IMPACT OF THE IMPLEMENTATION OF THE 2000/2001 IECC ON COMMERCIAL ENERGY USE IN TEXAS: ANALYSIS OF COMMERCIAL ENERGY SAVINGS

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Outline

METHODOLOGY

- Overview
- Analysis procedure
- The commercial simulation model

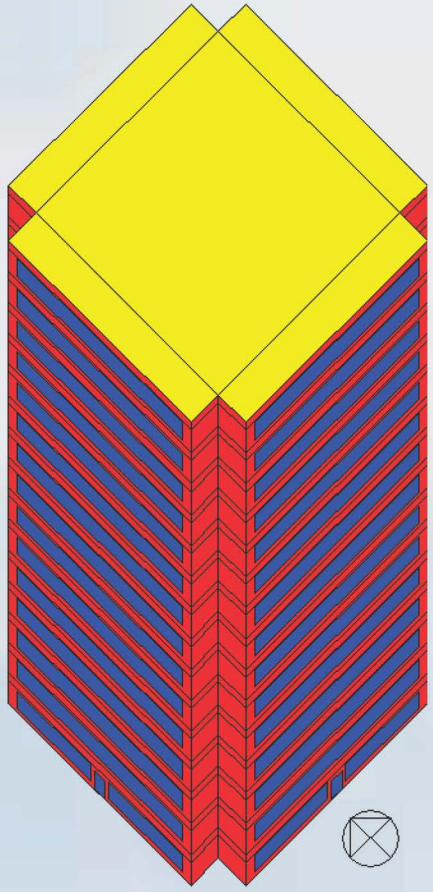
RESULTS

Methodology

OVERVIEW:

In order to quantify the annual and Ozone Season Day (OSD) energy savings due to the implementation of ASHRAE 90.1-1999 for new commercial construction:

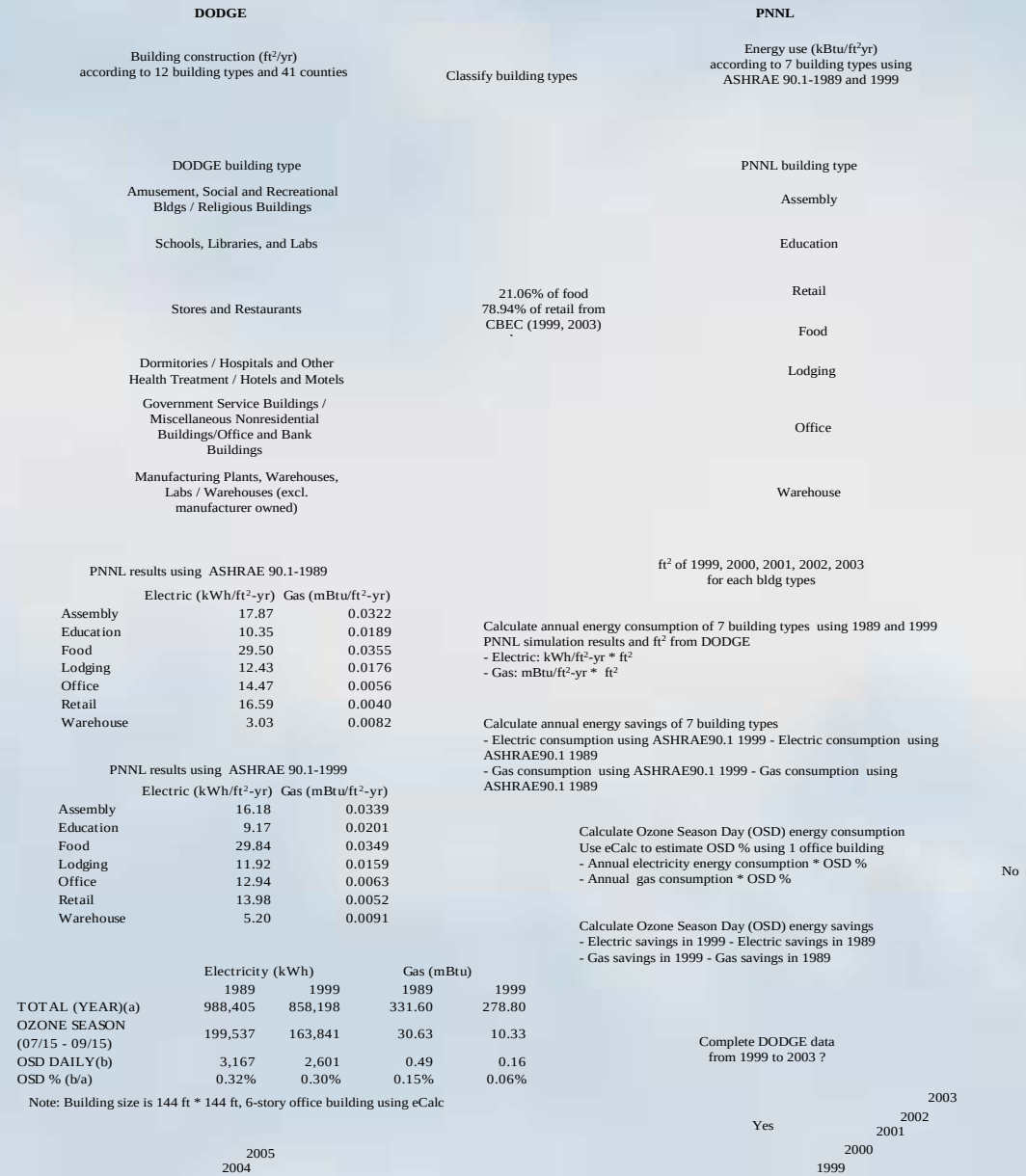
- Published analysis from a PNNL study on the impact of the implementation of ASHRAE 90.1-1999 for entire United States was used.
- The energy saving numbers for this analysis were then mapped to the published characteristics of new construction from F.W. Dodge for Texas.
- The commercial DOE-2.1e simulation model with Houston weather data was used to obtain the percentage savings for OSD.



Methodology

ANALYSIS PROCEDURE:

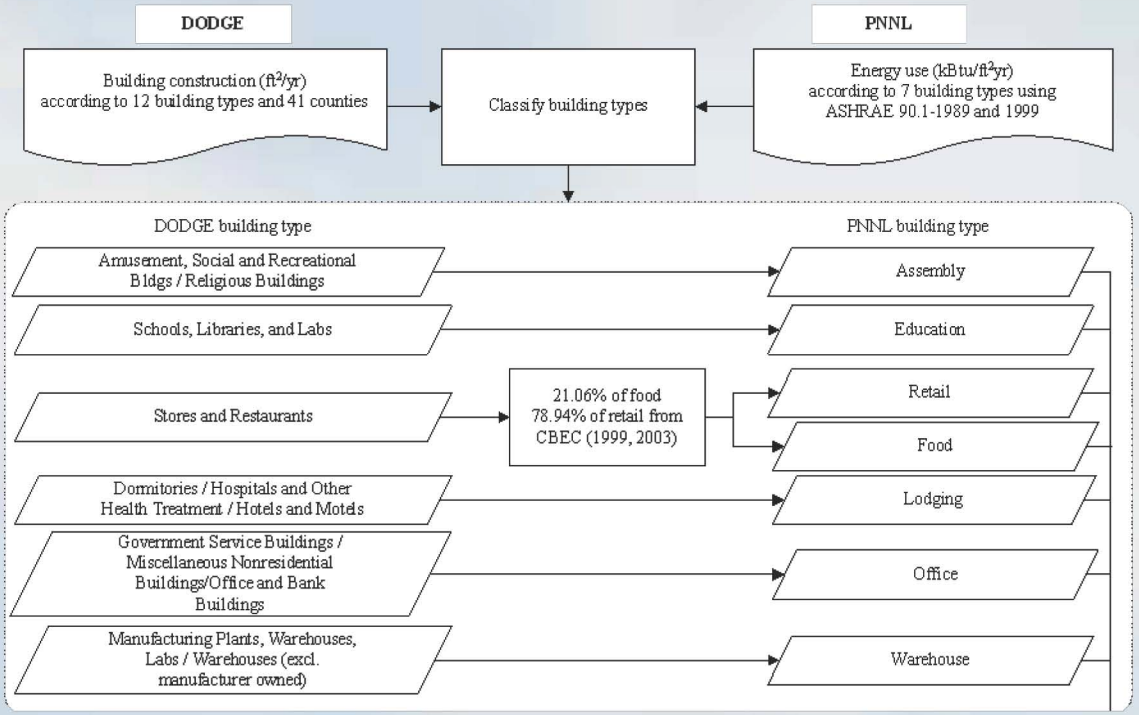
Published analysis from PNNL and published new building characteristics from F.W. Dodge were used to quantify the savings from the implementation of ASHRAE 90.1-1999:



Methodology

ANALYSIS PROCEDURE:

- Energy use for 7 building types for ASHRAE 90.1 1989 and 1999 was obtained from PNNL.
- New building construction square footage from 1999 to 2003 for 12 building types was obtained from F.W. Dodge.
- 6 building types from F.W. Dodge were mapped to the 7 types from PNNL.
- “Stores and restaurants” was divided between Retail and food for PNNL.



