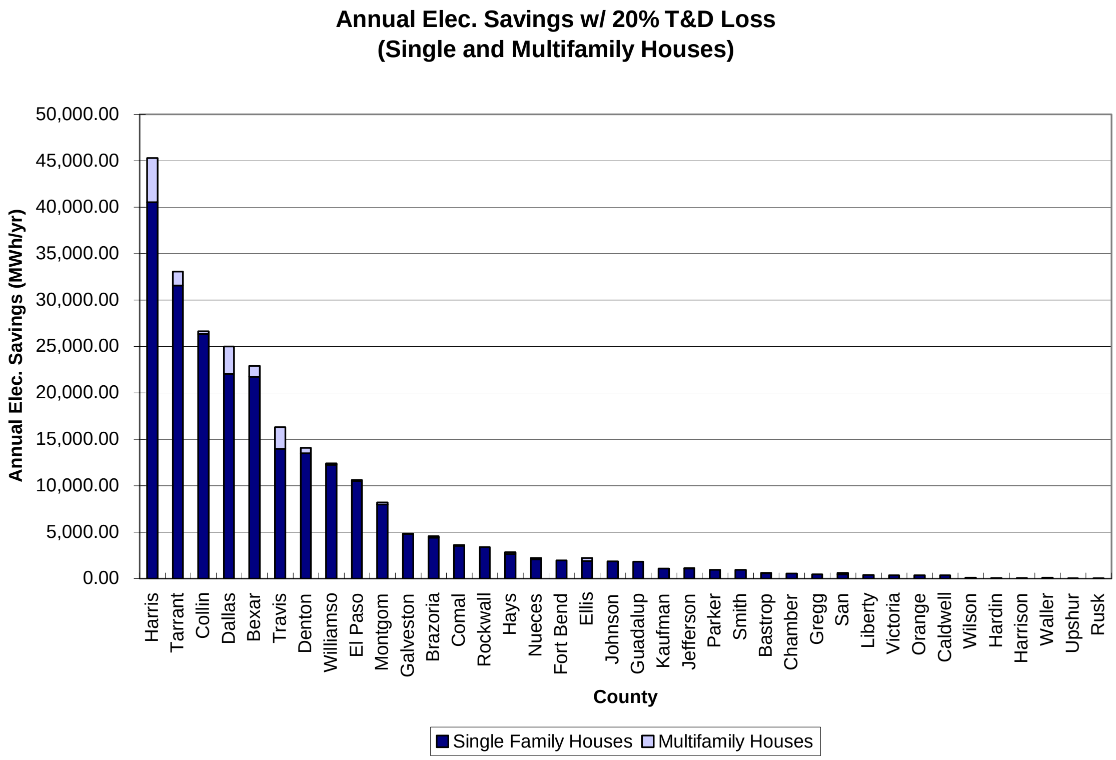
In Table 45 the combined NOx emissions reduction are listed from single-family electricity savings, multi-family electricity savings, and natural gas savings (single-family and multi-family). In Figure 60 and Figure 61 the annual and peak-day electricity savings are shown for the combined single-family and multi-family savings. Figure 62 and Figure 63 present the combined total NOx reductions from electricity and natural gas savings in single-family and multi-family households in the 38 non-attainment and affected counties, and those counties calculated by eGRID to have electricity power production facilities.

The total NOx reductions from electricity and natural gas savings from new construction in 2003 are calculated to be 472.67 tons NOx/year, which represents 340.43 tons NOx/year (72.0%) from single-family residential, 22.18 tons NOx/year (4.7%) from multi-family residential, and 110.06 tons NOx/year (23.3%) from natural gas savings from single-family and multi-family residential. On a peak summer day the NOx reductions in 2003 are calculated to be 2.44 tons of NOx/day, which represents 2.13 tons NOx/day (87.3%) from single-family residential, 0.11 tons NOx/day (4.5%) from multi-family residential, and 0.198 tons NOx/day (8.2%) from natural gas savings from single-family and multi-family residential.

In Figure 62 and Figure 63 it is worth pointing out that the comparative magnitude of the annual and peak-day NOx emissions reduction from natural gas compared to savings from electricity vary significantly, as is expected since the annual savings include heating period NOx emissions reduction, and the peak-day (i.e., cooling) savings include only those savings associated with the elimination of pilot lights. This can be identified by comparing the size of the natural gas portion of the stacked-bar figure for each county. In the annual NOx reduction graph (Figure 62) this portion is about the same size as the contribution from electricity savings in non-attainment and affected counties. Whereas, the natural gas portion of the peak-day savings (Figure 63) is significantly smaller. Furthermore, the savings from the natural gas reductions remain in the counties where the houses are built (i.e., they are not distributed to other counties using eGRID as were the electricity savings).

| County | Single Family Houses | | | | Multifamily Houses | | | | Natural Gas | | | | Combined | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Annual Electricity Savings per County w/ 20% T&D Loss (MWh/County) | Annual NOx Reductions (Tons) | Peak-day Electricity Savings per County w/ 20% T&D Loss (MWh/County) | Peak-day NOx Reductions (Tons) | Total Annual Electricity Savings per County w/ 20% T&D Loss (MWh/County) | Annual NOx Reductions (Tons) | Peak-day Electricity Savings per County w/ 20% T&D Loss (MWh/County) | Peak-day NOx Reductions (Tons) | Total Annual N.G. Savings (Therm/County) | Annual NOx Reductions (Tons) | Total Peak-day N.G. Savings (Therm/County) | Peak-day NOx Reductions (Tons) | Total Annual Electricity Savings per County w/ 20% T&D Loss (MWh/County) | Annual NOx Reductions (Tons) | Peak-day Electricity Savings per County w/ 20% T&D Loss (MWh/County) | Peak-day NOx Reductions (Tons) |
| Harris | 40,540.39 | 14.56 | 232.1034 | 0.0848 | 4,740.54 | 1.28 | 21.5221 | 0.0059 | 1,401,308 | 17.38 | 3,944.88 | 0.0489 | 45,280.93 | 33.22 | 253.6255 | 0.1397 |
| Tarrant | 31,575.96 | 20.36 | 221.6916 | 0.1354 | 1,494.58 | 1.07 | 8.2381 | 0.0057 | 1,256,931 | 15.59 | 1,851.48 | 0.0230 | 33,070.54 | 37.02 | 229.9297 | 0.1641 |
| Collin | 26,355.41 | 1.59 | 169.0878 | 0.0103 | 293.39 | 0.10 | 1.5179 | 0.0005 | 1,131,042 | 14.02 | 1,248.36 | 0.0155 | 26,648.79 | 15.72 | 170.6056 | 0.0263 |
| Dallas | 22,049.20 | 31.35 | 154.8052 | 0.2087 | 2,935.46 | 1.65 | 16.1802 | 0.0088 | 1,061,786 | 13.17 | 1,859.28 | 0.0231 | 24,984.66 | 46.17 | 170.9853 | 0.2406 |
| Bexar | 21,742.68 | 23.19 | 100.9902 | 0.1093 | 1,191.27 | 1.33 | 4.8447 | 0.0055 | 662,063 | 8.21 | 1,226.76 | 0.0152 | 22,933.96 | 32.72 | 105.8350 | 0.1300 |
| Travis | 13,968.36 | 3.44 | 89.4785 | 0.0218 | 2,362.12 | 0.55 | 10.6295 | 0.0025 | 624,189 | 7.74 | 1,220.28 | 0.0151 | 16,330.48 | 11.73 | 100.1080 | 0.0394 |
| Denton | 13,519.72 | 0.69 | 86.7381 | 0.0046 | 563.52 | 0.04 | 2.9155 | 0.0002 | 620,380 | 7.69 | 764.04 | 0.0095 | 14,083.24 | 8.43 | 89.6536 | 0.0143 |
| Williamson | 12,255.64 | 0.00 | 78.5072 | 0.0000 | 137.78 | 0.00 | 0.6200 | 0.0000 | 368,028 | 4.56 | 544.92 | 0.0068 | 12,393.42 | 4.56 | 79.1272 | 0.0068 |
| El Paso | 10,501.44 | 0.00 | 61.4719 | 0.0000 | 106.02 | 0.00 | 0.5551 | 0.0000 | 411,079 | 5.10 | 436.68 | 0.0054 | 10,607.47 | 5.10 | 62.0270 | 0.0054 |
| Montgomery | 7,975.87 | 0.00 | 45.6637 | 0.0000 | 225.12 | 0.00 | 1.0220 | 0.0000 | 208,308 | 2.58 | 573.96 | 0.0071 | 8,200.99 | 2.58 | 46.6858 | 0.0071 |
| Galveston | 4,815.19 | 13.97 | 27.5681 | 0.0814 | 21.84 | 1.22 | 0.1023 | 0.0056 | 114,896 | 1.42 | 313.92 | 0.0039 | 4,837.03 | 16.62 | 27.6704 | 0.0910 |
| Brazoria | 4,411.42 | 1.49 | 25.2564 | 0.0084 | 144.06 | 0.14 | 0.6746 | 0.0006 | 117,076 | 1.45 | 323.04 | 0.0040 | 4,555.48 | 3.08 | 25.9311 | 0.0131 |
| Comal | 3,537.33 | 0.00 | 16.4302 | 0.0000 | 78.89 | 0.00 | 0.3208 | 0.0000 | 97,864 | 1.21 | 170.04 | 0.0021 | 3,616.22 | 1.21 | 16.7510 | 0.0021 |
| Rockwall | 3,395.60 | 0.00 | 21.7851 | 0.0000 | 0.00 | 0.00 | 0.0000 | 0.0000 | 142,044 | 1.76 | 149.52 | 0.0019 | 3,395.60 | 1.76 | 21.7851 | 0.0019 |
| Hays | 2,663.26 | 0.00 | 17.0603 | 0.0000 | 181.50 | 0.00 | 0.8167 | 0.0000 | 94,047 | 1.17 | 159.60 | 0.0020 | 2,844.76 | 1.17 | 17.8771 | 0.0020 |
| Nueces | 2,098.48 | 3.35 | 10.1645 | 0.0199 | 118.40 | 0.23 | 0.4584 | 0.0011 | 56,419 | 0.70 | 151.80 | 0.0019 | 2,216.89 | 4.28 | 10.6230 | 0.0229 |
| Fort Bend | 1,958.75 | 36.09 | 11.2143 | 0.2102 | 0.00 | 3.17 | 0.0000 | 0.0146 | 45,892 | 0.57 | 125.16 | 0.0016 | 1,958.75 | 39.83 | 11.2143 | 0.2263 |
| Ellis | 1,908.05 | 0.00 | 13.3962 | 0.0000 | 335.87 | 0.00 | 1.8513 | 0.0000 | 99,847 | 1.24 | 185.40 | 0.0023 | 2,243.92 | 1.24 | 15.2475 | 0.0023 |
| Johnson | 1,854.08 | 0.00 | 13.0173 | 0.0000 | 6.81 | 0.00 | 0.0376 | 0.0000 | 65,928 | 0.82 | 84.48 | 0.0010 | 1,860.89 | 0.82 | 13.0548 | 0.0010 |
| Guadalupe | 1,831.02 | 0.00 | 8.5047 | 0.0000 | 0.00 | 0.00 | 0.0000 | 0.0000 | 47,158 | 0.58 | 77.52 | 0.0010 | 1,831.02 | 0.58 | 8.5047 | 0.0010 |
| Kaufman | 1,098.26 | 0.00 | 7.0461 | 0.0000 | 0.80 | 0.00 | 0.0041 | 0.0000 | 46,020 | 0.57 | 48.60 | 0.0006 | 1,099.06 | 0.57 | 7.0502 | 0.0006 |
| Jefferson | 1,078.85 | 0.00 | 5.6106 | 0.0000 | 39.82 | 0.00 | 0.1620 | 0.0000 | 28,249 | 0.35 | 82.68 | 0.0010 | 1,118.67 | 0.35 | 5.7726 | 0.0010 |
| Parker | 940.19 | 0.00 | 6.0320 | 0.0000 | 1.60 | 0.00 | 0.0083 | 0.0000 | 39,406 | 0.49 | 41.88 | 0.0005 | 941.80 | 0.49 | 6.0403 | 0.0005 |
| Smith | 933.87 | 0.00 | 6.3112 | 0.0000 | 33.07 | 0.00 | 0.1722 | 0.0000 | 12,005 | 0.15 | 70.68 | 0.0009 | 966.94 | 0.15 | 6.4834 | 0.0009 |
| Bastrop | 592.37 | 3.06 | 3.7771 | 0.0178 | 39.39 | 0.29 | 0.1698 | 0.0013 | 19,215 | 0.24 | 36.36 | 0.0005 | 631.76 | 3.60 | 3.9469 | 0.0195 |
| Chambers | 540.33 | 12.25 | 2.8100 | 0.0711 | 0.00 | 1.09 | 0.0000 | 0.0050 | 12,218 | 0.15 | 35.76 | 0.0004 | 540.33 | 13.49 | 2.8100 | 0.0765 |
| Gregg | 492.13 | 0.00 | 3.2809 | 0.0000 | 0.00 | 0.00 | 0.0000 | 0.0000 | 17,152 | 0.21 | 30.72 | 0.0004 | 492.13 | 0.21 | 3.2809 | 0.0004 |
| San Patricio | 474.85 | 0.00 | 2.3001 | 0.0000 | 143.21 | 0.00 | 0.5545 | 0.0000 | 23,463 | 0.29 | 64.20 | 0.0008 | 618.06 | 0.29 | 2.8545 | 0.0008 |
| Liberty | 406.16 | 0.00 | 2.1122 | 0.0000 | 0.00 | 0.00 | 0.0000 | 0.0000 | 9,104 | 0.11 | 26.88 | 0.0003 | 406.16 | 0.11 | 2.1122 | 0.0003 |
| Victoria | 362.27 | 1.14 | 1.9181 | 0.0067 | 0.00 | 0.08 | 0.0000 | 0.0004 | 7,654 | 0.09 | 21.36 | 0.0003 | 362.27 | 1.31 | 1.9181 | 0.0074 |
| Orange | 357.20 | 0.00 | 1.8576 | 0.0000 | 0.00 | 0.00 | 0.0000 | 0.0000 | 8,077 | 0.10 | 23.64 | 0.0003 | 357.20 | 0.10 | 1.8576 | 0.0003 |
| Caldwell | 355.42 | 0.00 | 2.2663 | 0.0000 | 0.00 | 0.00 | 0.0000 | 0.0000 | 9,417 | 0.12 | 15.48 | 0.0002 | 355.42 | 0.12 | 2.2663 | 0.0002 |
| Wilson | 102.04 | 0.00 | 0.4739 | 0.0000 | 0.00 | 0.00 | 0.0000 | 0.0000 | 2,628 | 0.03 | 4.32 | 0.0001 | 102.04 | 0.03 | 0.4739 | 0.0001 |
| Hardin | 85.22 | 0.00 | 0.4432 | 0.0000 | 0.00 | 0.00 | 0.0000 | 0.0000 | 1,927 | 0.02 | 5.64 | 0.0001 | 85.22 | 0.02 | 0.4432 | 0.0001 |
| Harrison | 80.74 | 0.00 | 0.5383 | 0.0000 | 0.00 | 0.00 | 0.0000 | 0.0000 | 2,814 | 0.03 | 5.04 | 0.0001 | 80.74 | 0.03 | 0.5383 | 0.0001 |
| Waller | 43.19 | 0.00 | 0.2473 | 0.0000 | 76.86 | 0.00 | 0.3489 | 0.0000 | 8,332 | 0.10 | 24.72 | 0.0003 | 120.05 | 0.10 | 0.5962 | 0.0003 |
| Upshur | 34.60 | 0.00 | 0.2307 | 0.0000 | 0.00 | 0.00 | 0.0000 | 0.0000 | 1,206 | 0.01 | 2.16 | 0.0000 | 34.60 | 0.01 | 0.2307 | 0.0000 |
| Rusk | 29.53 | 4.19 | 0.1996 | 0.0280 | 0.80 | 0.22 | 0.0041 | 0.0012 | 354 | 0.00 | 2.16 | 0.0000 | 30.33 | 4.41 | 0.2037 | 0.0292 |
| WARD | | 31.09 | | 0.2073 | | 1.63 | | 0.0087 | | | | | 0.00 | 32.72 | 0.0000 | 0.2160 |
| MCLENNAN | | 24.46 | | 0.1629 | | 1.28 | | 0.0068 | | | | | 0.00 | 25.74 | 0.0000 | 0.1698 |
| MITCHELL | | 23.88 | | 0.1590 | | 1.25 | | 0.0067 | | | | | 0.00 | 25.13 | 0.0000 | 0.1657 |
| FAYETTE | | 14.74 | | 0.0865 | | 1.35 | | 0.0061 | | | | | 0.00 | 16.10 | 0.0000 | 0.0926 |
| HOOD | | 13.36 | | 0.0891 | | 0.70 | | 0.0037 | | | | | 0.00 | 14.05 | 0.0000 | 0.0928 |
| FREESTONE | | 13.36 | | 0.0891 | | 0.70 | | 0.0037 | | | | | 0.00 | 14.05 | 0.0000 | 0.0928 |
| FANNIN | | 10.41 | | 0.0694 | | 0.55 | | 0.0029 | | | | | 0.00 | 10.96 | 0.0000 | 0.0723 |
| YOUNG | | 9.83 | | 0.0655 | | 0.52 | | 0.0028 | | | | | 0.00 | 10.35 | 0.0000 | 0.0683 |
| CHEROKEE | | 5.97 | | 0.0399 | | 0.31 | | 0.0016 | | | | | 0.00 | 6.28 | 0.0000 | 0.0416 |
| TITUS | | 5.97 | | 0.0399 | | 0.31 | | 0.0016 | | | | | 0.00 | 6.28 | 0.0000 | 0.0416 |
| LLANO | | 1.90 | | 0.0110 | | 0.18 | | 0.0008 | | | | | 0.00 | 2.08 | 0.0000 | 0.0118 |
| PALO PINTO | | 1.71 | | 0.0110 | | 0.11 | | 0.0006 | | | | | 0.00 | 1.82 | 0.0000 | 0.0115 |
| HENDERSON | | 1.78 | | 0.0119 | | 0.09 | | 0.0005 | | | | | 0.00 | 1.87 | 0.0000 | 0.0124 |
| LIMESTONE | | 1.49 | | 0.0084 | | 0.14 | | 0.0006 | | | | | 0.00 | 1.63 | 0.0000 | 0.0091 |
| RED RIVER | | 1.16 | | 0.0078 | | 0.06 | | 0.0003 | | | | | 0.00 | 1.22 | 0.0000 | 0.0081 |
| GRIMES | | 1.01 | | 0.0064 | | 0.07 | | 0.0003 | | | | | 0.00 | 1.08 | 0.0000 | 0.0067 |
| CALHOUN | | 0.90 | | 0.0055 | | 0.06 | | 0.0003 | | | | | 0.00 | 0.96 | 0.0000 | 0.0058 |
| HASKELL | | 0.86 | | 0.0053 | | 0.05 | | 0.0002 | | | | | 0.00 | 0.91 | 0.0000 | 0.0055 |
| ROBERTSON | | 0.84 | | 0.0054 | | 0.05 | | 0.0003 | | | | | 0.00 | 0.89 | 0.0000 | 0.0056 |
| JONES | | 0.78 | | 0.0049 | | 0.05 | | 0.0002 | | | | | 0.00 | 0.83 | 0.0000 | 0.0051 |
| CROCKETT | | 0.78 | | 0.0049 | | 0.05 | | 0.0002 | | | | | 0.00 | 0.83 | 0.0000 | 0.0051 |
| CAMERON | | 0.78 | | 0.0049 | | 0.05 | | 0.0002 | | | | | 0.00 | 0.83 | 0.0000 | 0.0051 |
| BRAZOS | | 0.69 | | 0.0046 | | 0.04 | | 0.0002 | | | | | 0.00 | 0.74 | 0.0000 | 0.0048 |
| LAMAR | | 0.58 | | 0.0039 | | 0.03 | | 0.0002 | | | | | 0.00 | 0.61 | 0.0000 | 0.0040 |
| NOLAN | | 0.58 | | 0.0039 | | 0.03 | | 0.0002 | | | | | 0.00 | 0.61 | 0.0000 | 0.0040 |
| WHARTON | | 0.26 | | 0.0015 | | 0.02 | | 0.0001 | | | | | 0.00 | 0.28 | 0.0000 | 0.0016 |
| HIDALGO | | 0.19 | | 0.0009 | | 0.02 | | 0.0001 | | | | | 0.00 | 0.21 | 0.0000 | 0.0010 |
| FRIO | | 0.12 | | 0.0006 | | 0.01 | | 0.0000 | | | | | 0.00 | 0.13 | 0.0000 | 0.0006 |
| WEBB | | 0.09 | | 0.0004 | | 0.01 | | 0.0000 | | | | | 0.00 | 0.10 | 0.0000 | 0.0005 |
| COKE | | 0.04 | | 0.0002 | | 0.00 | | 0.0000 | | | | | 0.00 | 0.05 | 0.0000 | 0.0002 |
| COLEMAN | | 0.03 | | 0.0001 | | 0.00 | | 0.0000 | | | | | 0.00 | 0.03 | 0.0000 | 0.0002 |
| HARDEMAN | | 0.01 | | 0.0001 | | 0.00 | | 0.0000 | | | | | 0.00 | 0.02 | 0.0000 | 0.0001 |
| TAYLOR | | 0.01 | | 0.0001 | | 0.00 | | 0.0000 | | | | | 0.00 | 0.02 | 0.0000 | 0.0001 |
| Total | 236,965.09 | 340.43 | 1,452.39 | 2.13 | 15,272.73 | 22.18 | 73.73 | 0.11 | 8,875,694 | 110.06 | 15,953.40 | 0.1978 | 252,237.82 | 472.67 | 1,526.12 | 2.44 |

