

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

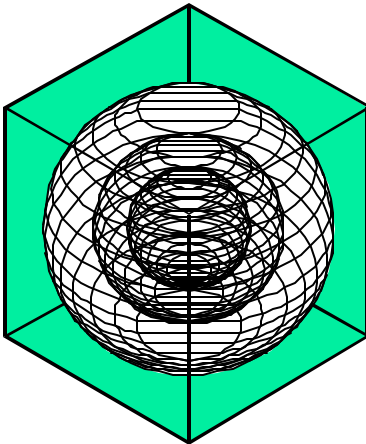
VOLUME I – SUMMARY REPORT

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

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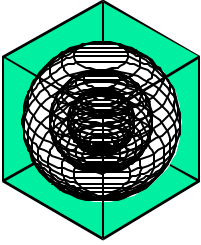
Energy Systems Laboratory
Texas A&M University System

December 2003



**ENERGY SYSTEMS
LABORATORY**

Texas Engineering Experiment Station
Texas A&M University System



ENERGY SYSTEMS LABORATORY

Texas Engineering Experiment Station
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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,

A handwritten signature in black ink that reads "Dan Turner". The signature is written in a cursive, flowing style.

W. Dan Turner, P.E.
Director

Enclosure

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

Disclaimer

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VOLUME I – SUMMARY REPORT

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

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 NO_x 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.

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.

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.

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.

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.

Energy and NO_x Reductions 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 multifamily residential (887,564 MBtu/year saved).

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

- 2.13 tons NO_x/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 multifamily 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 Volume II of this report.

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.

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 NO_x 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 are contained in Volume II of 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.

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.

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 Volume II of 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.

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. See Volume II for a complete description of the cost-effectiveness of this technique.
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. See Volume II of this report for a complete analysis.
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.

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.