Methodology

ANALYSIS PROCEDURE:

- Annual energy consumption per square foot for the 6 building types was multiplied by the total new square footage for both pre-code and code.
- The savings were then calculated from the difference in energy consumption between pre-code and code.
- OSD savings obtained from using a ratio between the annual and OSD consumption from a typical commercial simulation.
- It is being assumed that the construction level will remain the same for 2004 and 2005.

PNNL results using ASHRAE 90.1-1989

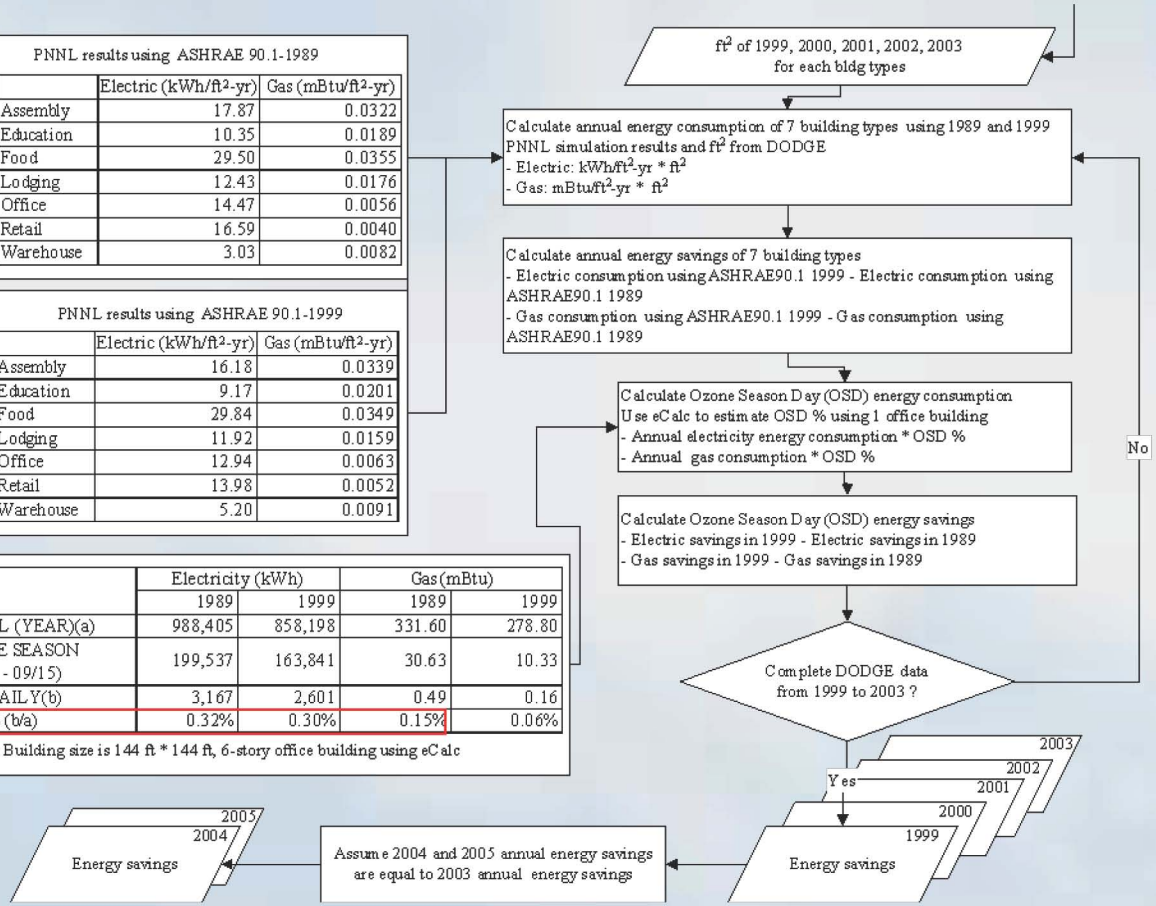
	Electric (kWh/ft²-yr)	Gas (mBtu/ft²-yr)
Assembly	17.87	0.0322
Education	10.35	0.0189
Food	29.50	0.0355
Lodging	12.43	0.0176
Office	14.47	0.0056
Retail	16.59	0.0040
Warehouse	3.03	0.0082

PNNL results using ASHRAE 90.1-1999

	Electric (kWh/ft²-yr)	Gas (mBtu/ft²-yr)
Assembly	16.18	0.0339
Education	9.17	0.0201
Food	29.84	0.0349
Lodging	11.92	0.0159
Office	12.94	0.0063
Retail	13.98	0.0052
Warehouse	5.20	0.0091

	Electricity (kWh)		Gas (mBtu)	
	1989	1999	1989	1999
TOTAL (YEAR)(a)	988,405	858,198	331.60	278.80
OZONE SEASON (07/15 - 09/15)	199,537	163,841	30.63	10.33
OSD DAILY(b)	3,167	2,601	0.49	0.16
OSD % (b/a)	0.32%	0.30%	0.15%	0.06%

Note: Building size is 144 ft * 144 ft, 6-story office building using eCalc



Methodology

THE COMMERCIAL SIMULATION MODEL:

- 6 story commercial building with a 144 x 144 ft foot print.
- Pre-calculated ASHRAE weighting factors have been used.
- Area density is taken as 275 ft^2/person.
- Lighting power density is taken 1.3 W/sq ft.
- Houston TMY2 weather data is used.

