METHODOLOGY TO CALCULATE NOx EMISSIONS REDUCTIONS FROM THE IMPLEMENTATION OF THE 2000 IECC/IRC CONSERVATION CODE IN TEXAS

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ABSTRACT

Four areas in Texas have been designated by the United States Environmental Protection Agency (EPA) as non-attainment areas because ozone levels exceed the National Ambient Air Quality Standard (NAAQS) maximum allowable limits. These areas face severe sanctions if attainment is not reached by 2007. Four additional areas in the state are also approaching national ozone limits (i.e., affected areas).

In 2001, the Texas State Legislature formulated and passed the Texas Emissions Reduction Plan (TERP), to reduce ozone levels by encouraging the reduction of emissions of NOx by sources that are currently not regulated by the state. An important part of this legislation is the State's energy efficiency program, which includes reductions in energy use and demand that are associated with the adoption of the 2001 IECC, which represents one of the first times that the EPA is considering emissions reductions credits from energy conservation – an important new development for building efficiency professionals, since this could pave the way for documented procedures for financial reimbursement for building energy conservation from the state's emissions reductions funding.

This paper provides a detailed discussion of the procedures that have been used to calculate the electricity savings and NOx reductions from residential construction in non-attainment and affected counties using the eGRID database. The previous paper by Haberl et al. (2004) presents results from the application of the methodology that is detailed in this paper.

BACKGROUND

In 2001, the Texas State Legislature formulated and passed Senate Bill 5 to further reduce ozone levels by encouraging the reduction of emissions of NO_x by sources that are currently not regulated by the TNRCC, including area sources (e.g., residential emissions), on-road mobile sources (e.g., all types of motor vehicles), and non-road mobile sources (e.g., aircraft, locomotives, etc.)[1]. An important part of this legislation is the evaluation of the State's new energy efficiency programs, which includes reductions in energy use and demand that are associated with specific utility-based energy conservation measures, and implementation of the International Energy Conservation Code (IECC 2001). In 2001 thirty-eight counties in Texas were designated by the EPA as either non-attainment or affected areas[2]. In 2003, three additional counties were classified as affected counties[3], bringing the total to forty-one counties (sixteen non-attainment and twenty-five affected counties). This paper provides a detailed discussion of the procedures that have been used to calculate the electricity savings and NOx reductions from residential construction in non-attainment and affected counties. The results from the application of the methodology described in this paper were presented in Haberl et al. (2004).

METHODOLOGY

In order to calculate the statewide NOx emissions from the implementation of the 2000 IECC to residential construction a series of methodologies were developed for calculating the annual and peak-day energy use (electricity and natural gas consumption) for buildings built to representative pre-code construction and comparing these to code-compliant construction for prototypical buildings that represent average construction practices in each county. These savings were then assigned to specific counties

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[1] In the 2003 Texas State legislative session, the emissions reductions legislation in Senate Bill 5 was modified by House bill 3235, and House bill 1365. In general, this new legislation strengthens the previous legislation, and did not reduce the stringency of the building code or the reporting of the emissions reductions.

[2] The sixteen counties designated as non-attainment counties include: 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 include: 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.

[3] These counties are Henderson, Hood and Hunt counties in the Dallas – Fort Worth area.

in the state and the electricity use traced back to the power plants that supplied the electricity use using the EPA's eGRID database[4].

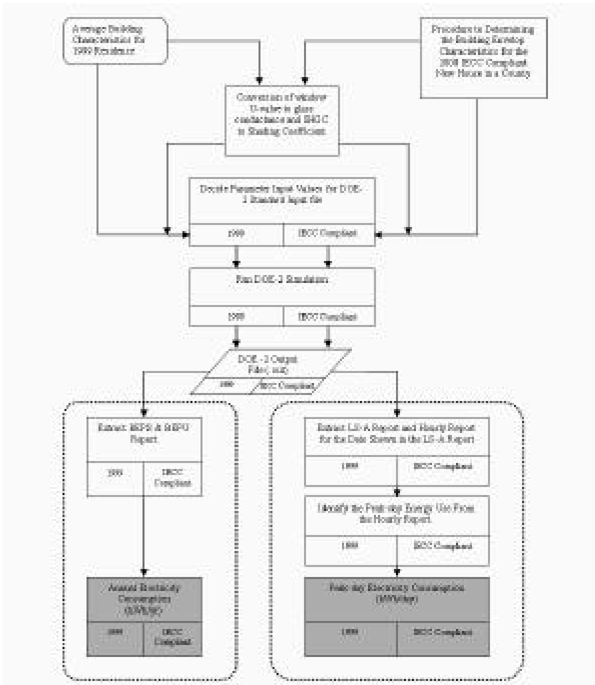

Figure 1: *Procedures for the annual and peak-day energy use calculations for 1999 residence and 2000 IECC complaint residences*