Table 45: 2003 Annual and Peak-Day NOx Reductions From Electricity and Natural Gas Savings Due to the IECC / IRC for Single-family and Multi-family Residences by County.



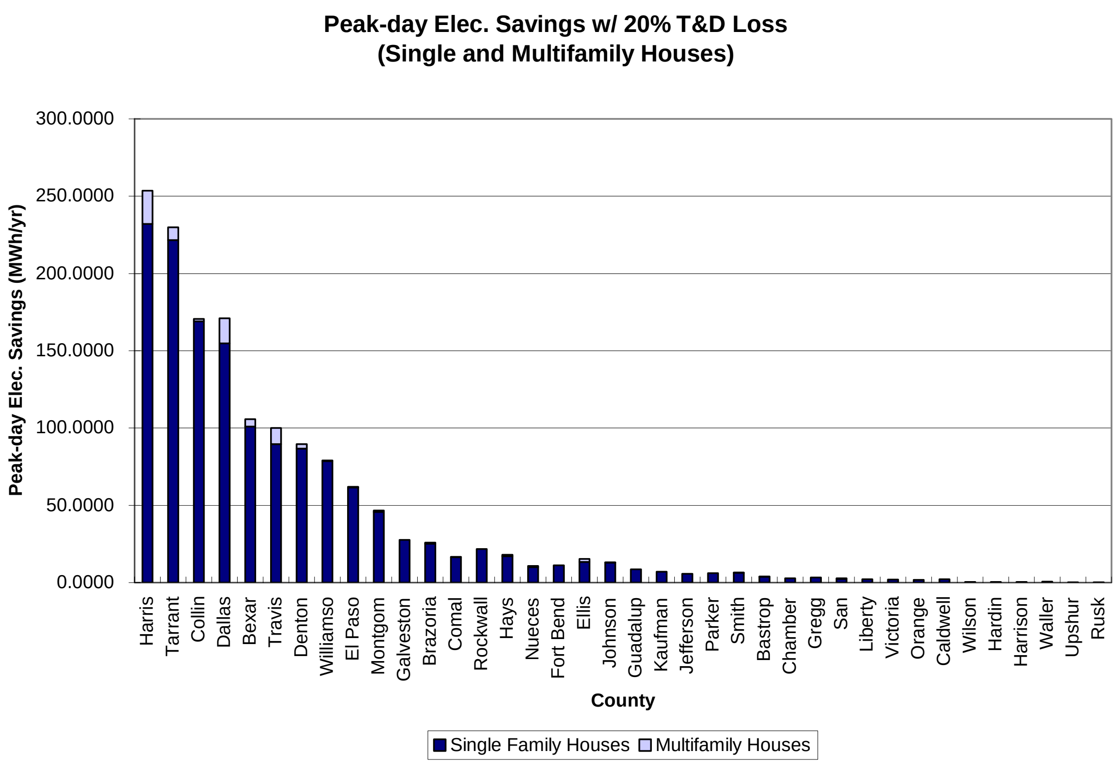
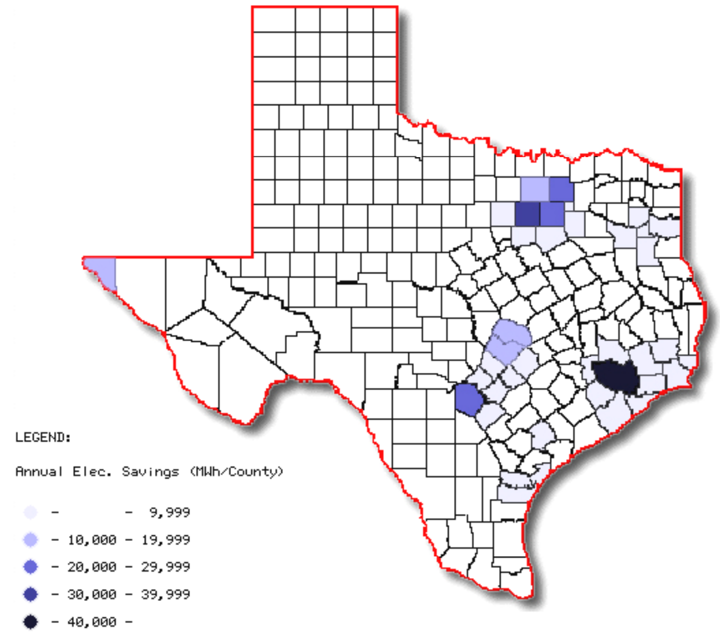




Figure 60: 2003 Annual and Peak-day Electricity Reductions From IECC / IRC by PCA for Single-family and Multi-family Residences by County Using eGRID.



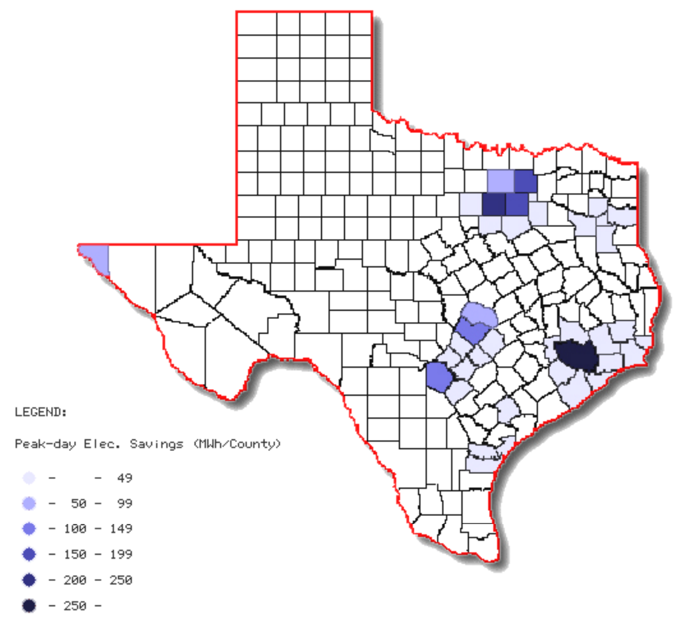
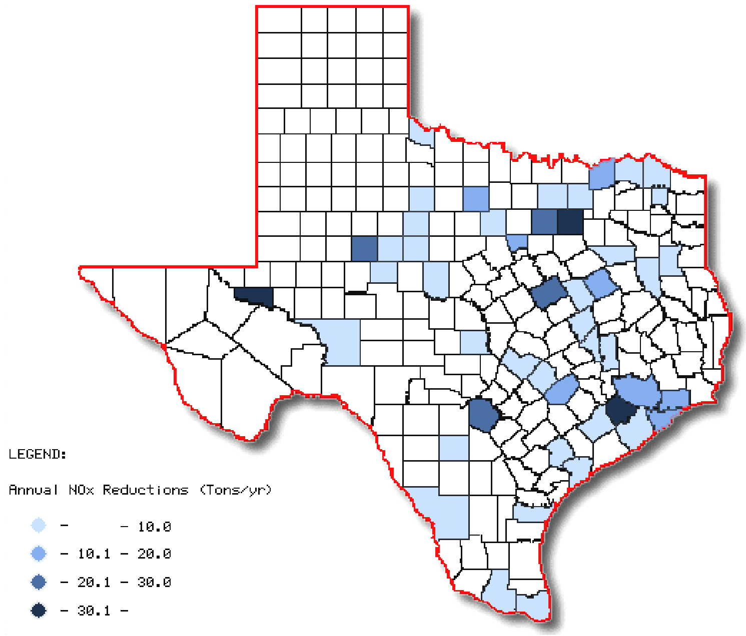




Figure 61: 2003 Annual and Peak-day Electricity Reductions From IECC / IRC by PCA for Single-family and Multi-family Residences by County Using eGRID.



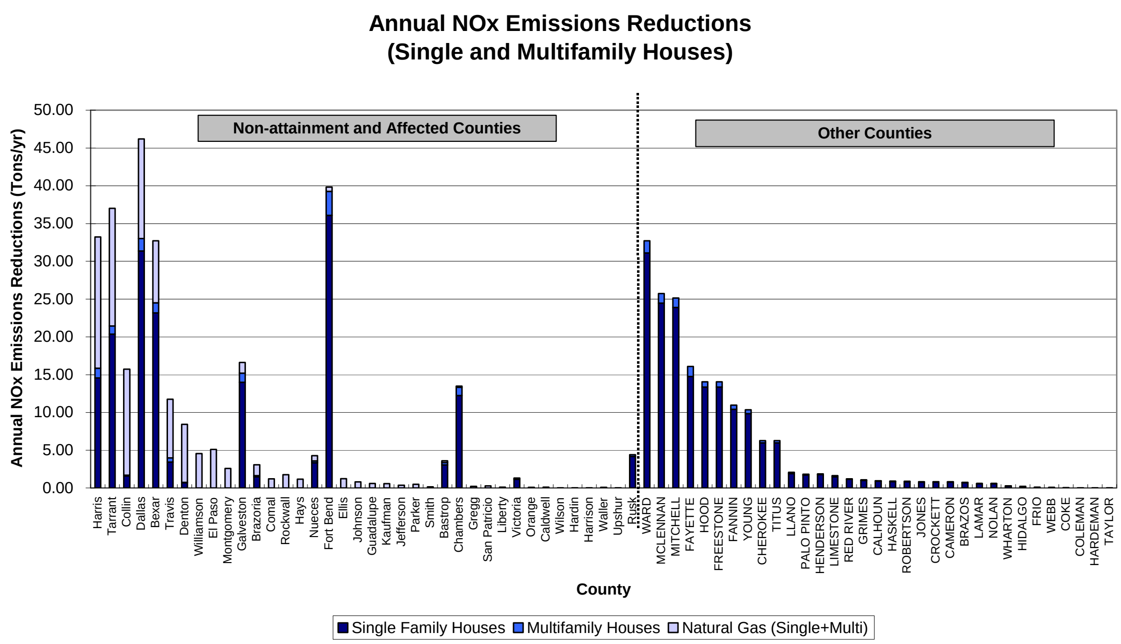
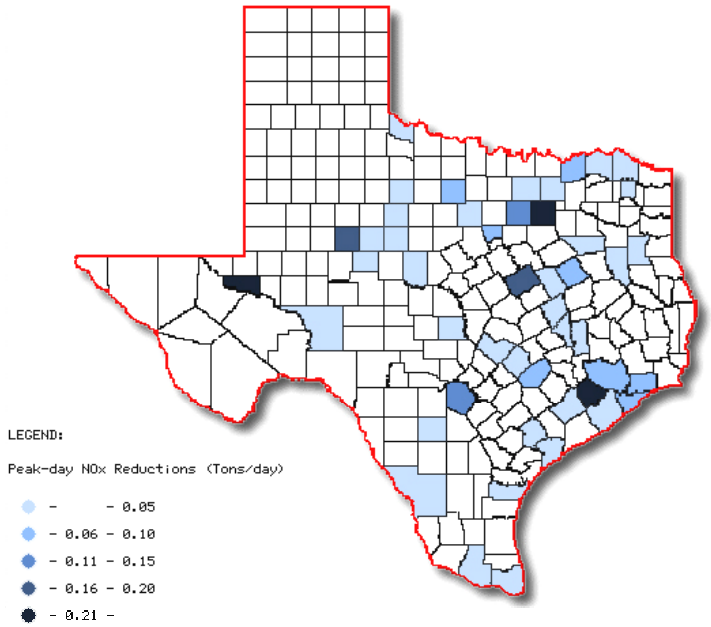




Figure 62: 2003 Annual NOx Reductions From Electricity and Natural Gas Savings Due to the IECC / IRC for Single-family and Multi-family Residences by County.