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NAME	DESCRIPTION	DEFAULT	STATUS	COMMENT
LOADS				
b01	Quick or thermal mode (Q or T)	Quick (Q)	Fixed	Q simulates the building as massless, T will include thermal mass
b02	Location	Bastrop (BAS)	User Defined	41 counties linked to 9 TRY packed weather files according to climate zone
b03	Azimuth of building (degree)	0	User Defined	Orientation of the building
b04	Length of building (ft)	122	User Defined	
b05	Width of building (ft)	122	User Defined	
b06	Floor to ceiling height (ft)	9	User Defined	
b07	Door height (ft)	7	Fixed	
b08	Door width (ft)	6	Fixed	
b09	Run year	2000	User Defined	
b10	Floor to floor height (ft)	13	User Defined	This defines the plenum height in conjunction with b06
b11	Number of floor	6	User Defined	
b12	Perimeter depth (ft)	15	Fixed	Used for thermal zoning
b13	Void			
b14	Underground floor mode	No (N)	User Defined	This allows the user to activate/deactivate underground floors
b15	Front wall: Attached to another building?	No (N)	User Defined	These 4 parameters are used to attach buildings to the different orientations of the model for the retail scenario
b16	Right wall: Attached to another building?	No (N)	User Defined	
b17	Back wall: Attached to another building?	No (N)	User Defined	
b18	Left wall: Attached to another building?	No (N)	User Defined	
b19	Building type	Office (O)	User Defined	Allows the user to switch between Office and Retail
b20	Code compliance	Code (C)	User Defined	Allows user to run user defined model or either of ASHRAE 90.1 1989 or 1999
c01	Roof absorptance	0.45	User Defined	c01 and c03 are used to determine "roof color"
c02	Roof roughness	1	Fixed	This is used to calculate the outside film coefficient for heat transfer calculations, DOE-2 allows values from 1 to 6 increasing in smoothness
c03	Roof outside emissivity	0.89	User Defined	c01 and c03 are used to determine "roof color"
c04	Roof insulation R-value (hr-sq.ft-F/Btu)	R-15	User Defined	
c05	Wall absorptance	0.57	User Defined	c05 and c07 are used to define "wall color"
c06	Wall roughness	2	Fixed	This is used to calculate the outside film coefficient for heat transfer calculations, DOE-2 allows values from 1 to 6 increasing in smoothness
c07	Wall outside emissivity	0.9	User Defined	c05 and c07 are used to define "wall color"
c08	Wall insulation R-value (hr-sq.ft-F/Btu)	R-13	User Defined	
c09	Ground reflectance	0.24	Fixed	This defines the fraction of sunlight reflected from the ground
c10	Void			
c11	U-Factor of glazing (Btu/hr-sq.ft-F)	1.22	User Defined	
c12	Solar Heat Gain Coefficient(SHGC)	0.17	User Defined	
c13	Number of pane of glazing	1	Fixed	
c14	Frame absorptance of glazing	0.7	Fixed	
c15	Frame type - A,B,C,D,E	Aluminum w/o thermal break (A)	User Defined	Allows user to select from 5 different frame types
c16	Void			
c17	Floor weight (lb/sq-ft)	70	User Defined	This corresponds to medium construction, user has a choice of light, medium or heavy construction
c18	Slab-on-grade floor insulation R-value (Exterior insulation, horizontal) (hr-sq.ft-F/Btu)	R-0 (A)	User Defined	User can choose from 9 insulation R-values and insulation depths
c19	Slab-on-grade floor R-value (hr-sq.ft-F/Btu)	0.88	Fixed	
c20	Below-grade wall insulation R-value (hr-sq.ft-F/Btu) (Exterior insulation, vertical, basement wall = 8 ft)	R-0 (A)	User Defined	User can choose from 9 insulation R-values
c21	Below-grade wall R-value (concrete wall) (hr-sq.ft-F/Btu)	0.88	Fixed	
c22	Void			
c23	Floor R-value	1.67	Fixed	
c24	Void			
c25	Ceiling R-value (hr-sq.ft-F/Btu)	1.89	Fixed	
c26	Interior wall R-value (hr-sq.ft-F/Btu)	2.01	Fixed	
c27	Percent window-front (%)	50	User Defined	
c28	Percent window-right (%)	50	User Defined	
c29	Percent window-back (%)	50	User Defined	
c30	Percent window-left (%)	50	User Defined	
sp01	void			
sp02	void			
sp03	Area per person (ft^2/person) for office	275	User Defined	
sp04	Lighting load (W/ft2) for office	1.3	User Defined	
sp05	Equipment load (W/ft2) for office	0.75	User Defined	
sp06	Area per person (ft^2/person) for retail	300	User Defined	
sp07	Lighting load (W/ft2) for retail	1.9	User Defined	
sp08	Equipment load (W/ft2) for retail	0.25	User Defined	
s01	Front Shade (S)	0	User Defined	
s02	Back Shade (N)	0	User Defined	
s03	Left Shade (W)	0	User Defined	
s04	Right Shade (E)	0	User Defined	

Methodology

THE COMMERCIAL SIMULATION MODEL:

- A built-up Variable Air Volume system was used.
- The type of the equipment and the efficiencies are chosen by an iterative procedure.
- 4 iterative runs are required for the code run and 3 for the pre-code run.

NAME	DESCRIPTION	DEFAULT	STATUS	COMMENT
SYSTEM				
sy01	Mode of system	Variable air volume (2)	User Defined	User can choose from Packaged single zone, variable air volume or packaged variable volume system
sy02	Cooling Capacity of cooling system (Btu/hr)	0	Fixed	DOE-2 is autosizing the system
sy03	Heating Capacity of heating system (Btu/hr)	0	Fixed	DOE-2 is autosizing the system
sy04	Seasonal Energy Efficiency Ratio (SEER) for PVAVS and PSZ	10	User Defined	
sy05	ANNUAL FUEL UTILIZATION EFFICIENCY (AFUE) for PSZ	0.8	User Defined	
sy06	**Spare parameter for systems other than VAVS**HEATING SEASONAL PERFORMANCE FACTOR (HSPF)	6.8	User Defined	Unused, since heatpump systems are not included in the office/retail scenario
sy07	**Spare parameter for Pilot light	0	Fixed	Unused
sy08	**Spare parameter for Pilot light	0	Fixed	Unused
sy09	**Spare parameter for Pilot light	0	Fixed	Unused
sy10	Void			
sy11	Exterior lighting (kW)	0	Fixed	
sy12	Void			
sy13	Fan control type	Variable frequency drives (1)	User Defined	User can choose from 4 different type of fan control
sy14	Economizer type	None (1)	User Defined	
sy15	Economizer drybulb limit (F) (use when economizer type(sy14) = dry bulb(2))	65	Fixed	This corresponds to the temperature above which the outside air dampers return to the minimum position
sy16	User input for numbers of fans	Autosized (A)	Fixed	Autosized by DOE-2
sy17	Number of Fans	6	Fixed	equal to the number of floors
sy18	Supply fan total pressure (in W.G)	5.5	Fixed	
sy19	Supply fan efficiency	0.54	Fixed	
sy20	Return fan total pressure (in W.G)	2	Fixed	
sy21	Return fan efficiency	0.51	Fixed	
sy22	Supply motor efficiency	0.5	Fixed	
sy23	Return motor efficiency	0.5	Fixed	
sy24	User input for DHW gallon/hr-person	Autosized (A)	Fixed	The size of DHW depends on the gallons per hour per person requirements of ASHRAE 90.1
sy25	Maximum DHW gallon/h-person (maximum hourly, to be used with occupancy schedule)	0.4	Fixed	
PLANT				
p01	Chiller type	Electric Centrifugal (1)	Fixed	
p02	Number of chillers	1	Fixed	
p03	Chillers size (MBtu/h)	-999	Fixed	Chiller is being autosized by DOE-2
p04	Condenser type	water-cooled (W)	Fixed	
p05	COP	5	User Defined	
p06	Switch for a chiller sizing	Autosized (A)	Fixed	Chiller is being autosized by DOE-2
p07	Cooling tower type	Open tower (O)		
p08	Void			
p09	Gpm/hp	38.2	Fixed	Value from ASHRAE 90.1 1999 for axial fan cooling towers
p10	Cooling tower capacity control	Two-speed fan (1)	Fixed	
p11	Boiler type	Gas fired-hotwater boiler (1)	User Defined	User can choose from gas fired or electric boilers
p12	Number of boilers	1	Fixed	
p13	Boiler size (MBtu/h)	-999	Fixed	Boiler is being autosized by DOE-2
p14	Boiler fuel type	Gas (G)	Fixed	Depends on the value of p10
p15	Boilers efficiency (Et,Ec,AFUE) (%)	80	User Defined	
p16	Switch for a boiler sizing	Autosized (A)	Fixed	Boiler is being autosized by DOE-2
p17	Void			
p18	DHW heater type	Gas water heater (1)	User Defined	User can choose from gas fired or electric water heaters
p19	Number of DHW heater	1	Fixed	
p20	DHW size (MBtu/h)	-999	Fixed	Water heater is being autosized by DOE-2
p21	DHW fuel type	Gas (G)	Fixed	Depends on the value of p18
p22	DHW heater Efficiency (Et,Ec,Energy factor) (%)	54	User Defined	
p23	Switch for a DHW heater sizing	Autosized (A)	Fixed	Water heater is being autosized by DOE-2
p24	DHW Storage Capacity (gal)	75	Fixed	

Results

COMPARISON BETWEEN ASHRAE 90.1-1989 AND 1999: (PNNL, 2002)

	Electric (kWh/sf-yr)			Gas (mBtu/sf-yr)		
	1989	1999	Diff. (%)	1989	1999	Diff. (%)
Assembly	17.87	16.18	-9.49	0.0322	0.0339	5.28
Education	10.35	9.17	-11.39	0.0189	0.0201	6.31
Food	29.50	29.84	1.16	0.0355	0.0349	-1.72
Lodging	12.43	11.92	-4.11	0.0176	0.0159	-9.48
Office	14.47	12.94	-10.61	0.0056	0.0063	12.66
Retail	16.59	13.98	-15.75	0.0040	0.0052	30.89
Warehouse	3.03	5.20	71.72	0.0082	0.0091	11.23

- Largest savings are obtained from “Education” and “Retail”.
- For “Warehouse” and “Food”, ASHRAE 90.1-1989 was more stringent.
- “Retail” has the most severe natural gas consumption penalty.