Calculation of Annual and Peak-day Electricity Savings in New Residential Construction Figure 1 shows the overall procedure for performing the energy savings calculations. In the first step, the building characteristics for the pre-code (i.e., 1999) and the code-compliant house were identified. The characteristics of the 1999 house were collected using the baseline construction data from the annual survey of the National Association of Home Builders (NAHB 2000). These 1999 data were assumed to represent the pre-code construction practices for each county. Next, the building characteristics for the code-compliant house were defined by determining the appropriate building envelope characteristics for the 2000 IECC compliant new house for a particular county. For the 1999 and code-compliant data, the windows U-value and the SHGC were converted to the DOE-2-required glass conductance and the Shading Coefficient (SC) values[5]. The 1999 and code-compliant building characteristics were then input separately into the standard DOE-2 input file as PARAMETERS. Two simulations, one for the 1999 house and one for the code-compliant house were then performed using the DOE-2.1e simulation program with the appropriate TMY-2 weather data assigned to the county.

From the output files of the DOE-2 simulations for the 1999 and the code-compliant houses, annual electricity, natural gas use, peak-day electricity use, and natural gas use on the peak-day for electricity were identified (Figure 2 to Figure 5). To calculate annual electricity and natural gas savings, DOE-2's BEPS (Figure 2) and BEPU (Figure 3) reports were extracted from the DOE-2.1e output files. The BEPS and BEPU reports contain the simulated annual building energy performance summary. From these reports, the total annual energy use (Btu), and total annual electricity (kWh) and natural gas (therms) use were identified for both the 1999 and code-compliant houses.

To calculate the peak-cooling electricity and natural gas savings, another procedure was required. First, the DOE-2 report LS-A was extracted from the output files for the 1999 house (Figure 4). This LS-A report makes it possible to identify the time and date of the peak cooling load for the pre-code house. Using the same peak day from the report LS-A for the 1999 pre-code house, the electricity and gas use of the pre-code and the code-compliant house for the same peak-cooling day were extracted from the hourly report (Figure 5). The peak-day electricity and gas savings were then calculated by comparing the pre-code values against the code-compliant values for each county using data from

[4] 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/.

[5] The DOE-2 program has several methods for entering window properties, including the two digit Window type, four digit window type (which calls library files previously prepared by the WindowX program, and a method that uses the glass conductance, and shading coefficient. Although the four digit window entry routine is recognized to yield more accurate values for high efficiency windows, it cannot be used in a general purpose simulation where only the U-value and shading coefficient are known, because the four digit method relies on window properties read from library files, which were previously created with the WindowX program that used characteristics from an actual window, including size and shape of the window.

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EPORT- BEPS  BUILDING ENERGY PERFORMANCE SUMMARY                 WEATHER FILE- HOUSTON  TX TMY2
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                                   ENERGY TYPE:  ELECTRICITY  NATURAL-GAS
                                   UNITS: MBTU

                                CATEGORY OF USE
                                ---------------

                                    AREA LIGHTS        13.2         0.0

                                   MISC EQUIPMT        13.2         0.0

                                     SPACE HEAT         0.0         7.6

                                     SPACE COOL        17.0         0.0

                                   PUMPS & MISC         0.2         0.0

                                      VENT FANS         2.5         0.0

                                   DOMHOT WATER         0.0        16.3
                                                 ----------  ----------

                                          TOTAL        45.9        23.9

TOTAL SITE ENERGY       69.86 MBTU     27.9 KBTU/SQFT-YR GROSS-AREA     23.4 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY    161.75 MBTU     64.7 KBTU/SQFT-YR GROSS-AREA     54.2 KBTU/SQFT-YR NET-AREA

                    PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE =  0.0
                    PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED                =  0.0
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Figure 2: *DOE-2 BEPS report*

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REPORT- BEPU  BUILDING ENERGY PERFORMANCE SUMMARY (UTILITY UNITS)    WEATHER FILE- HOUSTON  TX TMY2
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                                   ENERGY TYPE:  ELECTRICITY  NATURAL-GAS
                                    SITE UNITS:      KWH          THERM

                                CATEGORY OF USE
                                ---------------

                                    AREA LIGHTS        3854.           0.