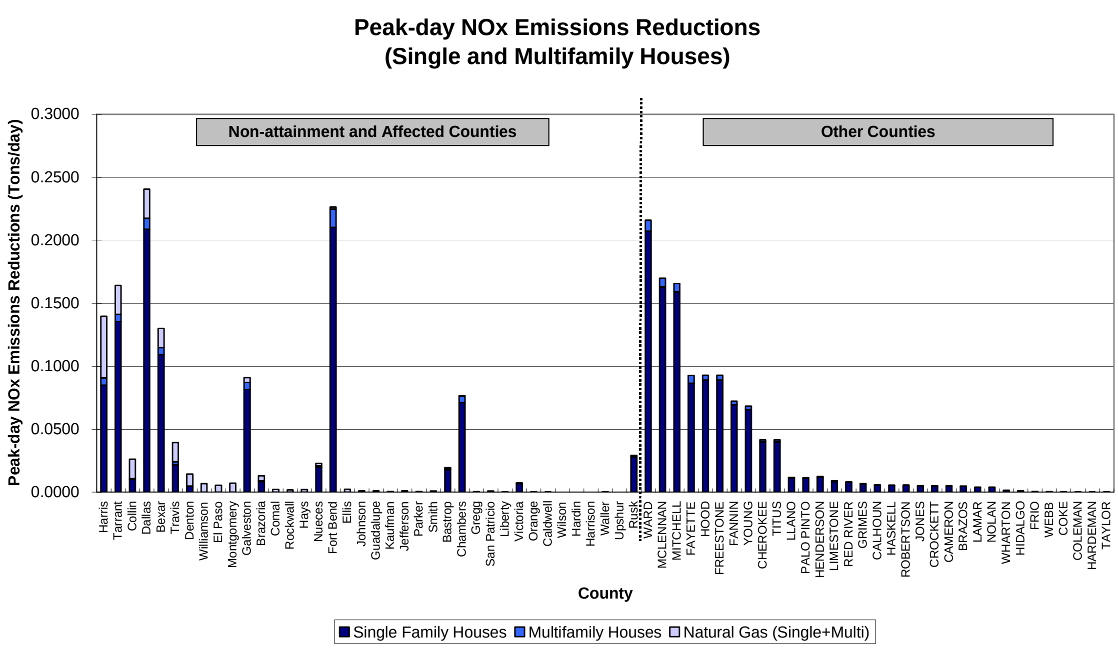




Figure 63: 2003 Peak Day NOx Reductions From Electricity and Natural Gas Savings Due to the IECC / IRC for Single-family and Multi-family Residences by County.

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# 10 APPENDIX

## 10.1 Residential Builder's Guide.

### Texas Residential Building Envelope Requirements

**Simplified Prescriptive Paths for Envelope compliance with the International Residential Code (IRC 2000)**

| Climate Zone | Path | Glazing and Insulation: Glazing Area% | Glazing U-Factor | Glazing SHGC[1] | Ceiling | Wall | Foundation Type: Floor | Basement Wall | Slab Perimeter | Crawl Space Wall |
|---|---|---|---|---|---|---|---|---|---|---|
| 9 (4,000-4,499 HDD[3]) | 1 | 15 | .45 | N/S | R-38 | R-13 | R-19 | R-8 | R-5, 2ft | R-11 |
| | 2 | 20 | .37 | N/S | R-38 | R-13 | R-19 | R-9 | R-6, 2ft | R-13 |
| | 3 | 25 | .37 | N/S | R-38 | R-19 | R-19 | R-9 | R-6, 2ft | R-13 |
| 8 (3,500-3,999 HDD) | 1 | 15 | .50 | N/S | R-30 | R-13 | R-19 | R-8 | R-5, 2ft | R-10 |
| | 2 | 20 | .42 | N/S | R-38 | R-13 | R-19 | R-8 | R-6, 2ft | R-10 |
| | 3 | 25 | .41 | N/S | R-38 | R-19 | R-19 | R-8 | R-6, 2ft | R-10 |
| 7 (3,000-3,499 HDD) | 1 | 15 | .55 | .40 | R-30 | R-13 | R-19 | R-7 | [2]R-4, 2ft | R-8 |
| | 2 | 20 | .46 | .40 | R-38 | R-13 | R-19 | R-7 | R-0 | R-8 |
| | 3 | 25 | .45 | .40 | R-38 | R-19 | R-19 | R-7 | R-0 | R-8 |
| 6 (2,500-2,999 HDD) | 1 | 15 | .60 | .40 | R-30 | R-13 | R-19 | R-6 | [2]R-4, 2ft | R-7 |
| | 2 | 20 | .50 | .40 | R-38 | R-13 | R-19 | R-6 | R-0 | R-7 |
| | 3 | 25 | .46 | .40 | R-38 | R-16 | R-19 | R-6 | R-0 | R-7 |
| 5 (2,000-2,499 HDD) | 1 | 15 | .65 | .40 | R-30 | R-13 | R-11 | R-5 | R-0 | R-6 |
| | 2 | 20 | .52 | .40 | R-38 | R-13 | R-11 | R-5 | R-0 | R-6 |
| | 3 | 25 | .50 | .40 | R-38 | R-13 | R-19 | R-8 | R-0 | R-10 |
| 4 (1,500-1,999 HDD) | 1 | 15 | .75 | .40 | R-26 | R-13 | R-11 | R-5 | R-0 | R-5 |
| | 2 | 20 | .60 | .40 | R-30 | R-13 | R-11 | R-5 | R-0 | R-5 |
| | 3 | 25 | .52 | .40 | R-30 | R-13 | R-13 | R-6 | R-0 | R-6 |
| 3 (1,000-1,499 HDD) | 1 | 15 | .75 | .40 | R-19 | R-11 | R-11 | R-0 | R-0 | R-5 |
| | 2 | 20 | .70 | .40 | R-30 | R-13 | R-11 | R-0 | R-0 | R-5 |
| | 3 | 25 | .55 | .40 | R-30 | R-13 | R-11 | R-0 | R-0 | R-5 |
| 2 (500-999 HDD) | 1 | 15 | .90 | .40 | R-19 | R-11 | R-11 | R-0 | R-0 | R-4 |
| | 2 | 20 | .75 | .40 | R-30 | R-13 | R-11 | R-0 | R-0 | R-4 |
| | 3 | 25 | .65 | .40 | R-30 | R-13 | R-11 | R-0 | R-0 | R-4 |

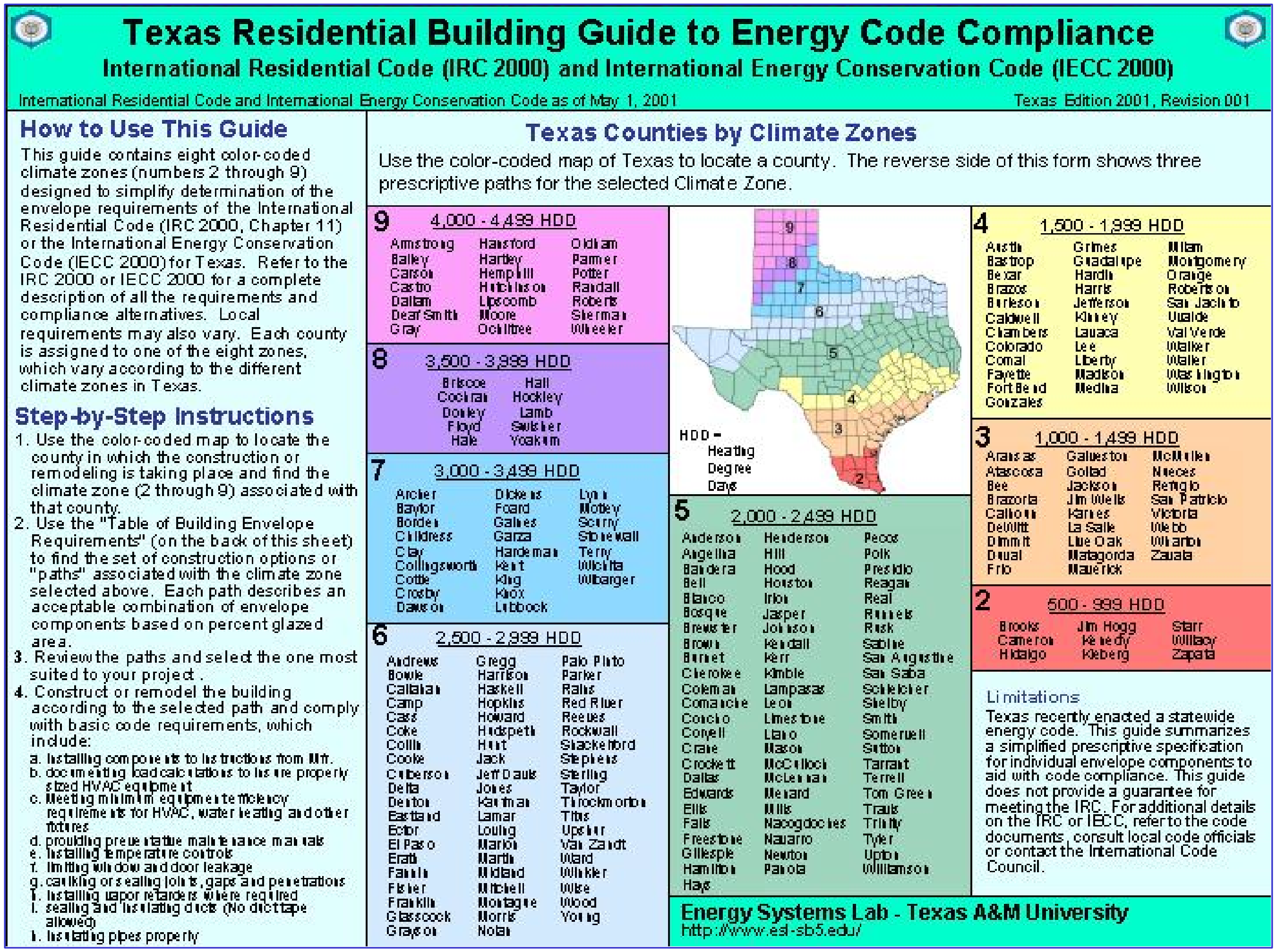
[1] N/S means "not specified". Calculations done using IECC Chap. 4 use a SHGC of .68 for the standard case.
[2] The map in IRC Figure R301.2(6) indicates that parts of Texas qualify as areas of "very heavy" termite infestation probability. Under an exception in the IRC, the slab perimeter insulation requirement in this path may be avoided. To make use of this exception and still comply with the Code, a builder must use IECC Section 502.2.1.4, IECC Section 502.2.4, or IECC Chapter 4, instead of this path.
[3] HDD = Heating Degree Days

**Notes:**

1. This table of building envelope requirements is based upon the 2000 International Residential Code (IRC), published by the International Code Council.
2. The IRC prescriptive requirements are applicable to homes with glazing areas of 15% and below. For homes designed with glazing areas greater than 15%, the IRC incorporates the International Energy Conservation Code (IECC) by reference, which contains additional prescriptive and performance-related compliance alternatives.
3. Source of requirements: 2000 IRC, Ch. 11 (up to 15% only) and 2000 IECC, Ch. 5, Prescriptive Packages for Climate Zones 2-9.
4. Window area %, U-factor, and SHGC are maximum acceptable levels.
5. Insulation R-values are minimum acceptable levels.
6. Applies to single-family, wood-frame residential construction, only. For mass wall construction, see IRC Section N1102.1.1.1; for steel-framed walls, see IRC Section N1102.1.1.2.
7. "Glazing" refers to any translucent or transparent material in exterior openings of buildings, including windows, skylights, sliding glass doors, the glass areas of opaque doors, and glass block.
8. Fenestration product (window, door, glazing) U-factor and SHGC must be determined from a National Fenestration Rating Council (NFRC) label on the product, or obtained from default tables (IECC Table 102.5.2(3) in Chapter 1).
9. Glazing area % is the ratio of the area of the rough opening of windows to the gross wall area, expressed as a percentage. Up to one percent of the total window area may be exempt from the U-factor requirement.
10. Opaque doors are not considered glazing (or "windows") and must have a maximum U-factor of 0.35. One exempt door allowed.
11. Infiltration requirements: Windows ≤ 0.30 cfm per sq.ft. of window area; doors ≤ 0.30 cfm per sq.ft. of door area (swinging doors below 0.50 cfm); determined in accordance with AAMA/WDMA 101/I.S.2 (must be tested and labeled in accordance with ASTM E 283).
12. R-2 shall be added to the requirements for slab insulation where uninsulated hot water pipes, air distribution ducts or electric heating cables are installed in or under the slab.
13. Floors over outside air must meet ceiling insulation requirements.
14. R-values for walls represent the sum of cavity insulation plus insulated sheathing, if any.
15. Prescriptive packages are based upon meeting or exceeding minimum equipment efficiencies for HVAC and water heating (IECC Table 503.2).



Figure 64: Example of the Laboratory's Builder's Guide available for distribution via the web and on laminated cardstock (page 1).



# Texas Residential Building Guide to Energy Code Compliance

## International Residential Code (IRC 2000) and International Energy Conservation Code (IECC 2000)

International Residential Code and International Energy Conservation Code as of May 1, 2001

Texas Edition 2001, Revision 001

### How to Use This Guide

This guide contains eight color-coded climate zones (numbers 2 through 9) designed to simplify determination of the envelope requirements of the International Residential Code (IRC 2000, Chapter 11) or the International Energy Conservation Code (IECC 2000) for Texas. Refer to the IRC 2000 or IECC 2000 for a complete description of all the requirements and compliance alternatives. Local requirements may also vary. Each county is assigned to one of the eight zones, which vary according to the different climate zones in Texas.

### Step-by-Step Instructions

1. Use the color-coded map to locate the county in which the construction or remodeling is taking place and find the climate zone (2 through 9) associated with that county.
2. Use the "Table of Building Envelope Requirements" (on the back of this sheet) to find the set of construction options or "paths" associated with the climate zone selected above. Each path describes an acceptable combination of envelope components based on percent glazed area.
3. Review the paths and select the one most suited to your project.
4. Construct or remodel the building according to the selected path and comply with basic code requirements, which include:
   a. installing components to instructions from Mfr.
   b. documenting load calculations to insure properly sized HVAC equipment
   c. Meeting minimum equipment efficiency requirements for HVAC, water heating and other fixtures
   d. providing preventative maintenance manuals
   e. installing temperature controls
   f. limiting window and door leakage
   g. caulking or sealing joints, gaps and penetrations
   h. installing vapor retarders where required
   i. sealing and insulating ducts (No duct tape allowed)
   j. insulating pipes properly

### Texas Counties by Climate Zones

Use the color-coded map of Texas to locate a county. The reverse side of this form shows three prescriptive paths for the selected Climate Zone.