Results

COMPARISON BETWEEN ASHRAE 90.1-1989 AND 1999: (F.W. Dodge, 2003)

- "Education" comprises 22% of the total new construction.
- More than 22% of the total new construction is in Harris County
- Dallas/ Fort Worth area comprises of 40% of the total new construction
- "Warehouse" is also more than 20% of the total new construction

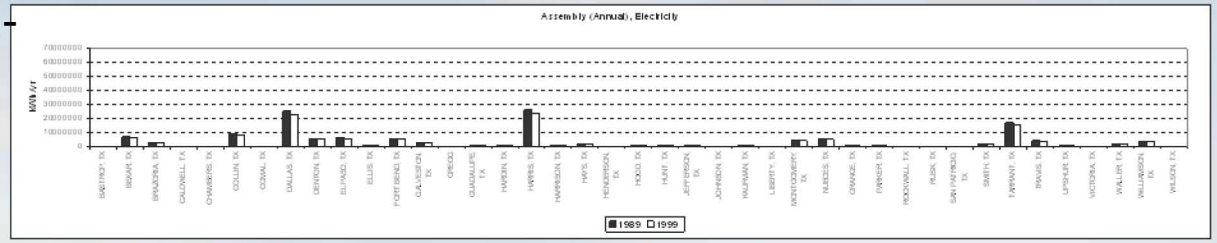
Counties	Assembly	Education	Retail	Food	Lodging	Office	Warehouse
				thousands sq.ft			
BASTROP, TX	0	272	13	4	0	45	0
BEXAR, TX	394	3230	2145	572	1533	840	1092
BRAZORIA, TX	149	462	206	55	2	144	138
CALDWELL, TX	0	46	1	0	0	0	0
CHAMBERS, TX	4	0	2	1	0	15	0
COLLIN, TX	509	1003	1160	309	1752	741	619
COMAL, TX	5	31	28	8	43	16	57
DALLAS, TX	1398	2363	2191	584	605	2343	3936
DENTON, TX	318	1729	547	146	809	878	2190
EL PASO, TX	353	816	377	101	286	437	754
ELLIS, TX	39	60	12	3	40	50	476
FORT BEND, TX	299	96	621	166	181	434	362
GALVESTON, TX	136	337	240	64	269	138	25
GREGG	14	0	195	52	131	40	44
GUADALUPE, TX	42	469	89	24	0	87	30
HARDIN, TX	21	0	135	36	0	0	0
HARRIS, TX	1452	4316	3353	895	2265	4284	5571
HARRISON, TX	24	0	121	32	0	0	19
HAYS, TX	94	140	41	11	11	16	40
HENDERSON, TX	0	0	126	34	0	5	0
HOOD, TX	48	0	16	4	0	10	0
HUNT, TX	59	148	0	0	0	30	50
JEFFERSON, TX	49	121	463	123	636	83	43
JOHNSON, TX	1	93	107	29	0	1	0
KAUFMAN, TX	42	351	0	0	0	11	590
LIBERTY, TX	1	161	6	2	30	15	0
MONTGOMERY, TX	248	1443	1177	314	192	377	233
NUECES, TX	314	59	350	93	773	74	600
ORANGE, TX	17	257	1	0	0	13	2
PARKER, TX	17	97	5	1	106	0	0
ROCKWALL, TX	0	425	3	1	0	38	200
RUSK, TX	0	0	0	0	0	0	0
SAN PATRICIO, TX	10	4	0	0	0	8	0
SMITH, TX	99	113	247	66	115	32	3
TARRANT, TX	954	1964	1780	475	980	3224	1828
TRAVIS, TX	229	244	1593	425	669	812	305
UPSHUR, TX	30	0	0	0	0	0	0
VICTORIA, TX	4	17	132	35	2	20	0
WALLER, TX	107	52	0	0	0	0	914
WILLIAMSON, TX	191	758	646	172	119	183	30
WILSON, TX	0	26	0	0	0	1	0
Total	7669	21704	18130	4836	11550	15440	20153

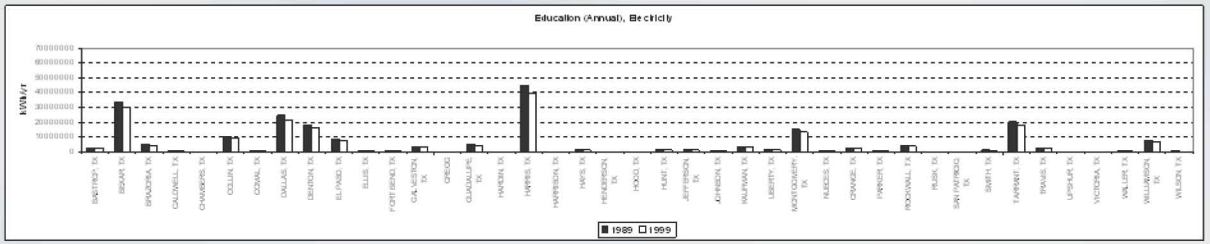
Results

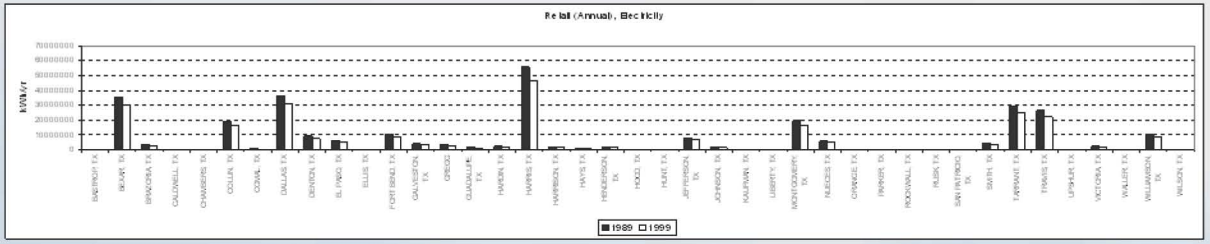
Assembly Education
Retail Food

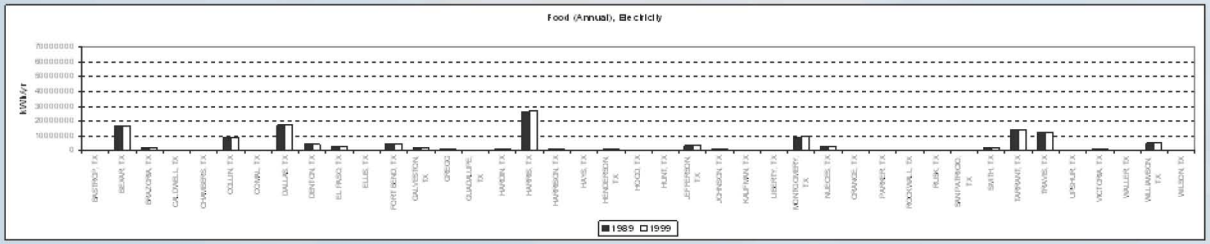
COMPARISON BETWEEN ASHRAE 90.1-1989 AND 1999: **(Annual Electricity)**

- “Retail” accounts for more than 41% of the total savings.
- “Education” save 22% of the total energy reduction.
- Harris county accounts for more than 10% of the total annual savings.
- “Food” incurs a penalty of 1,657 MWh/year.