                                   MISC EQUIPMT        3854.           0.

                                     SPACE HEAT           0.          76.

                                     SPACE COOL        4967.           0.

                                   PUMPS & MISC          65.           0.

                                      VENT FANS         721.           0.

                                   DOMHOT WATER           0.         163.
                                                 ----------  ----------

                                          TOTAL       13460.         239.

TOTAL ELECTRICITY    13460. KWH    5.384 KWH /SQFT-YR GROSS-AREA    4.511 KWH     /SQFT-YR NET-AREA
TOTAL NATURAL-GAS    239. THERM   0.096 THERM /SQFT-YR GROSS-AREA   0.080 THERM   /SQFT-YR NET-AREA

                   PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE =  0.0
                   PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED                =  0.0
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Figure 3: *DOE-2 BEPU report*

REPORT- LS-A SPACE PEAK LOADS SUMMARY   WEATHER FILE- HOUSTON TX TMY2

SPACE NAME	MULTIPLIER SPACE	MULTIPLIER FLOOR	COOLING LOAD (KBTU/HR)	TIME OF PEAK	DRY-BULB	WET-BULB	HEATING LOAD (KBTU/HR)	TIME OF PEAK	DRY-BULB	WET-BULB
RM-1	1.	1.	26.312	JUL 29 2 PM	95.F	76.F	-21.432	JAN 11 4 AM	18.F	15.F
GARAGE-1	1.	1.	38.593	JUL 30 2 PM	97.F	78.F	-48.068	JAN 11 4 AM	18.F	15.F
SUM			64.905				-69.501			
BUILDING PEAK			63.659	JUL 30 2 PM	97.F	78.F	-69.501	JAN 11 4 AM	18.F	15.F

Figure 4: *DOE-2 LS-A report*

REP1 = HOURLY-REPORT

	PLANT TOTAL ELECTRIC KW ----(10)
730 1	0.880
730 2	0.880
730 3	0.880
730 4	0.880
730 5	0.880
730 6	0.880
730 7	1.710
730 8	2.425
730 9	2.821
73010	3.523
73011	4.347
73012	4.386
73013	4.880
73014	4.928
73015	5.002
73016	4.888
73017	4.494
73018	4.119
73019	3.414
73020	2.682
73021	2.167
73022	1.960
73023	1.654
73024	1.563
0 DAILY SUMMARY (JUL 30)	
MN	0.880
MX	5.002
SM	66.242
AV	2.760

REP1 = HOURLY-REPORT

	END-USE HEATING FUEL PA1 BTU/HR ----(15)	END-USE DHW HEAT FUEL PA1 BTU/HR ----(18)
730 1	500.000	1708.971
730 2	500.000	1708.971
730 3	500.000	1708.971
730 4	500.000	1708.971
730 5	500.000	1708.971
730 6	500.000	1708.971
730 7	500.000	1708.971
730 8	500.000	1708.971
730 9	500.000	1708.971
73010	500.000	1708.971
73011	500.000	1708.971
73012	500.000	1708.971
73013	500.000	1708.971
73014	500.000	1708.971
73015	500.000	1708.971
73016	500.000	1708.971
73017	500.000	1708.971
73018	500.000	1708.971
73019	500.000	1708.971
73020	500.000	1708.971
73021	500.000	1708.971
73022	500.000	1708.971
73023	500.000	1708.971
73024	500.000	1708.971
0 DAILY SUMMARY (JUL 30)		
MN	500.000	1708.971
MX	500.000	1708.971
SM	12000.000	41015.289
AV	500.000	1708.970

Figure 5: *DOE-2 hourly report for one day.*

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	TNMP	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-Galveston Area Council	RELIANT(CENTER POINT)	Bellville	San Bernard 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)	TNMP	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	TNMP	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	TNMP	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 Bernard 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	TNMP	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	TNMP	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	TNMP	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	TNMP	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	TNMP	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)	TNMP	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 Valley EC				
GRAY	1	Panhandle Regional Planning Commission	XCEL(SPS)	Greenbelt EC						
GRAYSON	22	Texoma Council of Governments	ONCOR	TNMP	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 Bernard EC					
GUADALUPE	18	Alamo Area Council of Governments	CPSB	Seguin	Guadalupe Valley 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)	TNMP	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 Bernard 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	TNMP	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	TNMP	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	TNMP	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	TNMP	J-A-C EC	Tri-County EC	Fort Belknap EC	Wise EC		