**9** 4,000 - 4,499 HDD

Armstrong, Bailey, Carson, Castro, Dallam, Deaf Smith, Gray, Hansford, Hartley, Hemphill, Hutchinson, Lipscomb, Moore, Ochiltree, Oldham, Parmer, Potter, Randall, Roberts, Sherman, Wheeler

**8** 3,500 - 3,999 HDD

Briscoe, Cochran, Donley, Floyd, Hale, Hall, Hockley, Lamb, Swisher, Yoakum

**7** 3,000 - 3,499 HDD

Archer, Baylor, Borden, Childress, Clay, Collingsworth, Cottle, Crosby, Dawson, Dickens, Foard, Gaines, Garza, Hardeman, Kent, King, Knox, Lubbock, Lynn, Motley, Scurry, Stonewall, Terry, Wichita, Wilbarger

**6** 2,500 - 2,999 HDD

Andrews, Bowie, Callahan, Camp, Cass, Coke, Collin, Cooke, Culberson, Delta, Denton, Eastland, Ector, El Paso, Erath, Fannin, Fisher, Franklin, Glasscock, Grayson, Gregg, Harrison, Haskell, Hopkins, Howard, Hudspeth, Hunt, Jack, Jeff Davis, Jones, Kaufman, Lamar, Loving, Marion, Martin, Midland, Mitchell, Montague, Morris, Nolan, Palo Pinto, Parker, Rains, Red River, Reeves, Rockwall, Shackelford, Stephens, Sterling, Taylor, Throckmorton, Titus, Upshur, Van Zandt, Ward, Winkler, Wise, Wood, Young



**5** 2,000 - 2,499 HDD

Anderson, Angelina, Bandera, Bell, Blanco, Bosque, Brewster, Brown, Burnet, Cherokee, Coleman, Comanche, Concho, Coryell, Crane, Crockett, Dallas, Edwards, Ellis, Falls, Freestone, Gillespie, Hamilton, Hays, Henderson, Hill, Hood, Houston, Irion, Jasper, Johnson, Kendall, Kerr, Kimble, Lampasas, Leon, Limestone, Llano, Mason, McCulloch, McLennan, Menard, Mills, Nacogdoches, Navarro, Newton, Panola, Pecos, Polk, Presidio, Reagan, Real, Runnels, Rusk, Sabine, San Augustine, San Saba, Schleicher, Shelby, Smith, Somervell, Sutton, Tarrant, Terrell, Tom Green, Travis, Trinity, Tyler, Upton, Williamson

**4** 1,500 - 1,999 HDD

Austin, Bastrop, Bexar, Brazos, Burleson, Caldwell, Chambers, Colorado, Comal, Fayette, Fort Bend, Gonzales, Grimes, Guadalupe, Hardin, Harris, Jefferson, Kinney, Lavaca, Lee, Liberty, Madison, Medina, Milam, Montgomery, Orange, Robertson, San Jacinto, Uvalde, Val Verde, Walker, Waller, Washington, Wilson

**3** 1,000 - 1,499 HDD

Aransas, Atascosa, Bee, Brazoria, Calhoun, DeWitt, Dimmit, Duval, Frio, Galveston, Goliad, Jackson, Jim Wells, Karnes, La Salle, Live Oak, Matagorda, Maverick, McMullen, Nueces, Refugio, San Patricio, Victoria, Webb, Wharton, Zavala

**2** 500 - 999 HDD

Brooks, Cameron, Hidalgo, Jim Hogg, Kenedy, Kleberg, Starr, Willacy, Zapata

### Limitations

Texas recently enacted a statewide energy code. This guide summarizes a simplified prescriptive specification for individual envelope components to aid with code compliance. This guide does not provide a guarantee for meeting the IRC. For additional details on the IRC or IECC, refer to the code documents, consult local code officials or contact the International Code Council.

**Energy Systems Lab - Texas A&M University**
http://www.esl-sb5.edu/

Figure 65: Example of the Laboratory's Builder's Guide available for distribution via the web and on laminated cardstock (page 2).

10.2 Code Compliance Form for Residential Areas.

# Texas Building Energy Efficiency Code Compliance Form For Residential Buildings in Unincorporated Areas

Effective Date: 9/1/2002

Texas law requires the person building a new residential structure to comply with the Texas Building Energy Efficiency Code (International Residential Code ("IRC") and/or International Energy Conservation Code ("IECC") as it existed on May 1, 2001) pursuant to Health and Safety Code Section 388.003 (single or multifamily units, three floors and under).

Common Address or Legal Description: ______________________________
__________ County: ______________________
This residence (select one of the following options):
__ 1. Has been compliance certified by a national, state, or local accredited energy efficiency program;
__ 2. Has been compliance certified from a private code-certified inspector using the IRC's Energy Efficiency Chapter (Chapter 11) or the IECC; or
__ 3. Has been built to include the following energy efficiency elements: (If this option is selected, complete the following 5 categories and provide any additional necessary information)

**(1) Insulation values (R-value of insulation installed) for each of the following:**

Framing material (check one): Wood Steel Mass Wall or Other (specify):

Attic ....................(R-value) ______
Cathedral ceiling ................ (R-value) _______
Opaque walls .......(R-value) ______ Floors over unheated spaces..... (R-value) ______
Floors over outside air ...... (R-value) ______ Ducts (outside conditioned space (R-value) ______
Foundation type: Slab-on-grade ......................... (R-value) ______ (Depth):
Crawlspace ............................ (R-value) ______ (Depth):
Basement (R-value, if applicable): _______ (Depth):
(Interior/Exterior):
Percent of basement walls underground _____ % Area of "very heavy termite infestation" (yes/no)

**(2) Ratings of windows and doors for each of the following:**

Glazing area percentage: ____________ %
(ratio of the area of the rough opening of glazing to the gross wall area)
Glazed door(s) (sliding or hinged) ......(U-factor) ________ (SHGC) _________
Other exterior doors .........................(U-factor) ________ (SHGC) _________
Windows (determined from NFRC rating):
(U-factor) __________ __________ __________
(SHGC) __________ __________ __________
(Air Infiltration) __________ __________ __________

**(3) HVAC equipment efficiency levels:**

Heating systems: Gas fired forced air furnace ......................... (AFUE rating) __________
Electric heat pump ....................................... (HSPF rating) __________

Version 1.0, November 20, 2001 Page 1 of 2

Figure 66: Example of the Laboratory's self-certification form for code compliance in unincorporated areas (front).

# Texas Building Energy Efficiency Code Compliance Form For Residential Buildings in Unincorporated Areas

Effective Date: 9/1/2002

Air conditioning systems: Electric unit ..............................(SEER rating) ____________
Electric heat pump ................. (EER rating) ____________
Ground source heat pump ....... (EER rating) ____________

**(4) Water heating efficiency levels:** Water heater fuel type .................. ____________
Water heater capacity ...................................____________
NAECA energy factor ..................................____________

**(5) Basic requirements** (*check to indicate the measures you have completed or write "N/A" if in applicable*):

Air-tight recessed lights (ASTM E 283): _________
Air sealed penetrations/gaps/holes, etc.: _________
HVAC piping insulation: ____________________
Multi-family units separately metered: _________
Heat pump thermostat: ____________________
Vapor retarders: ____________ (where installed: ________________________________)
U.L. 181 duct sealing products (or mastics): _____
Shower heads rated at 2.5gpm/80psi: _________
Circulating hot-water piping insulation: _______
Thermostats for each system: ______________
Equipment maintenance information: _________

**Additional Information:** *(attach additional sheet if necessary)* ____________________

________________________________________________________________

________________________________________________________________

**Complete the following Certification, as applicable:**

**Accredited energy efficiency program:**____________________________

**Inspector name/address:**______________________________________________

________________________________________________________________

**Inspector certified by:** ---------________________________ **Certification number:** __________

**Builder or Seller name/address:** ______________________________________

**Builder or Seller signature:** __________________________ **Date:** ________________

**Buyer signature(s):** ________________________________ **Date:** ________________

**Inspector signature:** ---------________________________________ **Date:** ____________

*This form may be reproduced-Form available from: Texas A&M University Energy Systems Laboratory, Weisenbaker Hall, College Station, Texas; or on the Internet at http://www-esl.tamu.edu/index.html*
*Telephone: (979) 862-2775, Facsimile (979) 862-8687*

Version 1.0, November 20, 2001 Page 1 of 2

Figure 67: Example of the Laboratory's self-certification form for code compliance in unincorporated areas (back).

## 10.3 Laboratory's Letter Regarding U.S.E.P.A.'s Energy Star New Homes Program.

**ENERGY SYSTEMS LABORATORY**
**Texas Engineering Experiment Station**
**Texas A&M University System**
3581 TAMU
College Station, Texas 77843-3581

August 30, 2002

To All Interested Parties in SB-5 Implementation:

The Energy Systems Laboratory (ESL) has received several written and verbal requests to analyze and determine if the United States Environmental Protection Agency's (EPA) Energy Star New Homes Program can be used to achieve equivalency to the Texas Building Energy Performance Standards (TBEPS) as defined by Senate Bill 5, 77$^{th}$ Legislature.

The Building Option Packages (BOPS) developed by the EPA for use in Texas that are posted on the Laboratory's SB-5 Web page meet or exceed the prescriptive energy requirements of the IRC2000/IECC2000 with 2001 Supplement. It is also our determination that any residential building design that meets or exceeds the equivalent energy performance levels of the posted BOPS could be used by Texas municipal code officials as evidence of compliance with the performance requirements of the Texas Building Energy Performance Standards (TBEPS) provided that the design meets all other mandatory code requirements as defined by the local code official.

The Laboratory stands ready to analyze additional BOPS for equivalency to the TBEPS. Also, the Laboratory can assist municipal code officials, on a fee basis, to determine if other alternative design packages are TBEPS code equivalent.

The Energy Star New Homes Program and its providers offer significant energy and emissions reductions to Texas. If you or your staff have any questions, do not hesitate to contact me at 979-845-9213.

Sincerely,

W. D. Turner

W. Dan Turner, P.E., Ph.D.
Director
Energy Systems Laboratory
Texas Engineering Experiment Station
Texas A&M University System
Energy Systems Laboratory Senate Bill 5 Web pages: http://eslsb5.tamu.edu

**ATTACHMENT** -Page 1, September 20, 2002

## Building Option Packages (BOPS) for A-1 Single Family Residences in Climate Zone # 3

| BOP Number | Maximum Window to Floor Area Ratio | Window Requirements | | Minimum Insulation Requirements | | | | | | Infiltration | Minimum Equipment Requirements | | Status |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Max. U-value | Max. SHGC | Attic | Exterior Wall | Floor Above Unheated Space | Basement Wall | Slab | Crawlspace Wall | Max. Rate (ACH) | Heat (AFUE) | Cool (SEER) | |
| Z3-1-ES | 18% | 0.65 | 0.40 | R-30 | R-13 | R-11 | R-6 | R-0 | R-6 | 0.35 | 80% | 11 | Pass |
| Z3-2-ES | 18% | 0.60 | 0.35 | R-30 | R-11 | R-11 | R-6 | R-0 | R-6 | 0.35 | 80% | 11 | Pass |
| Z3-3-ES | 21% | 0.60 | 0.40 | R-19 | R-11 | R-11 | R-6 | R-0 | R-6 | 0.35 | 80% | 14 | Pass |

**Energy Systems Laboratory**
**Code Traceable Test Suite**
**Reference House Characteristics:**

1. No exterior shading devices, adjacent buildings or shade trees.
2. No movable window shades.
3. Window calculations comply with NFRC 100 and 200.
4. Window SHGC per Section 402.1.3.1.4 (IECC 2000/2001 Supplement).
5. Window U-value, attic and exterior wall insulation per Table 502.2.4(3) (IECC 2000/2001 Supplement).
6. Slab on grade foundation. No basement or crawlspace.
7. Heating and cooling equipment are sized by DOE-2.1E (Version-119).
8. Thermostat setting per Table 402.1.3.5 (IECC 2000/2001 Supplement).
9. Water heater efficiency is according to NAECA 1987.
10. Infiltration rate complies with ASHRAE Standard 136-1993.
11. HVAC equipment performance per Table 503.2 (IECC 2000/2001 Supplement).
12. For climate zone 3, the Houston TMY2 weather file was used.

**Other Footnotes:**

1. The Energy Systems Laboratory continues to conduct ongoing analysis of BOPs in Climate Zones 3, 4, 5, & 6 including electric heat pump and electric water heating options and will publish the results as soon as practical. It is our intent that the approved Energy Star BOPs represent both gas and electric options.
2. The Laboratory will continue to work closely on the technical details with the EPA to determine which Builder Option Packages meet or exceed the Texas Building Energy Performance Standards for all fuel types. The BOPs submitted in April 2002 to the Laboratory for evaluation that were withdrawn by EPA, are not published.
3. It is not our intent to evaluate all possible BOPs for use in Texas by the Energy Star program, but rather to give a representative sample to be used as benchmarks by local code officials for helping determine Texas code compliance.
4. For the Energy Star footnotes that govern the use of these BOPs, see (www.energystar.gov).

**ATTACHMENT** -Page 2, September 20, 2002

## ***Building Option Packages (BOPS) for A-1 Single Family Residences in Climate Zone # 4***

| BOP Number | Maximum Window to Floor Area Ratio | Window Requirements | | Minimum Insulation Requirements | | | | | | Infiltration | Minimum Equipment Requirements | | Status |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Max. U-value | Max. SHGC | Attic | Exterior Wall | Floor Above Unheated Space | Basement Wall | Slab | Crawlspace Wall | Max. Rate (ACH) | Heat (AFUE) | Cool (SEER) | |
| Z4-1-ES | 18% | 0.65 | 0.40 | R-30 | R-13 | R-11 | R-6 | R-0 | R-6 | 0.35 | 80% | 11 | **Pass** |
| Z4-2-ES | 18% | 0.60 | 0.35 | R-30 | R-11 | R-11 | R-6 | R-0 | R-6 | 0.35 | 80% | 11 | **Pass** |

**Energy Systems Laboratory**
**Code Traceable Test Suite**
**Reference House Characteristics:**

1. No exterior shading devices, adjacent buildings or shade trees.
2. No movable window shades.
3. Window calculations comply with NFRC 100 and 200.
4. Window SHGC per Section 402.1.3.1.4 (IECC 2000/2001 Supplement).
5. Window U-value, attic and exterior wall insulation per Table 502.2.4(3) (IECC 2000/2001 Supplement).
6. Slab on grade foundation. No basement or crawlspace.
7. Heating and cooling equipment are sized by DOE-2.1E (Version-119).
8. Thermostat setting per Table 402.1.3.5 (IECC 2000/2001 Supplement).
9. Water heater efficiency is according to NAECA 1987.
10. Infiltration rate complies with ASHRAE Standard 136-1993.
11. HVAC equipment performance per Table 503.2 (IECC 2000/2001 Supplement).
12. For climate zone 4, the Houston TMY2 weather file was used.

**Other Footnotes:**

1. The Energy Systems Laboratory continues to conduct ongoing analysis of BOPs in Climate Zones 3, 4, 5, & 6 including electric heat pump and electric water heating options and will publish the results as soon as practical. It is our intent that the approved Energy Star BOPs represent both gas and electric options.
2. The Laboratory will continue to work closely on the technical details with the EPA to determine which Builder Option Packages meet or exceed the Texas Building Energy Performance Standards for all fuel types. The BOPs submitted in April 2002 to the Laboratory for evaluation that were withdrawn by EPA, are not published.
3. It is not our intent to evaluate all possible BOPs for use in Texas by the Energy Star program, but rather to give a representative sample to be used as benchmarks by local code officials for helping determine Texas code compliance.
4. For the Energy Star footnotes that govern the use of these BOPs, see (www.energystar.gov).