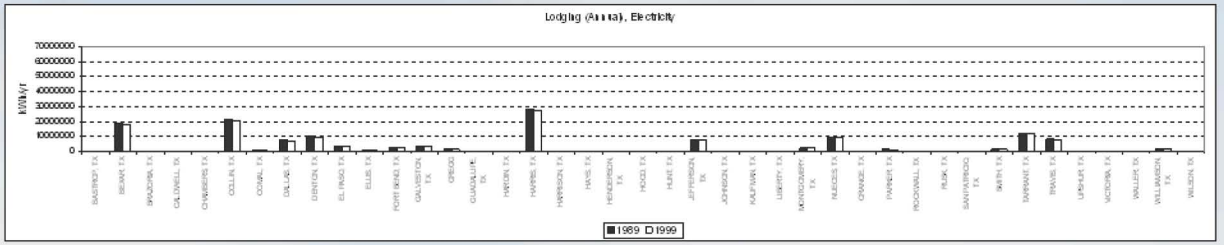


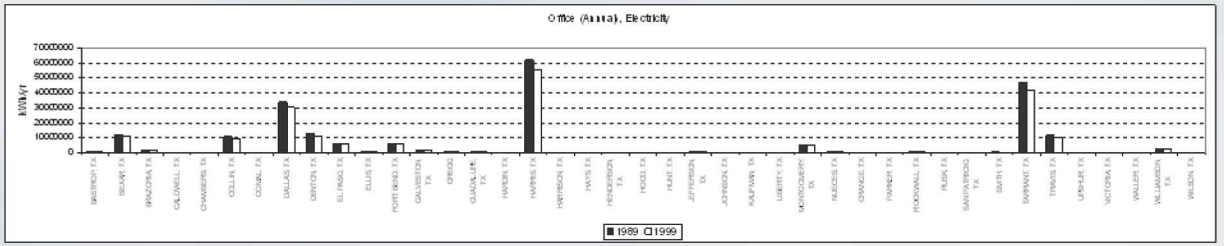
Results

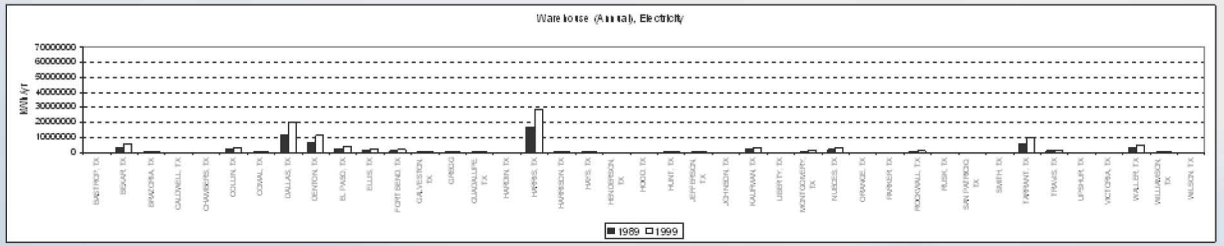
COMPARISON BETWEEN ASHRAE 90.1-1989 AND 1999: **(Annual Electricity)**

- "Office" accounts for more than 41% of the total savings.
- "Warehouse" incurs a penalty of 43,770 MWh/year.

Lodging Office Warehouse



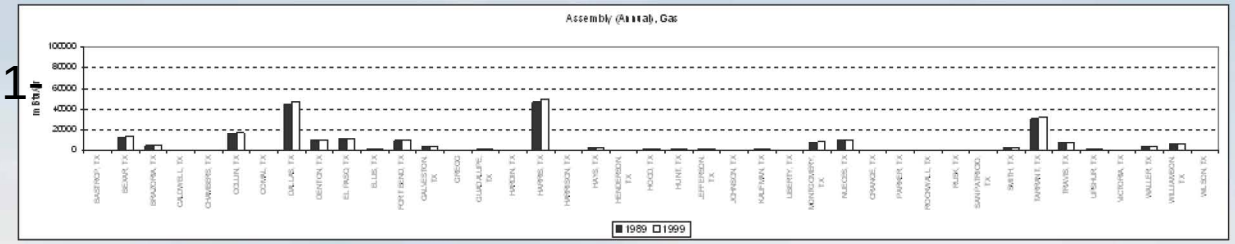


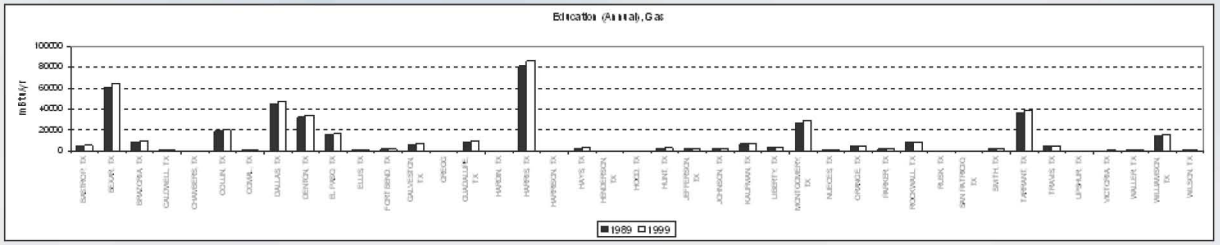


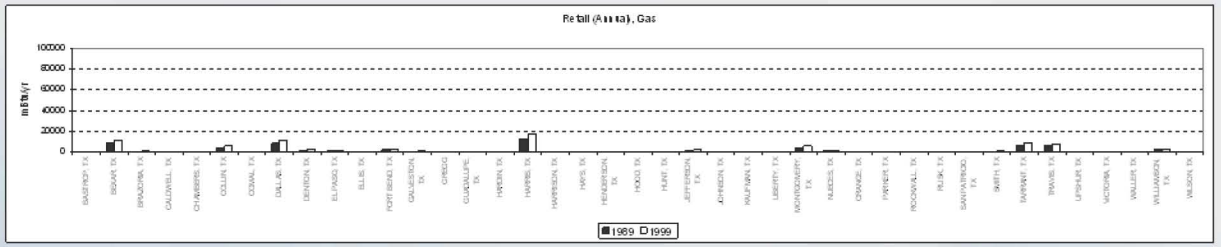
Results

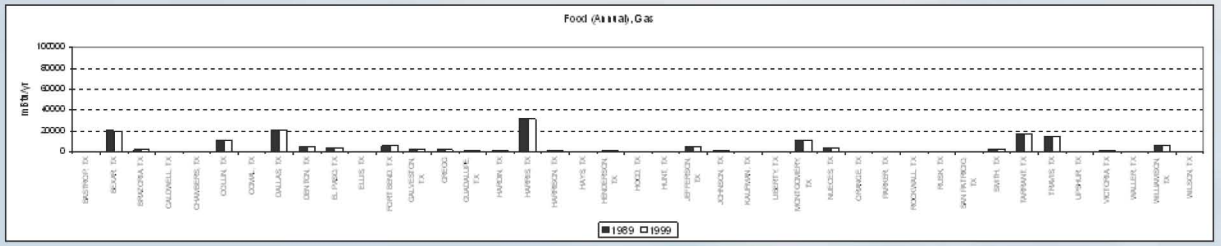
COMPARISON BETWEEN ASHRAE 90.1-1989 AND 1999: (MBtu/year)

- Natural Gas consumption goes up for all categories except for “Food” and “Lodging”
- This increase in gas consumption in most cases is caused by the reduction in lighting power density (LPD) in 90.1-1999 and better glazing.