Table 1:*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	TNMP	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	TNMP	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 EC	Fayette EC
LEE	12	Capital 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	TNMP	North Plains EC							
LIVE OAK	20	Coastal Bend Council of Governments	CPL(AEP)	San Patricio EC	Karnes EC	Nueces EC					
LLANO	12	Capital 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	TNMP	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	Goldthwaite	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	TNMP	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 Bernard 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	TNMP	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	TNMP	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	TNMP	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	TNMP	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)	TNMP	Lamar County EC	Bowie-Cass EC				
REEVES	9	Permian Basin Regional Planning Commission	WTU(AEP)	ONCOR	TNMP	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	Bremond	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	TNMP	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	TNMP	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)	TNMP	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	Capital 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 Bernard EC					
WARD	9	Permian Basin Regional Planning Commission	ONCOR	TNMP							
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	Capital 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	TNMP							
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	TNMP	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 2: *PUCT power suppliers by county (Obtained from PUCT website, http://www.puc.state.tx.us. November, 2002) (Part b).*

the hourly report[6].

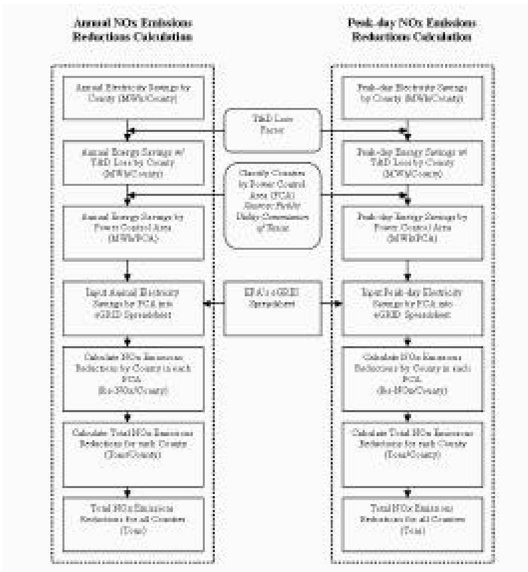


Figure 6: *Annual and peak-day NO_x emission reductions calculation.*

Calculation of NOx Emissions From Code Implementation in New Residential Construction Using eGRID The next steps in the methodology involved multiplying the DOE-2-calculated electricity and gas savings (annual and peak day) from the comparison of the pre-code to code-compliant construction times the number of new units in each county to obtain the county-wide electricity and gas savings (annual and peak day) as shown in **Figure 6**. Next, the county-wide electricity savings were then adjusted to account for transmissions and distribution losses[7] (T&D losses). Then, a utility company was assigned to each county using the Texas Public Utility Commission's (PUCT) listing of utility providers[8] (Table 1: and Table 2:). After this step, the 38 counties were grouped according to utility (i.e., PCA) as shown in Table 3. This grouping was performed to allow for the total utility electricity savings to be input into the EPA's eGRID database.

For a given region, eGRID produces a matrix such as that shown in Table 4, which shows the pounds of NOx per MWh produced by a specific utility in each county[9]. In Table 4 the counties are listed alphabetically in each row, with the utilities listed in each column. The bottom row of Table 4 gives the total lbs-NOx/MWh for each utililty, which represents the NOx emissions from all the utility plants that serve that utility. Each individual row in Table 4 gives the lbs-NOx/MWh produced in each county, which includes the emissions from all utilities that have plants located in that county. A large value in a given cell of a row for a utility provider indicates large power generation facility.