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## *Building Option Packages (BOPS) for A-1 Single Family Residences in Climate Zone # 5*

| BOP Number | Maximum Window to Floor Area Ratio | Window Requirements | | Minimum Insulation Requirements | | | | | | Infiltration | Minimum Equipment Requirements | | Status |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Max U-value | Max SHGC | Attic | Exterior Wall | Floor Above Unheated Space | Basement Wall | Slab | Crawlspace Wall | Max Rate (ACH) | Heat (AFUE) | Cool (SEER) | |
| Z5-1-ES | 15% | 0.50 | 0.40 | R-30 | R-13 | R-19 | R-7 | R-0 | R-8 | 0.35 | 80% | 10 | Pass |
| Z5-2-ES | 18% | 0.45 | 0.35 | R-38 | R-13 | R-19 | R-7 | R-0 | R-8 | 0.35 | 80% | 10 | Pass |
| Z5-3-ES | 18% | 0.45 | 0.40 | R-30 | R-13 | R-19 | R-7 | R-0 | R-8 | 0.35 | 80% | 11 | Pass |
| Z5-4-ES | 21% | 0.40 | 0.35 | R-30 | R-15 | R-19 | R-7 | R-0 | R-8 | 0.35 | 80% | 11 | Pass |
| Z5-5-ES | 18% | 0.50 | 0.40 | R-30 | R-13 | R-19 | R-7 | R-0 | R-8 | 0.35 | 80% | 12 | Pass |
| Z5-6-ES | 21% | 0.40 | 0.40 | R-30 | R-13 | R-19 | R-7 | R-0 | R-8 | 0.35 | 80% | 12 | Pass |
| Z5-7-ES | 21% | 0.50 | 0.40 | R-30 | R-15 | R-19 | R-7 | R-0 | R-8 | 0.35 | 80% | 12 | Pass |
| Z5-8-ES | 18% | 0.55 | 0.40 | R-30 | R-13 | R-19 | R-7 | R-0 | R-8 | 0.35 | 80% | 14 | Pass |
| Z5-9-ES | 21% | 0.50 | 0.40 | R-30 | R-13 | R-19 | R-7 | R-0 | R-8 | 0.35 | 80% | 13 | Pass |

**Energy Systems Laboratory**
**Code Traceable Test Suite**
**Reference House Characteristics:**

1. No exterior shading devices, adjacent buildings or shade trees.
2. No movable window shades.
3. Window calculations comply with NFRC 100 and 200.
4. Window SHGC per Section 402.1.3.1.4 (IECC 2000/2001 Supplement).
5. Window U-value, attic and exterior wall insulation per Table 502.2.4(3) (IECC 2000/2001 Supplement).
6. Slab on grade foundation. No basement or crawlspace.
7. Heating and cooling equipment are sized by DOE-2.1E (Version-119).
8. Thermostat setting per Table 402.1.3.5 (IECC 2000/2001 Supplement).
9. Water heater efficiency is according to NAECA 1987.
10. Infiltration rate complies with ASHRAE standard 136-1993.
11. HVAC equipment performance per Table 503.2 (IECC 2000/2001 Supplement).
12. For climate zone 5, Fort Worth TMY2 weather file was used.

**Other Footnotes:**

1. The Energy Systems Laboratory continues to conduct ongoing analysis of BOPs in Climate Zones 3, 4, 5, & 6 including electric heat pump and electric water heating options and will publish the results as soon as practical. It is our intent that the approved Energy Star BOPs represent both gas and electric options.
2. The Laboratory will continue to work closely on the technical details with the EPA to determine which Builder Option Packages meet or exceed the Texas Building Energy Performance Standards for all fuel types. The BOPs submitted in April 2002 to the Laboratory for evaluation that were withdrawn by EPA, are not published.
3. It is not our intent to evaluate all possible BOPs for use in Texas by the Energy Star program, but rather to give a representative sample to be used as benchmarks by local code officials for helping determine Texas code compliance.
4. For the Energy Star, footnotes that govern the use of these BOPs, see (www.energystar.gov).

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## *Building Option Packages (BOPS) for A-1 Single Family Residences in Climate Zone # 6*

| BOP Number | Maximum Window to Floor Area Ratio | Window Requirements | | Minimum Insulation Requirements | | | | | | Infiltration | Minimum Equipment Requirements | | Status |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Max U-value | Max SHGC | Attic | Exterior Wall | Floor Above Unheated Space | Basement Wall | Slab | Crawlspace Wall | Max Rate (ACH) | Heat (AFUE) | Cool (SEER) | |
| Z6-1-ES | 15% | 0.50 | 0.40 | R-30 | R-13 | R-19 | R-7 | R-0 | R-8 | 0.35 | 80% | 10 | Pass |
| Z6-2-ES | 18% | 0.45 | 0.35 | R-38 | R-13 | R-19 | R-7 | R-0 | R-8 | 0.35 | 80% | 10 | Pass |
| Z6-3-ES | 18% | 0.45 | 0.40 | R-30 | R-13 | R-19 | R-7 | R-0 | R-8 | 0.35 | 80% | 11 | Pass |
| Z6-4-ES | 21% | 0.40 | 0.35 | R-30 | R-15 | R-19 | R-7 | R-0 | R-8 | 0.35 | 80% | 11 | Pass |
| Z6-5-ES | 18% | 0.50 | 0.40 | R-30 | R-13 | R-19 | R-7 | R-0 | R-8 | 0.35 | 80% | 12 | Pass |
| Z6-6-ES | 21% | 0.40 | 0.40 | R-30 | R-13 | R-19 | R-7 | R-0 | R-8 | 0.35 | 80% | 12 | Pass |
| Z6-7-ES | 21% | 0.50 | 0.40 | R-30 | R-15 | R-19 | R-7 | R-0 | R-8 | 0.35 | 80% | 12 | Pass |
| Z6-8-ES | 18% | 0.55 | 0.40 | R-30 | R-13 | R-19 | R-7 | R-0 | R-8 | 0.35 | 80% | 14 | Pass |
| Z6-9-ES | 21% | 0.50 | 0.40 | R-30 | R-13 | R-19 | R-7 | R-0 | R-8 | 0.35 | 80% | 13 | Pass |

**Energy Systems Laboratory Code Traceable Test Suite Reference House Characteristics:**

1. No exterior shading devices, adjacent buildings or shade trees.
2. No movable window shades.
3. Window calculations comply with NFRC 100 and 200.
4. Window SHGC per Section 402.1.3.1.4 (IECC 2000/2001 Supplement).
5. Window U-value, attic and exterior wall insulation per Table 502.2.4(3) (IECC 2000/2001 Supplement).
6. Slab on grade foundation. No basement or crawlspace.
7. Heating and cooling equipment are sized by DOE-2.1E (Version-119).
8. Thermostat setting per Table 402.1.3.5 (IECC 2000/2001 Supplement).
9. Water heater efficiency is according to NAECA 1987.
10. Infiltration rate complies with ASHRAE standard 136-1993.
11. HVAC equipment performance per Table 503.2 (IECC 2000/2001 Supplement).
12. For climate zone 6, Fort Worth TMY2 weather file was used.

**Other Footnotes:**

1. The Energy Systems Laboratory continues to conduct ongoing analysis of BOPs in Climate Zones 3, 4, 5, & 6 including electric heat pump and electric water heating options and will publish the results as soon as practical. It is our intent that the approved Energy Star BOPs represent both gas and electric options.
2. The Laboratory will continue to work closely on the technical details with the EPA to determine which Builder Option Packages meet or exceed the Texas Building Energy Performance Standards for all fuel types. The BOPs submitted in April 2002 to the Laboratory for evaluation that were withdrawn by EPA, are not published.
3. It is not our intent to evaluate all possible BOPs for use in Texas by the Energy Star program, but rather to give a representative sample to be used as benchmarks by local code officials for helping determine Texas code compliance.
4. For the Energy Star, footnotes that govern the use of these BOPs, see (www.energystar.gov).

10.4 Laboratory comments on Project No. 22241 filed with the Texas Public Utilities Commission on October 9, 2002.

**ENERGY SYSTEMS LABORATORY**
Texas Engineering Experiment Station
Texas A&M University System

3581 TAMU
College Station, Texas 77843-3581

TO: Nieves López
Chief Policy Analyst
Public Utility Commission of Texas
1701 N. Congress Ave.
Austin, TX 78701
(512) 936-7307

October 9th, 2002

FROM:

Jeff Haberl, ESL
Charles Culp, ESL
Bahman Yazdani, ESL

CC:

Tom Fitzpatrick, ESL
Malcolm Verdict, ESL
Dan Turner, ESL
Cathy Riley, TEES
Theresa Gross, TPUC
Jess Totten, TPUC

SUBJECT:
Comments on Project No. 22241, Energy Efficiency Implementation Docket.

Dear Nieves:

Thank you for the opportunity to provide comments on the June 21, 2002, and September 12, 2002 petitions filed by Frontier Associates on behalf of the Electric Utility Marketing Managers Organization of Texas, which we have downloaded from your web site. www.puc.state.tx.us/electric/projects/22241/22241arc/22241arc.cfm. We would like to compliment Frontier Associates on their job well done.

However, we felt that it was important to provide comments about the format of the reporting of the deemed savings in the Frontier report, because we are concerned about how those savings will be translated by the TCEQ into NOx reductions using the USEPA's EGRID database. Specifically, in the Laboratory's 2002 Annual report to the Texas Emissions Reduction Plan (TERP) Advisory Committee, we reported on our progress of our first year's work. This progress included the development of methods for calculating NOx emissions reductions from implementation of the 2000 IECC/IRC in the 38 non-attainment and affected counties in Texas.

As part of this process, we worked closely with the TNRCC (now TCEQ) to discuss the planned process for reporting emissions, and how the Laboratory's MWh savings per county would be translated into NOx emissions reductions. The estimated savings from implementing the 2000

Figure 68: Laboratory comments to PUC, October 2002, p.1.

TPUC letter, 10/9/2002

IECC/IRC to the projected 91,632 new single-family units in the non-attainment and affected counties is 297,160 MWh/yr, which results in 417 tons-NOx/yr, or 2.09 tons-NOx/peak-day[1] as shown in the Table 1 below. The cost associated with implementing the IECC/IRC is estimated to be an average $500 per house[2], which results in $/ton-NOx costs ranging from $9,156 to $13,734 $/ton-NOx-10yr, or $14 to $20 $/ton-NOx-peak-day[3].

During our discussions with the TRNCC we learned that the TNRCC was planning on using the USEPA's EGRID database for translating the estimated electricity savings per county (MWh/yr) which were reported by the Laboratory, the TPUC and the SECO into NOx reductions (tons-NOx/day). To perform this calculation we discovered that the EGRID spreadsheet takes the appropriate value for lbs-NOx/MWh for each utility service[4] district and converts this into average daily tons-NOx/day by dividing the annual tons-NOx/year by 365.

When we performed this calculation on our estimated annual electricity savings from the implementation of the 2000 IECC/IRC to the expected at the 91,632 single-family houses for 2002 we calculated 1.14 tons-NOx/day as shown in column 17 of Table 1. Although this value of NOx reductions seemed reasonable to us, we had concerns about averaging the annual NOx reductions since our code-traceable Test Suite[5] demonstrated that a large portion of the energy savings from the implementation of the 2000 IECC/IRC to Texas houses comes from the use of low-E windows, which contributes significantly to cooling-season electricity reductions.

To further investigate, we repeated our code-traceable Test Suite and studied the peak daily kWh savings during the cooling season[6]. When we recalculated the tons-NOx/day using these peak daily values for all 38 counties, we discovered that the tons-NOx/day was 2.09, which is almost twice the value that one obtains using EGRID.

In Figure 1 below there is a clear 2:1 bias in the NOx emissions savings of the average daily EGRID value versus the peak daily NOx emissions from the Laboratory's code-traceable Test Suite. *In other words, EGRID appears to only claim ½ of the emissions credits that the Laboratory simulated on a peak day.*

We reported this immediately to the TNRCC and then in August 2002 to the TERP Advisory Committee. Following the meeting, we had several discussions with the TNRCC, which resulted in the TNRCC's announcement at the August 2002 TERP Advisory Committee meeting that adjustments will need to be made to the EGRID database to allow it to correctly report the NOx emissions reductions from cooling-season-related energy conservation measures such as those in the implementation of the IECC/IRC for 2002 [7].

[1] The lbs-NOx/MWh values we used were those reported by the TNRCC in their Appendix A, Description of the Methodology for Determining Credit for Energy Efficiency, which is part of the Houston/Galveston Attainment Demonstration and Post-1999 Rate-of-Progress SIP, dated June 5, 2002, Table 3, p. 6.
[2] These costs are based on conversations with local building contractors and building officials in the Bryan/College Station area. Since these costs will vary in other metropolitan areas, a range of costs were provided to the TNRCC.
[3] Additional information about this is contained in the appendix to the Laboratory's Annual Report to the TNRCC.
[4] This involves a matrix calculation to estimate the interaction of the electricity supply grid.
[5] The Laboratory's code-traceable Test Suite is based on a DOE-2 simulation of a single family residence. Additional information about the Test Suite can be found in the Laboratory's Annual 2002 Report to the TNRCC.
[6] To accomplish this we compared the total kWh/day consumption for each house on the same peak day.
[7] Energy conservation measures that conserve the same amount of energy each day (i.e., weather-independent measures) would not need an adjustment.

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Figure 69: Laboratory comments to PUC, October 2002, p.2.

TPUC letter, 10/9/2002

It is our understanding that TCEQ plans on convening a Senate Bill 5 working group with the appropriate individuals from the Laboratory, the TPUC, the SECO and others, to discuss how to adjust the savings for the first year of Senate Bill 5. Unfortunately, the "correction" to the EGRID database is not a simple multiplier, since the error depends upon the amount of electricity saved during the cooling season versus the whole year.

A peak-daily MWh value for the deemed savings listed in the Frontier Associates report can be accomplished if one has "peak kWh/day" deemed savings calculated for each and every energy conservation measure, as well as the already reported kW, and kWh values listed in the report. This will need to be calculated for a consensus "peak day" on the TMY2 weather tape for each county that represents a day that is statistically similar to the TCEQ's Ozone day for the state of Texas.

The Laboratory is also comparing the deemed savings listed for Energy Star Homes on pages 43-44 of the Frontier report, and the deemed savings listed for the high SEER air-conditioning systems on pages 42-43 against the savings that the Laboratory submitted in our 2002 Annual Report to the TNRCC.

We would be happy to meet with the TPUC to discuss these important issues and to offer our assistance in helping the TPUC make sure that their MWh savings are correctly translated into peak tons-NOx/day as required by the Texas State Legislature.

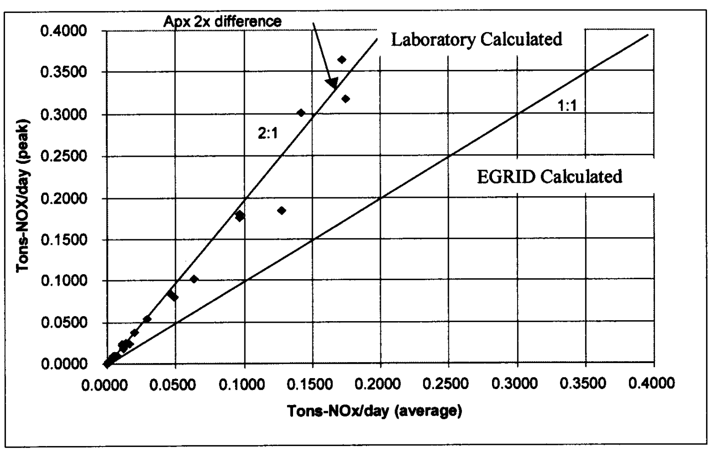


*Figure 1: Comparison of tons-NOx/day(peak) versus tons-NOx/day(average).*

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Figure 70: Laboratory comments to PUC, October 2002, p.3.