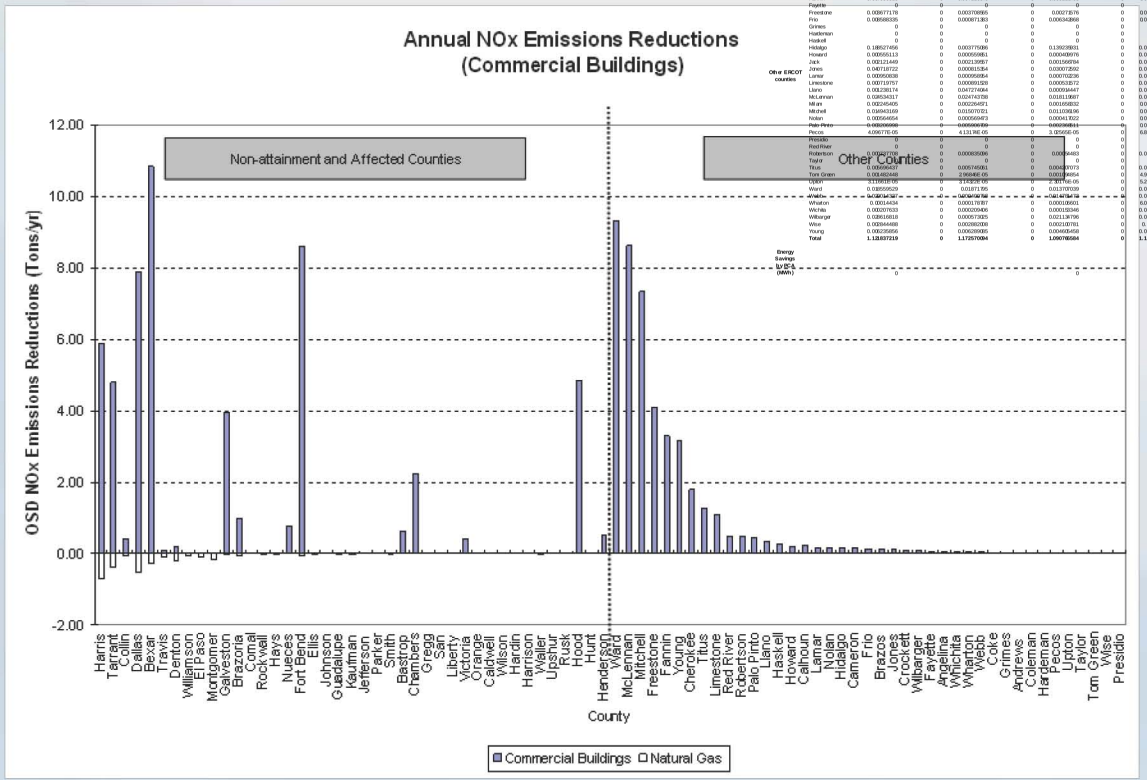


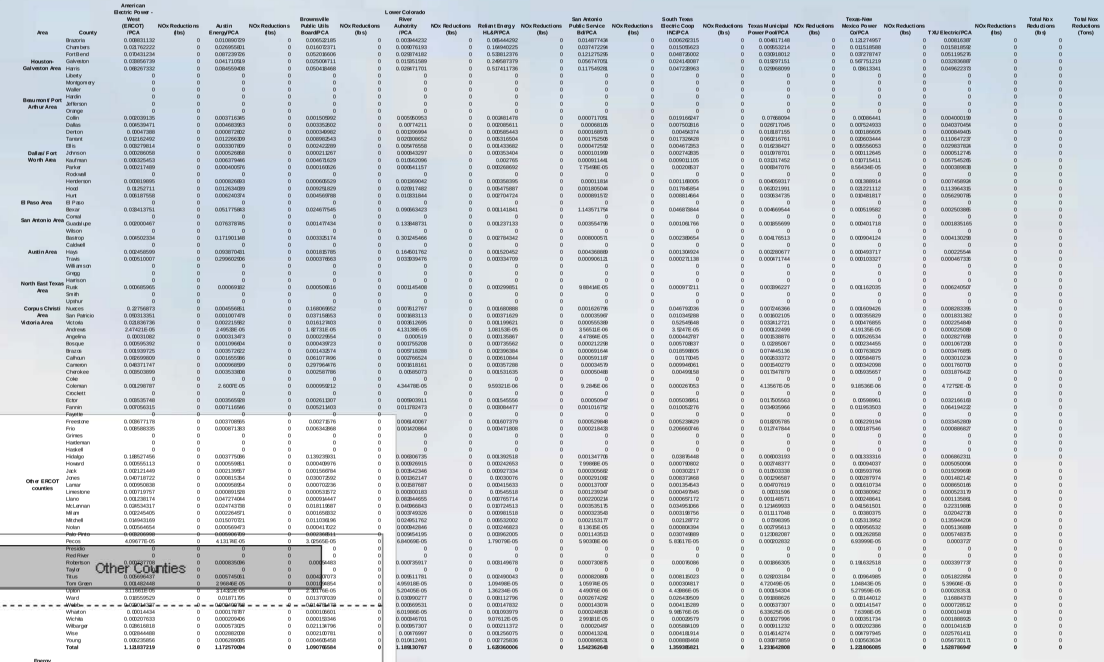


Results

NOx emissions reduction calculations:

US-EPA 2007 25% annual and OSD eGRID tool is used





Annual NOx Emissions Results

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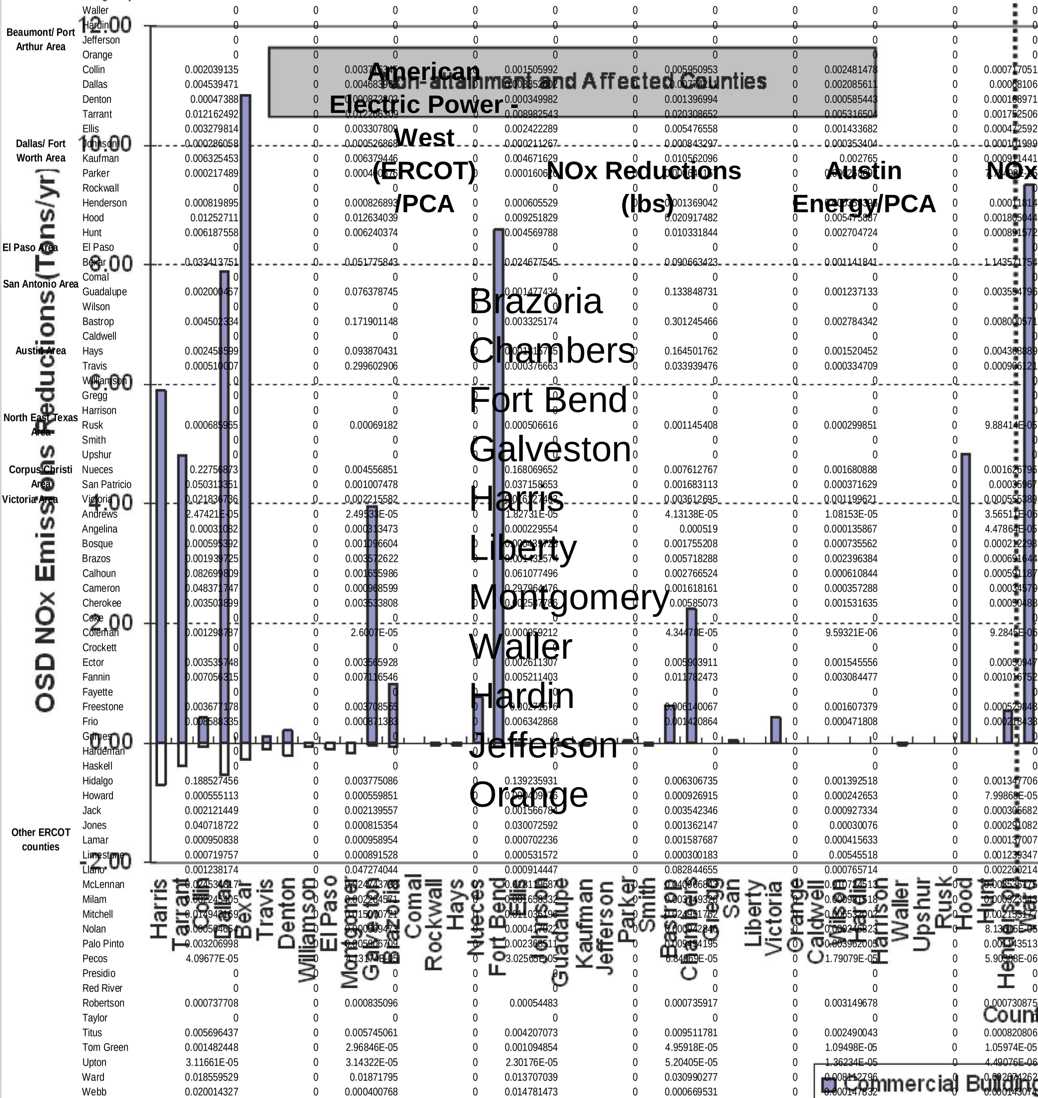