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		
		Austin Energy/PCA			
Nueces	CPL	American Electric Power West (ERCOT)/PCA	ERCOT		
San Patricio	CPL	American Electric Power West (ERCOT)/PCA	ERCOT		
Victoria	CPL	American Electric Power West (ERCOT)/PCA	ERCOT		
		American Electric Power West (ERCOT)/PCA			
Bastrop		Lower Colorado River Authority/PCA	ERCOT		
Caldwell		Lower Colorado River Authority/PCA	ERCOT		
Comal		Lower Colorado River Authority/PCA	ERCOT		
Guadalupe		Lower Colorado River Authority/PCA	ERCOT		
Hays		Lower Colorado River Authority/PCA	ERCOT		
Wilson		Lower Colorado River Authority/PCA	ERCOT		
		Lower Colorado River Authority/PCA			
Brazoria	Reliant Energy HL&P	Reliant Energy HL&P/PCA	ERCOT		
Fort Bend	Reliant Energy HL&P	Reliant Energy HL&P/PCA	ERCOT		
Galveston	Reliant Energy HL&P	Reliant Energy HL&P/PCA	ERCOT		
Harris	Reliant Energy HL&P	Reliant Energy HL&P/PCA	ERCOT		
Waller	Reliant Energy HL&P	Reliant Energy HL&P/PCA	ERCOT		
		Reliant Energy HL&P/PCA			
Bexar	San Antonio Public Service Bd	San Antonio Public Service Bd/PCA	ERCOT		
		San Antonio Public Service Bd/PCA			
Ellis	TXU	TXU Electric/PCA	ERCOT		
Johnson	TXU	TXU Electric/PCA	ERCOT		
Kaufman	TXU	TXU Electric/PCA	ERCOT		
Parker	TXU	TXU Electric/PCA	ERCOT		
Rockwall	TXU	TXU Electric/PCA	ERCOT		
Smith	TXU	TXU Electric/PCA	ERCOT		
Williamson	TXU	TXU Electric/PCA	ERCOT		
Collin	TXU	TXU Electric/PCA	ERCOT		
Dallas	TXU	TXU Electric/PCA	ERCOT		
Denton	TXU	TXU Electric/PCA	ERCOT		
Tarrant	TXU	TXU Electric/PCA	ERCOT		
		TXU Electric/PCA			
Chambers	EGS	Entergy Electric System/PCA	SERC		
Hardin	EGS	Entergy Electric System/PCA	SERC		
Jefferson	EGS	Entergy Electric System/PCA	SERC		
Liberty	EGS	Entergy Electric System/PCA	SERC		
Montgomery	EGS	Entergy Electric System/PCA	SERC		
Orange	EGS	Entergy Electric System/PCA	SERC		
		Entergy Electric System/PCA			
El Paso	EL PASO Electric Company	El Paso Electric Co/PCA	WSCC		
		El Paso Electric Co/PCA			
Gregg	SWEPCO	Southwestern Public Service Co/PCA	SPP		
Harrison	SWEPCO	Southwestern Public Service Co/PCA	SPP		
Rusk	SWEPCO	Southwestern Public Service Co/PCA	SPP		
Upshur	SWEPCO	Southwestern Public Service Co/PCA	SPP		
		Southwestern Public Service Co/PCA			
Total					

Table 3: *Calculation table for energy use by PCA*

[6] The dates for these peak-cooling days across the 41 counties are non-coincident, which is assumed to give results that are the most consistent with the measured weather data for the EPA's episode days for 1999 (Dallas-Ft. Worth), and 2000 (Houston, Galveston, Beaumont, Port Author). Use of coincident peak across different TMY-2 weather files gives lower temperature values.

[7] These T&D losses were assumed to be 20% for the 2003 calculations.

[8] For the calculations performed for the 2003 Annual report, the first utility listed for each county was assumed to be the only utility for that county.

[9] The information shown is from the November 2002 edition of the eGRID database, provided by Art Diem at the USEPA.

		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	0.08	0.30	0.08	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	0.06	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 4: *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).*

The values in eGRID are assembled for a given period of time and represent the measured NOx emissions for a given utility divided by the total power production for a given plant.

Before the eGRID database could be used it needed to be modified, as shown in Table 5. First, the non-attainment and affected counties (i.e., rows) that did not contain electric utility generation facilities were added to the matrix as shown in Table 5. These additions appear as rows that have 0.00 lbs-NOx/MWh values since they represent counties that did not contain power plants for the utilities listed in the November 2002 version of eGRID[10]. After all 38 counties had been added to the modified eGRID database, each column of eGRID was expanded to include a multiplier as shown in Table 5. These multipliers were used to calculate the lbs-NOx/MWh for each MWh saved by the utility, which is the row bottom of Table 5. Calculation of the annual NOx reductions and peak-day NOx reductions by county[11] was then accomplished by adding across each row, which yields the Total NOx reductions shown in the far right column of Table 5. The values in this column

[10] The utilities listed in the 2002 eGRID include: American Electric Power (AEP), Austin Energy, Brownsville Public Utility Board, Lower Colorado River Authority (LCRA), Reliant Energy, San Antonio Public Service, South Texas Electric Coop, Texas Municipal Power Pool, Texas-New Mexico Power Company, and TXU.