TPUC letter, 10/9/2002

| | County | Power Control Area[1] | TMY2[2] | Climate Zone[3] | Division (East or West)[4] | No. of projected units[5] | Floor Area (ft2)[6] | 1999 Average Energy Use (KWh)[7] | IECC 2001 Energy Use (KWh)[8] | 1999 Peak Day(KWH /House)[9] | IECC Peak Day(KWH /House)[10] | Savings per house (kWh)[11] | Total Savings (MWh) 1999-IECC w/ 20% T&D Loss[12] | lb-NOx/MWh[13] | Total Savings: Tons/Year[14] | Total Savings: Tons/Day[15] | Total Savings: Peak Tons/Day[16] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Affected County | Bastrop | ERCOT | Austin | 4 | West | 146 | 2,426 | 16,545 | 13,310 | 77.98 | 59.56 | 3,235 | 566.77 | 2.69 | 0.7623 | 0.0021 | 0.0036 |
| | Bexar | San Antonio Public Service Bd | San Antonio | 4 | West | 7,168 | 2,426 | 16,681 | 13,332 | 71.48 | 55.66 | 3,349 | 28,806.76 | 3.24 | 46.6669 | 0.1279 | 0.1837 |
| | Caldwell | ERCOT | Austin | 4 | West | 101 | 2,426 | 16,545 | 13,310 | 77.98 | 59.56 | 3,235 | 392.08 | 2.69 | 0.5274 | 0.0014 | 0.0025 |
| | Comal | ERCOT | San Antonio | 4 | West | 1,111 | 2,426 | 16,681 | 13,332 | 71.48 | 55.66 | 3,349 | 4,464.89 | 2.69 | 6.0053 | 0.0165 | 0.0236 |
| | Ellis | TXU | Fort Worth | 5 | West | 649 | 2,426 | 15,465 | 12,448 | 82.47 | 61.45 | 3,017 | 2,349.64 | 3.34 | 3.9239 | 0.0108 | 0.0228 |
| | Gregg | SWEPCO | Lufkin | 6 | East | 194 | 2,548 | 13,139 | 11,258 | 65.34 | 52.74 | 1,881 | 437.90 | 2.68 | 0.5870 | 0.0016 | 0.0033 |
| | Guadalupe | ERCOT | San Antonio | 4 | West | 478 | 2,426 | 16,681 | 13,332 | 71.48 | 55.66 | 3,349 | 1,920.99 | 2.69 | 2.5837 | 0.0071 | 0.0102 |
| | Harrison | SWEPCO | Lufkin | 6 | East | 33 | 2,548 | 13,139 | 11,258 | 65.34 | 52.74 | 1,881 | 74.49 | 2.68 | 0.0999 | 0.0003 | 0.0006 |
| | Hays | ERCOT | Austin | 5 | West | 737 | 2,426 | 16,662 | 13,160 | 76.83 | 58.28 | 3,502 | 3,097.17 | 2.69 | 4.1657 | 0.0114 | 0.0184 |
| | Johnson | TXU | Fort Worth | 5 | West | 629 | 2,426 | 15,465 | 12,448 | 82.47 | 61.45 | 3,017 | 2,277.23 | 3.34 | 3.8030 | 0.0104 | 0.0221 |
| | Kaufman | TXU | Fort Worth | 6 | West | 218 | 2,426 | 15,725 | 12,419 | 78.10 | 58.40 | 3,306 | 864.85 | 3.34 | 1.4443 | 0.0040 | 0.0072 |
| | Nueces | CRI | Corpus Chrsti | 3 | East | 841 | 2,548 | 14,354 | 12,651 | 63.46 | 56.11 | 1,703 | 1,718.67 | 2.68 | 2.3039 | 0.0063 | 0.0083 |
| | Parker | TXU | Fort Worth | 6 | West | 302 | 2,426 | 15,725 | 12,419 | 78.10 | 58.40 | 3,306 | 1,198.09 | 3.34 | 2.0008 | 0.0055 | 0.0099 |
| | Rockwall | TXU | Fort Worth | 6 | West | 1,111 | 2,426 | 15,725 | 12,419 | 78.10 | 58.40 | 3,306 | 4,407.56 | 3.34 | 7.3606 | 0.0202 | 0.0366 |
| | Rusk | SWEPCO | Lufkin | 5 | East | 17 | 2,548 | 13,139 | 11,253 | 65.34 | 52.97 | 1,886 | 38.47 | 2.68 | 0.0516 | 0.0001 | 0.0003 |
| | San Patricio | CRI | Corpus Chrsti | 3 | East | 218 | 2,548 | 14,354 | 12,651 | 63.46 | 56.11 | 1,703 | 445.50 | 2.68 | 0.5972 | 0.0016 | 0.0021 |
| | Smith | TXU | Lufkin | 5 | East | 465 | 2,548 | 13,139 | 11,253 | 65.34 | 52.97 | 1,886 | 1,052.39 | 3.34 | 1.7575 | 0.0048 | 0.0096 |
| | Travis | Austin Energy | Austin | 5 | West | 5,922 | 2,426 | 16,662 | 13,160 | 76.83 | 58.28 | 3,502 | 24,886.61 | 1.44 | 17.9184 | 0.0491 | 0.0791 |
| | Upshur | SWEPCO | Lufkin | 6 | East | 17 | 2,548 | 13,139 | 11,258 | 65.34 | 52.74 | 1,881 | 38.37 | 2.68 | 0.0514 | 0.0001 | 0.0003 |
| | Victoria | CRI | Victoria | 3 | East | 156 | 2,548 | 13,923 | 12,251 | 67.25 | 60.21 | 1,672 | 313.00 | 2.68 | 0.4196 | 0.0011 | 0.0015 |
| | Williamson | TXU | Austin | 5 | West | 4,111 | 2,426 | 16,662 | 13,160 | 76.83 | 58.28 | 3,502 | 17,276.07 | 2.68 | 23.1586 | 0.0634 | 0.1022 |
| | Wilson | ERCOT | San Antonio | 4 | West | 16 | 2,426 | 16,681 | 13,332 | 71.48 | 55.66 | 3,349 | 64.30 | 2.69 | 0.0865 | 0.0002 | 0.0003 |
| Nonattainment County | Brazoria | Reliant Energy HL & P | Houston | 3 | East | 2,008 | 2,548 | 13,740 | 11,859 | 66.52 | 55.568 | 1,881 | 4,532.46 | 1.88 | 4.2605 | 0.0117 | 0.0207 |
| | Chambers | EGS | Port Arthur | 4 | East | 318 | 2,548 | 12,913 | 11,297 | 59.02 | 49.96 | 1,616 | 616.67 | 2.68 | 0.8266 | 0.0023 | 0.0039 |
| | Collin | TXU | Fort Worth | 5 | West | 9,639 | 2,426 | 15,725 | 12,419 | 78.10 | 58.40 | 3,306 | 38,239.84 | 3.34 | 63.8605 | 0.1750 | 0.3172 |
| | Dallas | TXU | Fort Worth | 5 | West | 8,595 | 2,426 | 15,465 | 12,448 | 82.47 | 61.45 | 3,017 | 31,117.34 | 3.34 | 51.9660 | 0.1424 | 0.3017 |
| | Denton | TXU | Fort Worth | 6 | West | 5,338 | 2,426 | 15,725 | 12,419 | 78.10 | 58.40 | 3,306 | 21,176.91 | 3.34 | 35.3654 | 0.0969 | 0.1757 |
| | El Paso | EL PASO Electric Company | El Paso | 6 | West | 3,098 | 2,426 | 16,085 | 12,684 | 76.74 | 56.52 | 3,401 | 12,643.56 | 2.68 | 16.9487 | 0.0464 | 0.0839 |
| | Fort Bend | Reliant Energy HL & P | Houston | 4 | East | 1,049 | 2,548 | 13,093 | 11,467 | 61.75 | 51.80 | 1,626 | 2,046.81 | 1.88 | 1.9240 | 0.0053 | 0.0098 |
| | Galveston | Reliant Energy HL & P | Houston | 3 | East | 2,338 | 2,548 | 13,740 | 11,859 | 66.52 | 55.568 | 1,881 | 5,277.33 | 1.88 | 4.9607 | 0.0136 | 0.0241 |
| | Hardin | EGS | Port Arthur | 4 | East | 19 | 2,548 | 12,913 | 11,297 | 59.02 | 49.96 | 1,616 | 36.84 | 2.68 | 0.0494 | 0.0001 | 0.0002 |
| | Harris | Reliant Energy HL & P | Houston | 4 | East | 19,183 | 2,548 | 13,093 | 11,467 | 61.75 | 51.80 | 1,626 | 37,429.87 | 1.88 | 35.1841 | 0.0964 | 0.1795 |
| | Jefferson | EGS | Port Arthur | 4 | East | 610 | 2,548 | 12,913 | 11,297 | 59.02 | 49.96 | 1,616 | 1,182.91 | 2.68 | 1.5857 | 0.0043 | 0.0074 |
| | Liberty | EGS | Port Arthur | 4 | East | 213 | 2,548 | 12,913 | 11,297 | 59.02 | 49.96 | 1,616 | 413.05 | 2.68 | 0.5537 | 0.0015 | 0.0026 |
| | Montgomery | EGS | Houston | 4 | East | 4,032 | 2,548 | 13,093 | 11,467 | 61.75 | 51.80 | 1,626 | 7,867.24 | 2.68 | 10.5460 | 0.0289 | 0.0538 |
| | Orange | EGS | Port Arthur | 4 | East | 172 | 2,548 | 12,913 | 11,297 | 59.02 | 49.96 | 1,616 | 333.54 | 2.68 | 0.4471 | 0.0012 | 0.0021 |
| | Tarrant | TXU | Fort Worth | 5 | West | 10,358 | 2,426 | 15,465 | 12,448 | 82.47 | 61.45 | 3,017 | 37,500.10 | 3.34 | 62.6252 | 0.1716 | 0.3636 |
| | Waller | Reliant Energy HL & P | Houston | 4 | East | 22 | 2,548 | 13,093 | 11,467 | 61.75 | 51.80 | 2,047 | 54.04 | 1.88 | 0.0508 | 0.0001 | 0.0002 |
| | TOTAL | | | | | | | | | | | 2,517 | 297,160.32 | | 417.4298 | 1.1436 | 2.0947 |

*Table 1: Emissions reductions from implementation of the 2000 IRC/IECC in 38 Texas counties.*

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Figure 71: Laboratory comments to PUC, October 2002, p.4.

## 10.5 Laboratory's Letter to Representative Chisum Regarding Analysis for Proposed Residential Efficient Lighting Program

**ENERGY SYSTEMS LABORATORY**
Texas Engineering Experiment Station
Texas A&M University System

3581 TAMU
College Station, Texas 77843-3581

The Honorable Warren Chisum
Chairman, House Environmental Regulation Committee
Chairman, TERP Advisory Board
P.O. Box 2910
Austin, Texas 78768-2910

September 18, 2002

Dear Chairman Chisum:

Per your request at the TERP Advisory Committee on August 15, 2002, the Energy Systems Laboratory has looked further into your suggestion of analyzing the impact of a compact fluorescent lamp (CFL) emissions reduction incentive program for the state of Texas.

Your suggestion could solve most, if not all, of the financial issues pertaining to the funding of Senate Bill 5. Our analysis shows that the revenue to the state from a $1 "emissions reduction" fee, levied at the distribution level, on each incandescent lamp sold would range from approximately $145 to $290 million in 2003. As more consumers shift to compact fluorescents and the program reaches a maximum penetration level, we expect the revenues to drop to approximately $76 million by 2012.

Based on our analysis, we conclude that a CFL emissions reduction incentive program could make a significant contribution to the statewide NOx emissions reduction program as consumers switch to more efficient lighting. This program would reduce statewide NOx emissions from 0.6 to 1.3 tons-NOx/day in 2003 growing to approximately 3.0 tons-NOx/day by 2012.

We are ready to meet with you in Austin, Pampa or elsewhere at your earliest convenience to discuss this important concept.

Please feel free to contact us at (979)458-0675, or Cathy Reiley at (979)845-1291.

Sincerely,

Jeff S. Haberl, Ph.D., P.E.
Associate Director

Charles Culp, Ph.D., P.E.
Associate Director

Bahman L. Yazdani, P.E.
Associate Director

cc: Cathy Reiley - Assistant Agency Director for External Affairs, Assistant Vice Chancellor for Engineering
W. Dan Turner - Director, Energy Systems Laboratory

10.6 Laboratory's Letter to Texas Public Citizen Regarding Analysis for Proposed Residential Efficient Lighting Program and Texas Tune-up Program

**ENERGY SYSTEMS LABORATORY**
Texas Engineering Experiment Station
Texas A&M University System

3581 TAMU
College Station, Texas 77843-3581

Thomas 'Smitty' Smith
Texas Public Citizen
1002 West Ave
Austin, Texas 78701

October 16th, 2002

Dear Smitty:

Per your request, the Energy Systems Laboratory has looked further into analyzing the emissions reduction impact of several programs for the state of Texas, including a Texas Tune-up using Continuous Commissioning$^{SM}$, a compact fluorescent lamp (CFL) emissions reduction incentive program, and the impact of implementing the 2001 IECC/IRC in the state of Texas.

Our analyses are summarized in the tables that follow for all 38 non-attainment counties, for the Dallas Ft. Worth area and the Houston-Galveston-Port Author area. Details are provided in the attached spreadsheet and letters.

We are ready to meet with you in Austin, or elsewhere at your earliest convenience to discuss this important concept.

Please feel free to contact us at (979)845-6-65, or Cathy Reiley at (979)845-1291.

Sincerely,

| | | |
|---|---|---|
| Jeff S. Haberl, Ph.D., P.E. | Charles Culp, Ph.D., P.E. | Bahman L. Yazdani, P.E. |
| Associate Director | Associate Director | Associate Director |

cc: Cathy Reiley - Assistant Agency Director for External Affairs & Assistant Vice Chancellor for Engineering
Charles Culp, Bahman Yazdani, Malcolm Verdict, Dan Turner, David Claridge, Energy Systems Laboratory

Summary Tables of Emissions Reductions From the Texas Tune-up Program, Residential CFL Replacement Program and Implementation of the IECC/IRC.

38 Non-attainment and affected Counties

| PROGRAM | MWh Ele.Saved 2007 – 2010 | Tons NOx Saved/yr * | Tons NOx/Peak-Day | Net Tax Revenue Million $ | $/ton-10-yr |
|---|---|---|---|---|---|
| Residential CFL Program | 3.3 – 5.7 million | 434- 518 | 1.2 – 1.4 | $37.1 - $20.3 | $30,116 - $32,984 |
| Texas Tune-up | 1.3 - 3.2 million | 161- 285 | 0.9 – 1.6 | N/A | $33,091 - $2,116 |
| IECC/IRC | 0.297 million (2002) | 334 - 500 | 1.7 – 2.5 | N/A | $9,100 - $13,700 |

Houston, Galveston, Port Author Non-attainment and affected Counties (34% of 38 county population)

| PROGRAM | MWh Ele.Saved 2007 - 2010 | Tons NOx Saved/yr * | Tons NOx/Peak-Day | Net Tax Revenue Million $ | $/ton-10-yr |
|---|---|---|---|---|---|
| Residential CFL Program | 1.1 – 1.9 million | 147- 176 | 0.4 – 0.5 | $12.6 - $6.9 | $30,116 - $32,984 |
| Texas Tune-up | 0.4 – 1.1 million | 55- 97 | 0.3 – 0.5 | N/A | $33,091 - $2,116 |
| IECC/IRC | 0.101 million (2002) | 113 - 170 | 0.6 – 0.8 | N/A | $9,100 - $13,700 |

Dallas-Ft. Worth Non-attainment and affected Counties (35% of 38 county population)

| PROGRAM | MWh Ele.Saved 2007 - 2010 | Tons NOx Saved/yr * | Tons NOx/Peak-Day | Net Tax Revenue Million $ | $/ton-10-yr |
|---|---|---|---|---|---|
| Residential CFL Program | 1.1 – 1.9 million | 147- 176 | 0.4 – 0.5 | $12.6 - $6.9 | $30,116 - $32,984 |
| Texas Tune-up | 0.4 – 1.1 million | 55- 97 | 0.3 – 0.5 | N/A | $33,091 - $2,116 |
| IECC/IRC | 0.101 million (2002) | 113 - 170 | 0.6 – 0.8 | N/A | $9,100 - $13,700 |

## 10.7 Detailed Analysis to Support the Laboratory's Letter to Texas Public Citizen Regarding Analysis for Proposed Residential Efficient Lighting Program and Texas Tune-up Program.

This section contains the detailed analysis that was performed to support the Laboratory's letter to Chairman Chisum and Texas Public Citizen. This analysis was performed using various assumptions to estimate the numbers of households and buildings that would be impacted by the different NOx reduction strategies as shown in Table 46 and Table 47.

### 10.7.1 Detailed Analysis of NOx Emissions Reduction from Commissioning of Commercial Building HVAC Systems: Texas Tune-up.