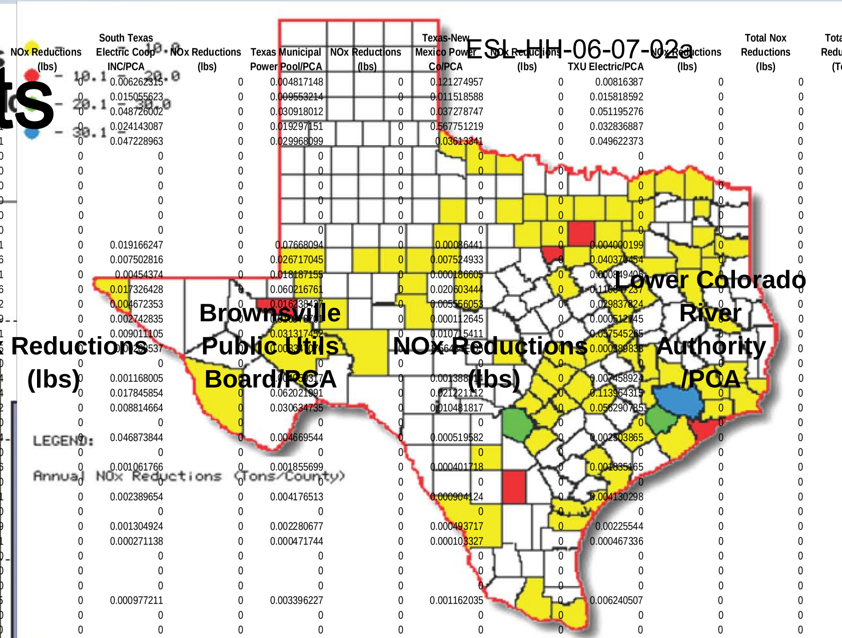

Area	County	American Electric Power - West (ERCOT) /PCA	NOx Reductions (lbs)	Austin Energy/PCA	NOx Reductions (lbs)	Brownsville Public Utils Board/PCA	NOx Reductions (lbs)	Lower Colorado River Authority /PCA	NOx Reductions (lbs)	Reliant Energy /PCA	NOx Reductions (lbs)	San Antonio Public Service Bd/PCA	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)
Houston-Galveston Area	Brazoria	0.008831132	0	0.010890729	0	0.006522185	0	0.003944232	0	[illegible]	0	[illegible]	0	0.006262315	0	0.004817148	0	0.121274957	0	0.00816387	0	0	0
	Chambers	0.021762222	0	0.026955801	0	0.016072371	0	0.009076193	0	[illegible]	0	[illegible]	0	0.015055623	0	0.009553214	0	0.011518588	0	0.015818592	0	0	0
	Fort Bend	0.070431234	0	0.087239726	0	0.052016606	0	0.029374182	0	[illegible]	0	[illegible]	0	0.048726002	0	0.030918012	0	0.037278747	0	0.051195276	0	0	0
	Galveston	0.033856739	0	0.041710519	0	0.025004711	0	0.015351589	0	[illegible]	0	[illegible]	0	0.024143087	0	0.019297151	0	0.567751219	0	0.032836887	0	0	0
	Harris	0.068267332	0	0.084559408	0	0.050418468	0	0.028471701	0	0.517411736	0	0.117549281	0	0.047228963	0	0.029968099	0	0.03613341	0	0.049622373	0	0	0
	Liberty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Montgomery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Waller	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beaumont/ Port Arthur Area	Hardin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Jefferson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Orange	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dallas/ Fort Worth Area	Collin	0.002039135	0	[illegible]	0	0.001505992	0	0.005950953	0	0.002481478	0	0.000717051	0	0.019166247	0	0.07668094	0	0.00086441	0	0.004000199	0	0	0
	Dallas	0.004539471	0	[illegible]	0	[illegible]	0	[illegible]	0	0.002085611	0	0.00068106	0	0.007502816	0	0.026717045	0	0.007524933	0	[illegible]	0	0	0
	Denton	0.00047388	0	[illegible]	0	0.000349982	0	0.001396994	0	0.000585443	0	0.000168971	0	0.00454374	0	[illegible]	0	[illegible]	0	[illegible]	0	0	0
	Tarrant	0.012162492	0	[illegible]	0	0.008982543	0	0.002308652	0	0.005316504	0	0.001752506	0	0.017326428	0	0.060216761	0	0.020603444	0	[illegible]	0	0	0
	Ellis	0.003279814	0	0.003307800	0	0.002422289	0	0.005476558	0	0.001433682	0	0.000472592	0	0.004672353	0	[illegible]	0	0.005556053	0	0.029837624	0	0	0
	Johnson	0.000286058	0	0.000526868	0	0.000211267	0	0.000843297	0	0.000353404	0	0.000111999	0	0.002742835	0	[illegible]	0	0.000112645	0	0.000512145	0	0	0
	Kaufman	0.006325453	0	0.006379446	0	0.004671629	0	0.010562096	0	0.002765	0	0.000911441	0	0.009011105	0	0.031317452	0	0.010715411	0	0.037545265	0	0	0
	Parker	0.000217489	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	0	0
	Rockwall	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Henderson	0.000819895	0	0.000826893	0	0.000605529	0	0.001369042	0	[illegible]	0	0.000111814	0	0.001168005	0	[illegible]	0	[illegible]	0	[illegible]	0	0	0
	Hood	0.01252711	0	0.012634039	0	0.009251829	0	0.020917482	0	0.005475887	0	0.001805044	0	0.017845854	0	0.062021991	0	0.021221212	0	[illegible]	0	0	0
	Hunt	0.006187558	0	0.006240374	0	0.004569788	0	0.010331844	0	0.002704724	0	0.000891572	0	0.008814664	0	0.030634735	0	0.010481817	0	0.056290785	0	0	0
El Paso Area	El Paso	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Antonio Area	Bexar	0.033413751	0	0.051775843	0	0.024677545	0	0.090663423	0	0.001141841	0	1.143571754	0	0.046873844	0	0.004669544	0	0.000519582	0	0.002503865	0	0	0
	Comal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Guadalupe	0.002000467	0	0.076378745	0	0.001477434	0	0.133848731	0	0.001237133	0	0.003554796	0	0.001061766	0	0.001855699	0	0.000401718	0	0.001835465	0	0	0
	Wilson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Austin Area	Bastrop	0.004502334	0	0.171901148	0	0.003325174	0	0.301245466	0	0.002784342	0	0.008000571	0	0.002389654	0	0.004176513	0	0.000904124	0	0.004130298	0	0	0
	Caldwell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hays	0.002458599	0	0.093870431	0	[illegible]	0	0.164501762	0	0.001520452	0	[illegible]	0	0.001304924	0	0.002280677	0	0.000493717	0	0.00225544	0	0	0
	Travis	0.000510007	0	0.299602906	0	0.000376663	0	0.033939476	0	0.000334709	0	0.000996121	0	0.000271138	0	0.000471744	0	0.000103327	0	0.000467336	0	0	0
	Williamson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North East Texas Area	Gregg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Harrison	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rusk	0.000685965	0	0.00069182	0	0.000506616	0	0.001145408	0	0.000299851	0	9.88414E-05	0	0.000977211	0	0.003396227	0	0.001162035	0	0.006240507	0	0	0
	Smith	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Upshur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corpus Christi Area	Nueces	0.22756873	0	0.004556851	0	0.168069652	0	0.007612767	0	0.001680888	0	0.001626796	0	0.046792036	0	0.007246366	0	0.001609426	0	0.008283395	0	0	0
	San Patricio	0.050313351	0	0.001007478	0	0.037158653	0	0.001683113	0	0.000371629	0	[illegible]	0	0.010345288	0	0.001602105	0	0.000355829	0	0.001831382	0	0	0
Victoria Area	Victoria	0.021834736	0	0.002215582	0	[illegible]	0	0.003612695	0	0.001199621	0	[illegible]	0	0.52545648	0	0.032412721	0	0.000476855	0	0.002254849	0	0	0
Other ERCOT counties	Andrews	2.47421E-05	0	2.49533E-05	0	1.82731E-05	0	4.13138E-05	0	1.08153E-05	0	[illegible]	0	3.5247E-05	0	0.000122499	0	4.19135E-05	0	0.000225089	0	0	0
	Angelina	[illegible]	0	0.000313473	0	0.000229554	0	0.000519	0	0.000135867	0	4.47864E-05	0	0.000442787	0	0.001538876	0	0.000526534	0	0.002827658	0	0	0
	Bosque	0.000595392	0	0.001096604	0	[illegible]	0	0.001755208	0	0.000735562	0	[illegible]	0	0.005708837	0	0.02285067	0	0.000234455	0	0.001067208	0	0	0
	Brazos	0.001939725	0	0.003572622	0	[illegible]	0	0.005718288	0	0.002396384	0	0.000691644	0	0.018598805	0	0.074445136	0	0.000763829	0	0.003476855	0	0	0
	Calhoun	0.082699809	0	0.001655986	0	0.061077496	0	0.002766524	0	0.000610844	0	0.000591187	0	0.0170045	0	0.002633372	0	0.000584875	0	0.003010234	0	0	0