[11] The calculation of annual NOx reductions required the input of annual savings of MWh/utility in the bottom row of the table. Similarly, the peak-day NOx reductions required the input of peak-day savings in MWh/utility in the bottom row of the table.

were then used to report the NOx reductions for each county, such as those shown in **Figure 7**.

Area	County	American Electric Power - West (WTU) /PCA	NOx Reductions (lbs)	Austin Energy/PCA	NOx Reductions (lbs)	Brownsville Public Utils Board/PCA	NOx Reductions (lbs/year)	Lower Colorado River Authority /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	0.31	0.00		0.00	0.01	0.00		0.00		0.00		0.00		0.00	0.00
	BEXAR	0.08	0.00	0.09	0.00	0.04	0.00	0.76	0.00		0.00	2.08	0.00	0.06	0.00	0.05	0.00		0.00		0.00	0.00
	TRAVIS		0.00	1.86	0.00		0.00	0.96	0.00		0.00		0.00		0.00		0.00		0.00		0.00	0.00
	FAYETTE	0.02	0.00	0.06	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	0.01	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	0.06	0.00	0.19	0.00		0.00	0.02	0.00	0.00
	DALLAS	0.08	0.00	0.06	0.00	0.04	0.00	0.09	0.00	0.01	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	0.04	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	0.05	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	0.00	0.00	0.02	0.00	0.18	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
	ERATH	0.02	0.00	0.02	0.00	0.01	0.00	0.02	0.00	0.01	0.00		0.00	0.03	0.00	0.04	0.00	0.02	0.00	0.17	0.00	0.00
	FISHER	0.09	0.00		0.00	0.09	0.00	0.01	0.00		0.00		0.00	1.19	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	0.27	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	0.08	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	0.02	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	0.48	0.00	0.00
	MITCHELL	0.04	0.00	0.04	0.00	0.02	0.00	0.07	0.00	0.02	0.00	0.01	0.00	0.00	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	0.02	0.00	0.01	0.00		0.00	0.09	0.00	0.30	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	0.03	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	0.06	0.00	0.02	0.00	0.18	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	0.08	0.00	0.03	0.00	0.16	0.00	0.00
	TARRANT	0.04	0.00	0.04	0.00	0.01	0.00	0.06	0.00	0.03	0.00	0.01	0.00	0.06	0.00	0.19	0.00	0.06	0.00	0.31	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	0.06	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	0.05	0.00	0.02	0.00	0.39	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	1.81	0.00	0.20	0.00	0.09	0.00	0.06	0.00	0.07	0.00	0.19	0.00	0.00
	GALVESTON	0.09	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	0.07	0.00	0.47	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	0.65	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
ETC	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	0.21	0.00	0.00
	CALHOUN	0.19	0.00		0.00	0.13	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
	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	0.06	0.00	0.05	0.00	0.02	0.00	0.01	0.00	0.06	0.00	0.03	0.00	0.10	0.00	0.61	0.00	0.00
	WEBB	0.06	0.00		0.00	0.04	0.00		0.00		0.00		0.00	0.03	0.00		0.00		0.00		0.00	0.00
	NUECES	0.74	0.00	0.01	0.00	0.56	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	0.01	0.00	0.00
	VICTORIA	0.38	0.00	0.01	0.00	0.22	0.00	0.01	0.00		0.00		0.00	0.00	0.00	0.02	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	3.09		2.88		2.37		5.17		3.48		2.63		3.37		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 5: *Modified eGRID database for calculating NOx emissions by the 38 non-attainment, and affected counties.*

<u>Calculation of Peak Day Electricity Savings Calculated From Monthly Utility Billing Data.</u> In Section 388.005 of the Texas Emissions Reduction Plan (TERP) political subdivisions (i.e., city and county governments) are required to establish a goal to reduce their electricity consumption by 5 percent per year beginning January 1st, 2002. Unfortunately, savings were then reported to the Texas State Energy Conservation Office as kWh/year, which were then divided by 365 to obtain average daily NOx reductions. For savings associated with cooling-related loads, this can lead to severe undercounting, which has been shown to be as much as 100% in residences[12].