In Table 46 the analysis is shown that was used to calculate the electricity savings that would result from tuning building HVAC systems in commercial buildings. Such an effort would reduce electricity use in commercial buildings by tuning the building to run more efficiently[125]. To begin the total square footage of buildings had to be calculated. This is shown in the upper left corner of the spreadsheet, and was calculated to be 50% of the total square footage of buildings listed in the West South Central Region by the USDOE's Energy Information Agency. The 4.2 billion square feet represent an assumed 1% growth per year for the EIA's published 1992 value. Base year buildings are assumed to have an annual energy use of 15 kWh/ft2. New buildings are added at a rate of 2% per year beginning in 2003. Annual electricity savings are estimated to be 10% from the tuning of commissioning of the HVAC system, using a technology developed by the Energy Systems Laboratory called Continuous Commissioning®. To accomplish this it is assumed that 50 engineers can be trained in the first year and 100 engineers are trained in years 2 through 7. These engineers then go and tune 600,000 ft2 of buildings per year. Electricity costs are estimated to be 0.75 $/kWh, and the cost to commission the buildings is estimated to be 0.30 $/ft2, with an annual maintenance cost of 0.02 $/ft2. Electricity saved at the building level is assumed to increase by 10% when it reaches the power plant. The average building size is assumed to be 50,000 ft2 and the maintenance cost for the building after the commissioning is performed is $1,200 pear year. Using these assumptions the projected lbs NOx/MWh emissions rates for the years 2003 through 2012 are calculated to be:

| Year | TCEQ Estimated Lbs-NOx/Mwh | TOTAL (Tons-NOx/year) | TOTAL (Tons-NOx/peak-day) | SAVINGS (Tons-NOx/year) | SAVINGS (Tons-NOx/peak-day) |
|---|---|---|---|---|---|
| 2003 | 1.54 | 27,256 | 151.4 | 38 | 0.2 |
| 2004 | 0.51 | 9,207 | 51.1 | 50 | 0.3 |
| 2005 | 0.51 | 9,391 | 52.2 | 114 | 0.6 |
| 2006 | 0.51 | 9,579 | 53.2 | 202 | 1.1 |
| 2007 | 0.26 | 4,981 | 27.7 | 161 | 0.9 |
| 2008 | 0.18 | 3,517 | 19.5 | 160 | 0.9 |
| 2009 | 0.18 | 3,588 | 19.9 | 218 | 1.2 |
| 2010 | 0.18 | 3,659 | 20.3 | 285 | 1.6 |
| 2011 | 0.18 | 3,733 | 20.7 | 361 | 2.0 |
| 2012 | 0.18 | 3,807 | 21.2 | 446 | 2.5 |
| | | | | | |

[125] For more information on this technology see Claridge et al. (1994; 1996).

### 10.7.2 Detailed Analysis of NOx Emissions Reduction from Compact Fluorescent Incentive Program.

In Table 47 the detailed calculations are shown to estimate the impact of a compact fluorescent incentive program. Compact fluorescent lamps are significantly more efficient than incandescent lamps, and can be inserted into most incandescent lamp fixtures without modifying the fixture. In such a program it is estimated that there are 8 million households in the non-attainment and affected counties that could be affected. The average size of these households is estimated to be 2,000 ft2, with an annual growth rate of 2.5%. Each household is estimated to have 50 incandescent lamps that could be changed to compact fluorescent lamps. The incandescent lamps are assumed to consume 75 Watts of electricity, and the compact fluorescent replacement lamps are assumed to consume 20 Watts. The transmissions and distribution losses are estimated to be 10%. The life of the incandescent lamp is estimated to be 750 hours and the life of the compact fluorescent lamp is estimated to be 10,000 hours. Each lamp is assumed to be in use 500 hours per year. The incandescents are assumed to be replaced every 1.5 years, and the compact fluorescents are assumed to be replaced every 20 years. The program is assumed to have a 10% market penetration rate (i.e., 10% of the housing stock is affected each year), with a maximum penetration of 80%. Initially, it is assumed that 5% of all households already have CFLs. The cost of a CFL is assumed to be $5.00 and the cost of the incandescent is assumed to be $0.50. The cost of energy is $0.085. Using these assumptions the projected lbs NOx/MWh emissions rates for the years 2003 through 2012 are calculated to be:

| YEAR | Households | TCEQ Estimated Lbs-NOx/Mwh | SAVINGS Tons-NOx/year | SAVINGS Tons-NOx/day |
|---|---|---|---|---|
| 2003 | 8,000,000 | 1.54 | 466 | 1.3 |
| 2004 | 8,200,000 | 0.51 | 474 | 1.3 |
| 2005 | 8,405,000 | 0.51 | 810 | 2.2 |
| 2006 | 8,615,125 | 0.51 | 1,163 | 3.2 |
| 2007 | 8,830,503 | 0.26 | 781 | 2.1 |
| 2008 | 9,051,266 | 0.18 | 678 | 1.9 |
| 2009 | 9,277,547 | 0.18 | 821 | 2.2 |
| 2010 | 9,509,486 | 0.18 | 971 | 2.7 |
| 2011 | 9,747,223 | 0.18 | 1,061 | 2.9 |
| 2012 | 9,990,904 | 0.18 | 1,088 | 3.0 |

Continuous Commissioning for Texas — Version 1.01 October 13th, 2002

INPUTS:

| | | | | | |
|---|---|---|---|---|---|
| Total FT2 (2002) = | 2,103,200,527 | Elec.Costs = $/kWh | $ 0.075 | T&D losses = | 110% |
| kWh/ft2-yr | 15 | CC main $/ft2 (1,2,3) | $ 0.02 | Avg.Bldg.Size= | 50,000 |
| Growth rate= | 2.00% | Engin.Trained 2-7th yr= | 100 | M&V/ bldg/yr= | $ 1,200 |
| Avg.Savings % = | 10% | Square ft/engin.= | 600,000 | Interval meters | |
| Engin.Trained 1st yr= | 50 | | | | |
| Cost/ft2 = | $ 0.30 | | | | |

| Year | Total Area (Ft2) Texas | Total Elec Use MWh/yr (w/T&D) | Engineers Trained | Commissioned Square Footage | Cumulative # of Buil ssuming 50,000ft2/bl | Cumulative Square Footage | Cum CC Saved MWh/yr (w/T&D) | lb-NOx/MWh TNRCC | Total tons-NOx/yr | Total Tons-NOx per Peak day (180 days/yr) | CC Savings tons-NOx/yr | CC Savings Tons-NOx per Peak day (180 days/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2002 | | | | | | | | | | | | |
| 2003 | 2,145,264,537 | 35,396,865 | 50 | 30,000,000 | 600 | 30,000,000 | 49,500 | 1.54 | 27,256 | 151.4 | 38 | 0.2 |
| 2004 | 2,188,169,828 | 36,104,802 | 150 | 90,000,000 | 1,800 | 120,000,000 | 198,000 | 0.51 | 9,207 | 51.1 | 50 | 0.3 |
| 2005 | 2,231,933,225 | 36,826,898 | 250 | 150,000,000 | 3,000 | 270,000,000 | 445,500 | 0.51 | 9,391 | 52.2 | 114 | 0.6 |
| 2006 | 2,276,571,889 | 37,563,436 | 350 | 210,000,000 | 4,200 | 480,000,000 | 792,000 | 0.51 | 9,579 | 53.2 | 202 | 1.1 |
| 2007 | 2,322,103,327 | 38,314,705 | 450 | 270,000,000 | 5,400 | 750,000,000 | 1,237,500 | 0.26 | 4,981 | 27.7 | 161 | 0.9 |
| 2008 | 2,368,545,393 | 39,080,999 | 550 | 330,000,000 | 6,600 | 1,080,000,000 | 1,782,000 | 0.18 | 3,517 | 19.5 | 160 | 0.9 |
| 2009 | 2,415,916,301 | 39,862,619 | 650 | 390,000,000 | 7,800 | 1,470,000,000 | 2,425,500 | 0.18 | 3,588 | 19.9 | 218 | 1.2 |
| 2010 | 2,464,234,627 | 40,659,871 | 750 | 450,000,000 | 9,000 | 1,920,000,000 | 3,168,000 | 0.18 | 3,659 | 20.3 | 285 | 1.6 |
| 2011 | 2,513,519,320 | 41,473,069 | 850 | 510,000,000 | 10,200 | 2,430,000,000 | 4,009,500 | 0.18 | 3,733 | 20.7 | 361 | 2.0 |
| 2012 | 2,563,789,706 | 42,302,530 | 950 | 570,000,000 | 11,400 | 3,000,000,000 | 4,950,000 | 0.18 | 3,807 | 21.2 | 446 | 2.5 |

| Year | Total Elec.Cost | CC Savings $/yr | CC first Costs $/yr | CC main & Mon Costs $/yr | Total Gross CC Costs $/yr | Gross CC Costs $/ton-10yr | Total Net CC Costs $/yr old | Net CC Costs $/ton-10yr old | 10-yr-CC-cost bldg fin.by.yr new | 10-yr-CC-save bldg fin.by.yr new | 10-yr-net-costs costs new |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | $ 2,654,764,865 | $ (3,712,500) | $ 9,000,000 | $ 1,320,000 | $ 10,320,000 | $ 58,245 | $ 6,607,500 | $ 48,505 | $ 22,200,000 | $ (37,125,000) | $ (14,925,000) |
| 2004 | $ 2,707,860,162 | $ (14,850,000) | $ 27,000,000 | $ 2,163,960 | $ 29,163,960 | $ 96,335 | $ 14,313,960 | $ 66,923 | $ 48,639,600 | $ (148,500,000) | $ (99,860,400) |
| 2005 | $ 2,762,017,365 | $ (33,412,500) | $ 45,000,000 | $ 3,608,910 | $ 48,608,910 | $ 71,380 | $ 15,196,410 | $ 41,968 | $ 81,089,100 | $ (334,125,000) | $ (253,035,900) |
| 2006 | $ 2,817,257,713 | $ (59,400,000) | $ 63,000,000 | $ 5,055,840 | $ 68,055,840 | $ 56,228 | $ 8,655,840 | $ 26,816 | $ 113,558,400 | $ (594,000,000) | $ (480,441,600) |
| 2007 | $ 2,873,602,867 | $ (92,812,500) | $ 81,000,000 | $ 6,504,750 | $ 87,504,750 | $ 90,783 | $ (5,307,750) | $ 33,091 | $ 146,047,500 | $ (928,125,000) | $ (782,077,500) |
| 2008 | $ 2,931,074,924 | $ (133,650,000) | $ 99,000,000 | $ 7,955,640 | $ 106,955,640 | $ 111,333 | $ (26,694,360) | $ 28,000 | $ 178,556,400 | $ (1,336,500,000) | $ (1,157,943,600) |
| 2009 | $ 2,989,696,423 | $ (181,912,500) | $ 117,000,000 | $ 9,408,510 | $ 126,408,510 | $ 96,697 | $ (55,503,990) | $ 13,364 | $ 211,085,100 | $ (1,819,125,000) | $ (1,608,039,900) |
| 2010 | $ 3,049,490,351 | $ (237,600,000) | $ 135,000,000 | $ 10,863,360 | $ 145,863,360 | $ 85,449 | $ (91,736,640) | $ 2,116 | $ 243,633,600 | $ (2,376,000,000) | $ (2,132,366,400) |
| 2011 | $ 3,110,480,158 | $ (300,712,500) | $ 153,000,000 | $ 12,320,190 | $ 165,320,190 | $ 76,541 | $ (135,392,310) | $ (6,792) | $ 276,201,900 | $ (3,007,125,000) | $ (2,730,923,100) |
| 2012 | $ 3,172,689,762 | $ (371,250,000) | $ 171,000,000 | $ 13,779,000 | $ 184,779,000 | $ 69,313 | $ (186,471,000) | $ (14,020) | $ 308,790,000 | $ (3,712,500,000) | $ (3,403,710,000) |

ASSUMPTIONS

1992 USEIA West South Central Region

| | |
|---|---|
| Education | 904,000,000 |
| Lodging | 261,000,000 |
| Mercantile & Service | 1,472,000,000 |
| Office | 1,171,000,000 |
| Total 1992 | 3,808,000,000 |
| Total 2002 = 1.01^10 | 4,206,401,054 |
| Assume = 50% SB5 | 2,103,200,527 |

Table 46: Detailed calculations for the NOx emissions reduction calculations for the implementation of Continuous Commissioning® in Existing Commercial buildings.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Incentive program for CFLs in Texas | | Version 1.01 September 2nd, 2002 | | | | | | | | | |
| | INPUTS: | | | Life | | Replacement | | Replacements | | Incentive | |
| Total houses (1999)= | 8,000,000 | | | Incan life= | 750 | Incan/yr= | 0.667 | Incan/house= | 33 | Cost/Inc Lamp= | $ 0.25 |
| Growth rate= | 2.50% | Lamps/house= | 50 | CFL life= | 10000 | CFL/yr= | 0.050 | CFL/house= | 3 | Pay/CFL Lamp= | $ (1.00) |
| Avg.House Size(ft2)= | 2,000 | Inc. kW/lamp= | 0.075 | Assumed Hrs/yr= | 500 | Conv/yr= | 5% | Max penetra= | 50% | | |
| | | CFLs kW/lamp= | 0.020 | Incan kW/house= | 3.75 | Init.Conv to CFL | 5% | Cost of incan=. | $ 0.50 | | |
| | | T&D losses= | 1.10 | CFL kW/house= | 1.00 | Cost of CFL | $ 5.00 | Cost of energy= | $ 0.075 | | |
| | | | | | Range 500 - 750 hrs | | | | | | |

| Year | Total Houses | New houses | Replace + New Lamps | Conversion to CFLs | New house CFLs purchased | Existing house CFLs convert | Replacement CFLs | Total CFLs Purchased | New house Incand purch | Existing house Inc. replace | Total Inc. Purchased |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | 8,830,503 | 220,763 | 305,388,233 | 5% | 551,906 | 15,269,412 | 1,131,408 | 16,952,726 | 10,486,222 | 279,632,599 | 290,118,821 |
| 2004 | 9,051,266 | 226,282 | 313,022,939 | 10% | 1,131,408 | 15,651,147 | 2,319,387 | 19,101,942 | 10,182,674 | 271,537,971 | 281,720,645 |
| 2005 | 9,277,547 | 231,939 | 320,848,512 | 15% | 1,739,540 | 16,042,426 | 3,566,057 | 21,348,023 | 9,857,394 | 262,863,841 | 272,721,236 |
| 2006 | 9,509,486 | 237,737 | 328,869,725 | 20% | 2,377,372 | 16,443,486 | 4,873,612 | 23,694,469 | 9,509,486 | 253,586,294 | 263,095,780 |
| 2007 | 9,747,223 | 243,681 | 337,091,468 | 25% | 3,046,007 | 16,854,573 | 6,244,315 | 26,144,896 | 9,138,022 | 243,680,580 | 252,818,601 |
| 2008 | 9,990,904 | 249,773 | 345,518,755 | 30% | 3,746,589 | 17,275,938 | 7,680,507 | 28,703,034 | 8,742,041 | 233,121,088 | 241,863,129 |
| 2009 | 10,240,676 | 256,017 | 354,156,724 | 35% | 4,480,296 | 17,707,836 | 9,184,607 | 31,372,739 | 8,320,550 | 221,881,321 | 230,201,871 |
| 2010 | 10,496,693 | 262,417 | 363,010,642 | 40% | 5,248,347 | 18,150,532 | 10,759,111 | 34,157,989 | 7,872,520 | 209,933,865 | 217,806,385 |
| 2011 | 10,759,111 | 268,978 | 372,085,908 | 45% | 6,052,000 | 18,604,295 | 12,406,599 | 37,062,895 | 7,396,889 | 197,250,361 | 204,647,249 |
| 2012 | 11,028,088 | 275,702 | 381,388,056 | 50% | 6,892,555 | 19,069,403 | 14,129,738 | 40,091,696 | 6,892,555 | 183,801,473 | 190,694,028 |