	Cameron	0.048371747	0	0.000968599	0	[illegible]	0	0.001618161	0	0.000357288	0	[illegible]	0	0.009946061	0	0.001540279	0	0.000342098	0	0.001760709	0	0	0
	Cherokee	0.003503899	0	0.003533808	0	[illegible]	0	0.00585073	0	0.001531635	0	[illegible]	0	0.00499158	0	0.017347879	0	0.005935657	0	0.031876422	0	0	0
	Coke	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Coleman	0.001298787	0	2.6001E-05	0	[illegible]	0	4.34478E-05	0	9.59321E-06	0	9.2845E-06	0	0.000267053	0	4.13567E-05	0	9.18536E-06	0	4.72752E-05	0	0	0
	Crockett	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Ector	0.003535748	0	0.003565928	0	0.002611307	0	0.005903911	0	0.001545556	0	[illegible]	0	0.005036951	0	0.017505563	0	0.00598961	0	0.032166163	0	0	0
	Fannin	0.007056315	0	0.007116546	0	0.005211403	0	0.011782473	0	0.003084477	0	0.001016752	0	[illegible]	0	0.034935966	0	0.011953503	0	0.064194222	0	0	0
	Fayette	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Freestone	0.003677178	0	0.003708565	0	[illegible]	0	[illegible]	0	0.001607379	0	[illegible]	0	[illegible]	0	0.018205785	0	0.006229194	0	0.033452809	0	0	0
	Frio	[illegible]	0	[illegible]	0	0.006342868	0	0.001420864	0	0.000471808	0	[illegible]	0	[illegible]	0	0.012747844	0	0.000187546	0	0.000886827	0	0	0
	Grimes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hardeman	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Haskell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hidalgo	0.188527456	0	0.003775086	0	0.139235931	0	0.006306735	0	0.001392518	0	[illegible]	0	0.03876448	0	0.006003193	0	0.001333316	0	0.006862311	0	0	0
	Howard	0.000555113	0	0.000559851	0	[illegible]	0	0.000926915	0	0.000242653	0	7.99868E-05	0	0.000790802	0	0.002748377	0	0.00094037	0	0.005050094	0	0	0
	Jack	0.002121449	0	0.002139557	0	[illegible]	0	0.003542346	0	0.000927334	0	[illegible]	0	0.00302217	0	0.010503338	0	0.003593766	0	0.019299698	0	0	0
	Jones	0.040718722	0	0.000815354	0	0.030072592	0	0.001362147	0	0.00030076	0	0.000291082	0	0.008372468	0	0.001296587	0	0.000287974	0	0.001482142	0	0	0
	Lamar	0.000950838	0	0.000958954	0	0.000702236	0	0.001587687	0	0.000415633	0	0.000137007	0	0.001354543	0	0.004707619	0	0.001610734	0	0.008650166	0	0	0
	Limestone	0.000719757	0	0.000891528	0	0.000531572	0	0.000300183	0	0.00545518	0	[illegible]	0	0.000497945	0	0.00031596	0	0.000380962	0	0.000523179	0	0	0
	Llano	0.001238174	0	0.047274044	0	0.000914447	0	0.082844655	0	0.000765714	0	0.002200214	0	0.000657172	0	0.001148571	0	0.000248641	0	0.001135861	0	0	0
	McLennan	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	0	0
	Milam	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	0	0
	Mitchell	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	0	0
	Nolan	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	0	0
	Palo Pinto	0.003206998	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	0	0	0
	Pecos	4.09677E-05	0	[illegible]	0	3.02563E-05	0	[illegible]	0	1.79079E-05	0	5.90398E-06	0	5.83617E-05	0	0.000202832	0	6.93999E-05	0	0.0003727	0	0	0
	Presidio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Robertson	0.000737708	0	0.000835096	0	0.00054483	0	0.000735917	0	0.003149678	0	0.000730875	0	0.00076086	0	0.001866305	0	0.191632518	0	0.003397737	0	0	0
	Taylor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Titus	0.005696437	0	0.005745061	0	0.004207073	0	0.009511781	0	0.002490043	0	0.000820806	0	0.008115023	0	0.028203184	0	0.00964985	0	0.051822854	0	0	0
	Tom Green	0.001482448	0	2.96846E-05	0	0.001094854	0	4.95918E-05	0	1.09498E-05	0	1.05974E-05	0	0.000304817	0	4.72049E-05	0	1.04843E-05	0	5.39604E-05	0	0	0
	Upton	3.11661E-05	0	3.14322E-05	0	2.30176E-05	0	5.20405E-05	0	1.36234E-05	0	4.49076E-06	0	4.43986E-05	0	0.000154304	0	5.27959E-05	0	0.000283531	0	0	0
	Ward	0.018559529	0	0.01871795	0	0.013707039	0	0.030990277	0	[illegible]	0	[illegible]	0	[illegible]	0	0.091888626	0	0.03144012	0	0.16884373	0	0	0
	Webb	0.020014327	0	0.000400768	0	0.014781473	0	0.000669531	0	[illegible]	0	[illegible]	0	[illegible]	0	0.000637307	0	0.000141547	0	0.000728512	0	0	0
	Wharton	0.00014434	0	0.000178787	0	0.000106601	0	6.01986E-05	0	0.001093979	0	0.000248638	0	9.98576E-05	0	6.33625E-05	0	7.6398E-05	0	0.000104918	0	0	0
	Wichita	0.000207633	0	0.000209406	0	0.000153346	0	0.000346701	0	9.07612E-05	0	2.99181E-05	0	0.00029579	0	0.001027996	0	0.000351734	0	0.001888925	0	0	0
	Wilbarger	0.028616818	0	0.000573025	0	0.021134796	0	0.000957307	0	0.000211372	0	0.00020457	0	0.005884109	0	0.000911232	0	0.000202386	0	0.001041639	0	0	0
	Wise	0.002844488	0	0.002882008	0	0.002100781	0	0.00476997	0	0.001256075	0	0.000413241	0	0.004181914	0	0.014614274	0	0.004797945	0	0.025761411	0	0	0
	Young	0.006235856	0	0.006289085	0	0.004605458	0	0.010412491	0	0.002725836	0	0.000898531	0	0.008883468	0	0.030873859	0	0.010563634	0	0.056730171	0	0	0
	Total	1.121837219	0	1.172570094	0	1.090766584	0	1.189130767	0	1.629360006	0	1.542362643	0	1.359385821	0	1.231642808	0	1.221806085	0	1.528786947	0	0	0

Energy Savings by PCA (MWh)

Summary

- **Procedures developed to the energy savings achieved due to the implementation of IECC 2000/2001 for commercial construction in the 41 non-attainment and affected counties in Texas.**
  - eCALC developed under EPA funding
    - Linked with EPA eGRID to calculate emissions reduction.
    - Residential, commercial and renewable simulation models with measured weather data from 1999 to 2003 available.
  - Planning under way for the verification of the commercial simulation model with measured data and calibrated simulation
  - TCEQ is considering submitting EE/RE as part of State SIP
- **Other states investigating Texas EE/RE procedures.**

Future Work

- **Development of simulation models for the 6 commercial building types based on the F.W. Dodge characteristics.**
- **Extend the analysis for all ERCOT area (194 counties).**
- **Use of the measured weather data from the 17 weather stations.**
- **Make the simulation models compatible with at least 5 most common commercial HVAC system.**

QUESTIONS?