To improve the reporting of peak-day NOx reductions from utility billing data, a method was developed to extract peak-day electricity reductions from monthly utility billing data as shown in Figure 8 and **Table 6**. In Figure 8 the simulated electricity use is shown for two identical single-family residences, with the exception that one is built to the NAHB's pre-code specifications, and one built to code-compliant specifications[13]. In part (a) of Figure 8 the simulated monthly electricity use of the pre-code house is plotted versus average monthly temperature with a three-parameter, weather-dependent model shown super-imposed over the data. This three-parameter model, which was calculated with ASHRAE's Inverse Model Toolkit (IMT) (Kissock et al. 2003, Haberl et al.

[12] For more information about the 2:1 differences in the peak-day NOx reductions versus average daily NOx reductions see the report by 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).

[13] For more information about the pre-code and code-compliant simulations see the report by Haberl, J., Culp, C., Yazdani, B., Fitzpatrick, T., Turner, D. 2003b. "Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP): Volume 1: Summary Report", Energy Systems Laboratory Report No. ESL-TR-05/03/12-03, Texas A&M University (December).

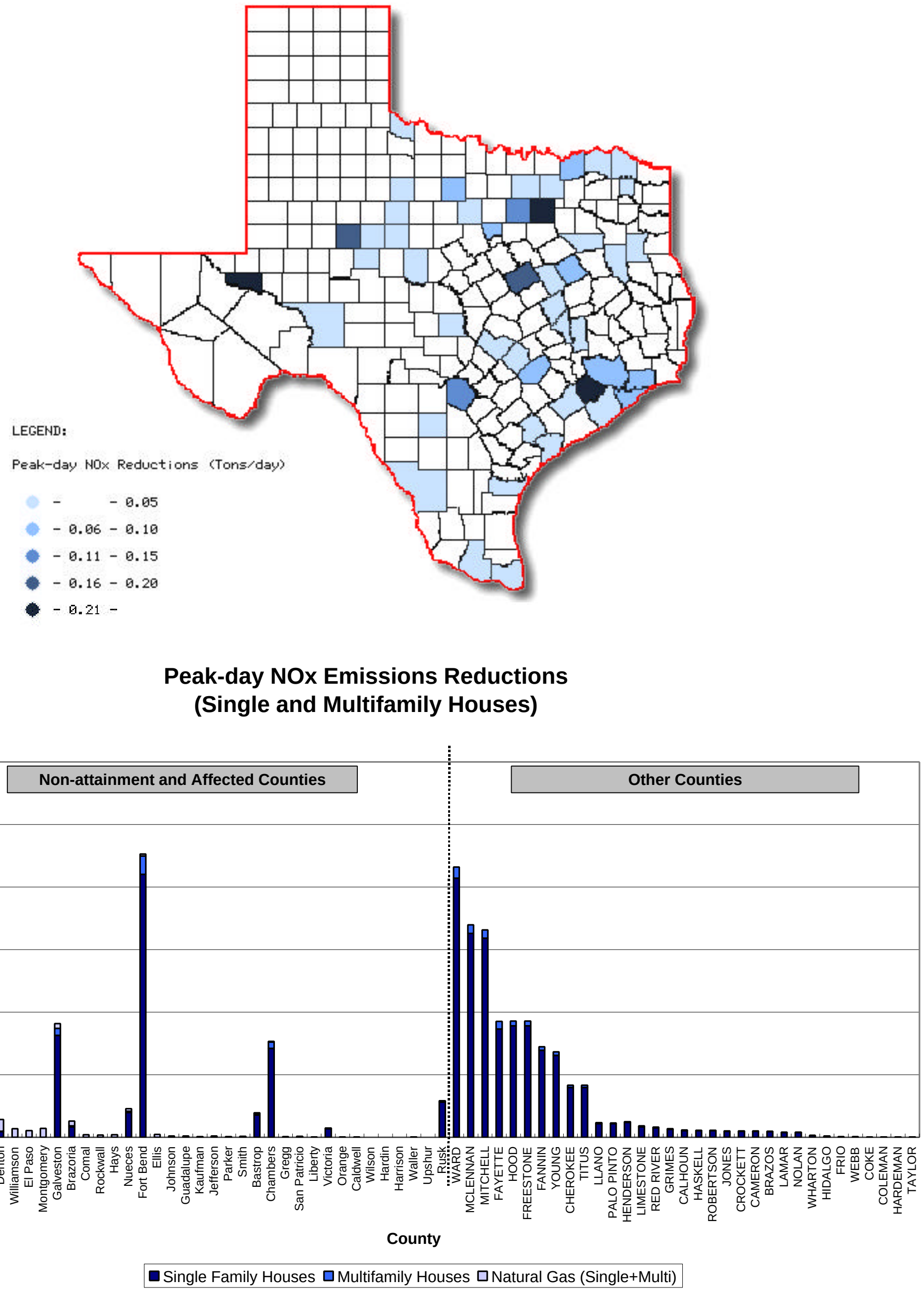


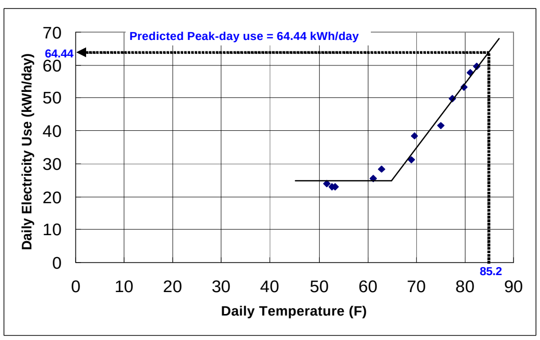
Figure 7: *2003 peak eay NOx reductions from electricity and natural gas savings due to the 2000 IECC for single-family and multi-family residences by county.*

2003), is used to predict the house's peak-day electricity savings using the model's daily coefficients (shown directly below the plot) times the peak daily temperature. In part (b) of Figure 8 the simulated monthly electricity use of the code-compliant house is plotted versus average monthly temperature with a three-parameter, weather-dependent model shown super-imposed over the data.

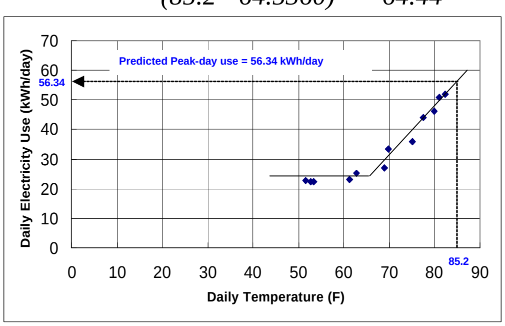
Table 6 contains a comparison of the peak-daily electricity use extracted using the described method versus the actual peak-daily electricity from the DOE-2 simulation of the pre-code and code-compliant house. According to the simulation, the peak day on the TMY-2 Houston weather file was July 29th, which had an average temperature of 85.2 F. On this day the DOE-2 simulation calculated an electricity use of 65.74