| Year | Tax Revenue from Incandescent | Incentive Paid for CFLs | Net Tax | Cumulative Tax | $ paid by house for all CFLs | $ paid by house for all incand | $ paid by house for incan or CFLs | $ paid by house for energy | $ total for res. purch + energy | $ total per house for purch incan or CFL | $ total per house for purch & energy |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | $ 72,529,705 | $ (16,952,726) | $ 55,576,979 | $ 55,576,979 | $ 84,763,632 | $ 145,059,411 | $ 229,823,042 | $ 1,192,125,000 | $ 1,421,948,042 | $ 26 | $ 161 |
| 2004 | $ 70,430,161 | $ (19,101,942) | $ 51,328,219 | $ 106,905,198 | $ 95,509,710 | $ 140,860,323 | $ 236,370,032 | $ 1,175,418,750 | $ 1,411,788,782 | $ 26 | $ 156 |
| 2005 | $ 68,180,309 | $ (21,348,023) | $ 46,832,286 | $ 153,737,484 | $ 106,740,115 | $ 136,360,618 | $ 243,100,733 | $ 1,157,132,109 | $ 1,400,232,842 | $ 26 | $ 151 |
| 2006 | $ 65,773,945 | $ (23,694,469) | $ 42,079,476 | $ 195,816,960 | $ 118,472,347 | $ 131,547,890 | $ 250,020,237 | $ 1,137,196,500 | $ 1,387,216,737 | $ 26 | $ 146 |
| 2007 | $ 63,204,650 | $ (26,144,896) | $ 37,059,755 | $ 232,876,715 | $ 130,724,478 | $ 126,409,301 | $ 257,133,778 | $ 1,115,540,903 | $ 1,372,674,681 | $ 26 | $ 141 |
| 2008 | $ 60,465,782 | $ (28,703,034) | $ 31,762,748 | $ 264,639,463 | $ 143,515,170 | $ 120,931,564 | $ 264,446,734 | $ 1,092,091,777 | $ 1,356,538,511 | $ 26 | $ 136 |
| 2009 | $ 57,550,468 | $ (31,372,739) | $ 26,177,729 | $ 290,817,192 | $ 156,863,694 | $ 115,100,935 | $ 271,964,629 | $ 1,066,772,983 | $ 1,338,737,612 | $ 27 | $ 131 |
| 2010 | $ 54,451,596 | $ (34,157,989) | $ 20,293,607 | $ 311,110,799 | $ 170,789,947 | $ 108,903,193 | $ 279,693,139 | $ 1,039,505,692 | $ 1,319,198,831 | $ 27 | $ 126 |
| 2011 | $ 51,161,812 | $ (37,062,895) | $ 14,098,918 | $ 325,209,717 | $ 185,314,473 | $ 102,323,625 | $ 287,638,097 | $ 1,010,208,302 | $ 1,297,846,400 | $ 27 | $ 121 |
| 2012 | $ 47,673,507 | $ (40,091,696) | $ 7,581,811 | $ 332,791,527 | $ 200,458,481 | $ 95,347,014 | $ 295,805,495 | $ 978,796,353 | $ 1,274,601,848 | $ 27 | $ 116 |

| | Population | Conversion to CFLs | Houses with Incandescents | Electricity from Houses/Incand. MWh/yr (w/ T&D) | lb-NOx/MWh (TNRCC via ARI) | Tons-NOx/yr | Tons-NOx/day |
|---|---|---|---|---|---|---|---|
| 2003 | 8,000,000 | 5% | 7,600,000 | 15,675,000 | 1.54 | 12,070 | 33.1 |
| 2004 | 8,200,000 | 10% | 7,380,000 | 15,221,250 | 0.51 | 3,881 | 10.6 |
| 2005 | 8,405,000 | 15% | 7,144,250 | 14,735,016 | 0.51 | 3,757 | 10.3 |
| 2006 | 8,615,125 | 20% | 6,892,100 | 14,214,956 | 0.51 | 3,625 | 9.9 |
| 2007 | 8,830,503 | 25% | 6,622,877 | 13,659,685 | 0.26 | 1,776 | 4.9 |
| 2008 | 9,051,266 | 30% | 6,335,886 | 13,067,765 | 0.18 | 1,176 | 3.2 |
| 2009 | 9,277,547 | 35% | 6,030,406 | 12,437,712 | 0.18 | 1,119 | 3.1 |
| 2010 | 9,509,486 | 40% | 5,705,692 | 11,767,989 | 0.18 | 1,059 | 2.9 |
| 2011 | 9,747,223 | 45% | 5,360,973 | 11,057,006 | 0.18 | 995 | 2.7 |
| 2012 | 9,990,904 | 50% | 4,995,452 | 10,303,120 | 0.18 | 927 | 2.5 |

| | Population | Conversion to CFLs | Houses with CFLs | Electricity from Houses/CFLs MWh/yr (w/ T&D) | lb-NOx/MWh | Tons-NOx/yr | Tons-NOx/day | Total Tons-NOx/day |
|---|---|---|---|---|---|---|---|---|
| 2003 | 8,000,000 | 5% | 400,000 | 220,000 | 1.54 | 169 | 0.5 | 33.5 |
| 2004 | 8,200,000 | 10% | 820,000 | 451,000 | 0.51 | 115 | 0.3 | 10.9 |
| 2005 | 8,405,000 | 15% | 1,260,750 | 693,413 | 0.51 | 177 | 0.5 | 10.8 |
| 2006 | 8,615,125 | 20% | 1,723,025 | 947,664 | 0.51 | 242 | 0.7 | 10.6 |
| 2007 | 8,830,503 | 25% | 2,207,626 | 1,214,194 | 0.26 | 158 | 0.4 | 5.3 |
| 2008 | 9,051,266 | 30% | 2,715,380 | 1,493,459 | 0.18 | 134 | 0.4 | 3.6 |
| 2009 | 9,277,547 | 35% | 3,247,142 | 1,785,928 | 0.18 | 161 | 0.4 | 3.5 |
| 2010 | 9,509,486 | 40% | 3,803,794 | 2,092,087 | 0.18 | 188 | 0.5 | 3.4 |
| 2011 | 9,747,223 | 45% | 4,386,250 | 2,412,438 | 0.18 | 217 | 0.6 | 3.3 |
| 2012 | 9,990,904 | 50% | 4,995,452 | 2,747,499 | 0.18 | 247 | 0.7 | 3.2 |

| | Population | Conversion to CFLs | Houses with Incandescents | Electricity from Houses/Incand. MWh/yr (w/ T&D) | Electricity saved from Inc -> CFL MWh/yr (w/ T&D) | lb-NOx/MWh | Tons-NOx/yr | Tons-NOx/day | Savings Tons-NOx/yr Incan. -> CFLs | Savings Tons-NOx/day Inc. -> CFLs | Electricity saved from Inc -> CFL $/yr (w/ T&D) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | 8,000,000 | 0% | 8,000,000 | 16,500,000 | 605,000 | 1.54 | 12,705 | 34.8 | 466 | 1.3 | $ 45,375,000 |
| 2004 | 8,200,000 | 0% | 8,200,000 | 16,912,500 | 1,240,250 | 0.51 | 4,313 | 11.8 | 316 | 0.9 | $ 93,018,750 |
| 2005 | 8,405,000 | 0% | 8,405,000 | 17,335,313 | 1,906,884 | 0.51 | 4,421 | 12.1 | 486 | 1.3 | $ 143,016,328 |
| 2006 | 8,615,125 | 0% | 8,615,125 | 17,768,695 | 2,606,075 | 0.51 | 4,531 | 12.4 | 665 | 1.8 | $ 195,455,648 |
| 2007 | 8,830,503 | 0% | 8,830,503 | 18,212,913 | 3,339,034 | 0.26 | 2,368 | 6.5 | 434 | 1.2 | $ 250,427,550 |
| 2008 | 9,051,266 | 0% | 9,051,266 | 18,668,236 | 4,107,012 | 0.18 | 1,680 | 4.6 | 370 | 1.0 | $ 308,025,886 |
| 2009 | 9,277,547 | 0% | 9,277,547 | 19,134,941 | 4,911,302 | 0.18 | 1,722 | 4.7 | 442 | 1.2 | $ 368,347,622 |
| 2010 | 9,509,486 | 0% | 9,509,486 | 19,613,315 | 5,753,239 | 0.18 | 1,765 | 4.8 | 518 | 1.4 | $ 431,492,929 |
| 2011 | 9,747,223 | 0% | 9,747,223 | 20,103,648 | 6,634,204 | 0.18 | 1,809 | 5.0 | 597 | 1.6 | $ 497,565,283 |
| 2012 | 9,990,904 | 0% | 9,990,904 | 20,606,239 | 7,555,621 | 0.18 | 1,855 | 5.1 | 680 | 1.9 | $ 566,671,573 |

Table 47: Detailed calculations for the NOx emissions reduction calculations for the implementation CFL program.

10.8 DOE-2 parameters for REScheck Comparison Versus the Laboratory's IECC Code-traceable Simulation (Section 4).

The information contained below includes the DOE-2 parameters that were used to simulate Brazoria County in the REScheck-web analysis (Section 4).

```
$***********************************PARAMETERS************************************
*********

PARAMETER

$***********BUILDING**************

      P-AREA     = 1600           $(SQ.FT), P-BWIDTH TIMES P-BUILDINGLENGTH,
$                                 SQUARE FOOTAGE OF THE AVERAGE HOUSE IN
$                                 UNITED STATES
$                                 (RESIDENTIAL ENERGY CONSUMPTION SURVEY 1997)
      P-AREA1    = 160            $PERIMETER, USED FOR THE FLOOR AREA WHEN WALLS
$                                  ARE CONSIDERED MASSLESS
      P-VOLUME   = 12800          $P-AREA TIMES P-WALLHEIGHT
      P-LATITUDE  = 29.98         $HOUSTON (DEG),DEFAULT TAKEN FROM WEATHER
FILE
      P-LONGITUDE = 95.37         $HOUSTON (DEG),DEFAULT TAKEN FROM WEATHER
FILE
      P-TIME-ZONE = 6             $CENTRAL TIME ZONE
      P-ALTITUDE  = 108           $FOR HOUSTON IAH(FT), DOE-2 DEFAULT = 0


      P-BUILDINGWIDTH = 40        $(FT)
      P-BUILDINGLENGTH = 40       $(FT)
      P-BUILDINGAZIMUTH = 0       $DOE-2 DEFAULT(DEG),
      P-OCCUPANCY = 2
      P-LEFTWALLWIDTH = 18        $P-BUILDINGWIDTH MINUS 22
      P-WALLHEIGHT = 8            $TYPICAL VALUE FOR INTERIOR CEILING HEIGHT
      P-AIRCHANGE = 0.462

$**********ROOF********************

      P-ROOFOUTEMISS = 0.9        $DOE-2 DEFAULT,OUTSIDE EMISSIVITY FOR ROOF
      P-ROOFABSORPTANCE = 0.5     $FOR ROOF,WHITE BUILT UP
$                                 ROOF,GREEN = 0.86
$                                 (DOE2.1E BDL SUMMARY,P.12)
      P-ROOFROUGHNESS = 1         $FOR BUILTUP ROOF (DARK)
$                                 1=WOOD SHINGLES OR BUILTUP ROOF
$                                 3=ASPHALT SHINGLES
$                                 5=METAL
$                                 (DOE2.1E BDL SUMMARY,P.12)
      P-ROOFUVALUE =  0.8         $PLY-WOOD(1/2"),(HR.FT^2.F/BTU)
$                                 DOE-2 MATERIAL LIBRARY
$                                 ROOFRVALUE WILL BE INPUT BY THE USER WHICH WILL
$                                 BE CONVERTED TO U-VALUE BY AN EXTERNAL ROUTINE

$***********WALL********************
```

```
        P-WALLABSORPTANCE = 0.55              $FOR BRICK,LIGHT(DOE2.1E BDL
SUMMARY,P.12)
        P-WALLROUGHNESS = 2                   $FOR BRICK (DOE2.1E BDL SUMMARY,P.12)
$                                   1=STUCCO
$                                   2-BRICK
$                                   3-CONCRETE
$                                   4-CLEAR PINE
$                                   5-SMOOTH PLASTER
$                                   6-GLASS OR PAINT ON PINE
$        P-WALLHEIGHT = 8.0                 (FT)
        P-WALLOUTEMISS  = 0.9               $OUTSIDE EMISSIVITY FOR WALLS
        P-GND-REFLECTANCE = 0.24            $FOR GRASS,PAGE III.100(DOE2.1A MANUAL),
$                                   DOE-2 DEFAULT=0.2(0 TO 1)
        P-WALLUVALUE = 0.091                $1ECC 2001 VALUE FOR TYPE A1 HOUSE WITH
$                                   GLAZING 15% OF WALL AREA(HR.FT^2.F/BTU)
$                                   ROOFRVALUE WILL BE INPUT BY THE USER WHICH WILL
$                                   BE CONVERTED TO U-VALUE BY AN EXTERNAL ROUTINE

$*********CEILING********************

        P-CLNGUVALUE = 0.0526               $1ECC 2001 VALUE FOR TYPE A1 HOUSE WITH
$                                   GLAZING 15% OF WALL AREA(HR.FT^2.F/BTU)
$                                   ROOFRVALUE WILL BE INPUT BY THE USER WHICH WILL
$                                   BE CONVERTED TO U-VALUE BY AN EXTERNAL ROUTINE

$*********DOOR***********************

        P-DOORHEIGHT = 6.67                 $AVERAGE DOOR HEIGHT,
$                                   HABITAT FOR HUMANITY, LOWE'S
        P-DOORWIDTH = 3.0                   $AVERAGE DOOR WIDTH
$                                   HABITAT FOR HUMANITY, LOWE'S
$                                   ONE DOOR AT THE FRONT AND ONE AT THE BACK IS
$                                   ASSUMED

$********WINDOW*********************

        P-WINDOWHEIGHT = 4.56               $(FT)
        P-WINDOWWIDTH = 9.16                $(FT),EQUIVALENT WINDOW WIDTH IF ONE
WINDOW IS
$                                   ASSUMED ON ALL SIDES
$        P-WINDOWOUTEMISS =                 OUTSIDE EMISSIVITY FOR WINDOWS,
$                                   INVALID KEYWORD
        P-SHADINGCOEFFICIENT= 0.528         $SHGC=0.4(BUILDER'S GUIDE),SC=SHGC/0.87,
THE
$                                   VALUE CALCULATED IS THE COMBINED SC FOR THE
$                                   WHOLE WINDOW (INCLUDING THE FRAME) USING
$                                   NFRC200 (WINDOW SC SPREADSHEET)
$
        P-FRAMEWIDTH=0.2189                 $EQUIVALENT FRAME WIDTH IF ONE WINDOW IS
$                                   CONSIDERED,AVERAGE FRAME WIDTH = 0.125(LOWE'S)
        P-GLASSCONDUCTANCE=0.6541           $VALUE FROM THE WINDOW U-FACTOR
SPREADSHEET
$                                   USING NFRC 100
        P-FRAMECONDUCTANCE= 3.037           $FOR ALUMINUM, DOE2.1E(SUPPLEMENT
P.2.116)
        P-FRAMEABSORPTANCE= 0.7             $WHITE GLOSS(DOE2.1E BDL SUMMARY P.12)
```

```
        P-PANES = 2                    $DEPENDING ON U-FACTOR AND SHGF DEFINED
$       P-VISTRANSMITTENCE
$       P-SPACERCODE = 1                    DOE-2 DEFAULT, USED ONLY FOR GLASS TYPE
FROM
$                               WINDOW LIBRARY
$                               0 = SPACER IS TAKEN FROM WINDOW LIBRARY,
$                               1=ALUMINUM
$                               2=STAINLESS STEEL
$                               3=BUTYL/METAL
$                               4=WOOD/FIBREGLASS
$                               5=U-FACTOR OF EDGE = U-FACTOR OF CENTER

$********FLOOR**********************

        P-FLOORWEIGHT = 11.5            $AS PER IECC2001(402.1.3.3)(LBS/SQ.FT)
        P-FLOORUVALUE = 0.0833
$                               CHANGE FROM 0.06 TO MATCH WITH WEB, 5/20/2003 S.KIM
        P-UEFFECTIVE = 0.088


$*********************SHADES*******************************************************
*************

     P-SHADEWIDTHF = 3                  $ASSUMED VALUES
     P-SHADEWIDTHR = 3
     P-SHADEWIDTHB = 3
     P-SHADEWIDTHL = 3
     P-SCHEDULE = 1
     P-TRANSMITTANCE = 1
     P-VIEWFACTORF = 0.5
     P-VIEWFACTORR = 0.5
     P-VIEWFACTORB = 0.5
     P-VIEWFACTORL = 0.5


             ..                 $END OF PARAMETER
```