	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 6: *Comparison of peak-day electricity savings from 2000 IECC for simulated vs. estimation using monthly utility billing data analyzed with ASHRAE's IMT.*



Part a
1999 Standard House:
Daily Elec.Use = 24.7609 + 1.9200 x
$(85.2 - 64.5360)^{+}$ = 64.44



Part b
IECC House:
Daily Elec.Use = 24.1879 + 1.7063 x
$(85.2 - 65.7680)^{+}$ = 56.34

Figure 8: *Estimation of peak-day electricity use from monthly utility billing data using ASHRAE's IMT.*

kWh/day for the 1999 pre-code 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 code-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), which is acceptable considering that hourly data are not available for most existing buildings. Therefore, this method is being proposed for use in improving the peak-daily electricity savings from buildings that report their savings with utility billing data.

SUMMARY

This paper has presented a detailed discussion of the procedures that have been used to calculate the electricity savings and NOx reductions from residential construction in non-attainment and affected counties. These procedures use the EPA's eGRID database, as well as utility supplier data from the Texas PUC to translate county-wide electricity savings to power plant NOx reductions. A procedure has also been presented that extracts peak-daily electricity savings from monthly utility billing data, including a comparison of the method versus simulated peak-daily electricity savings for a house built to pre-code and code-compliant specifications. Results of the application of these procedures are reported in companion paper by Haberl et al. (2004).

REFERENCES

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Haberl, J., Im, P., Culp, C., Yazdani, B., Fitzpatrick, T. 2004. “NOx Emissions Reductions From Implementation of the 2000 IECC/IRC Conservation Code to Residential Construction in Texas”, Proceedings of the Fourteenth Symposium on Improving Building Systems in Hot and Humid Climates, Texas A&M University, Richardson, Texas (May).

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