


A METHODOLOGY FOR CALCULATING INTEGRATED NOx EMISSIONS REDUCTIONS FROM ENERGY EFFICIENCY AND RENEWABLE ENERGY (EE/RE) PROGRAMS ACROSS STATE AGENCIES IN TEXAS

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

Energy Systems Laboratory
Texas Engineering Experiment Station
Texas A&M University System



Acknowledgements

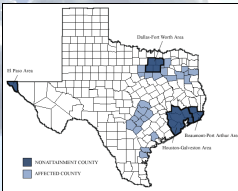
- Faculty/Staff: David Claridge, Dan Turner, Malcolm Verdict, Larry Degelman, Sherry Hughes, Angie Shafer, Juan-Carlos Baltazar, Zi Liu, Jaya Mukhopadhyay, Seongchan Kim, Don Gilman, Charles Culp and Bahman Yazdani
- Students: Piljae Im, Mini Maholtra
- Jay Zarnekau (Frontier and Associates), Theresa Gross (PUC), Jess Totten (PUC), Glenn Jennings (SECO), Steve Anderson (TCEQ), Alfred Reyes (TCEQ), Akin Olubiye (TCEQ), Warren Lasher (ERCOT), Dan Woodfin (ERCOT), and David Hitchcock (HARC), Art Diem (USEPA), and Julie Rosenberg (USEPA).

© Energy Systems Laboratory 2007 p. 2

Legislative Response

41 Counties in Texas designated non-attainment or affected.

Senate Bill 5 (77th Legislature, 2001)
Ch. 386, Texas Emissions Reduction Plan
Sec. 386.205. Evaluation Of State Energy Efficiency Programs (with PUC)
Ch. 388, Texas Building Energy Performance Standards
Sec. 388.003. Adoption Of Building Energy Efficiency Performance Standards.
Sec. 388.004. Enforcement Of Energy Standards Outside Of Municipality.
Sec. 388.007. Distribution Of Information And Technical Assistance.
Sec. 388.008. Development Of Home Energy Ratings.
TERP Amended (78th Legislature, 2003)
Ch. 388, Texas Building Energy Performance Standards
HB 1365) Sec. 388.004. Enforcement Of Energy Standards Outside Of Municipality.
HB 1525) Sec. 388.005. Energy Efficient Building Program.
Ch. 388, Texas Building Energy Performance Standards
HB 3235) Sec. 388.009. Certification of Municipal Inspectors.
TERP Amended (79th Legislature, 2005)
Ch. 382, Health and Safety Code
HB 2129) Sec. 386.056 Development of Creditable Statewide emissions from wind and other renewables.
HB 965) Sec. 382.0275 Commission Action Relating to Water Heaters
TERP Amended (80th Legislature, 2007)
Ch. 382, Health and Safety Code
HB 3653) Sec. 388.003 added subsection (b-1), (b-2), (b-3) that allow SECO to adopt new editions of the IECC based on written recommendations from the Laboratory.
HB 3653) Sec. 388.008 Development of Standardized report formats for newly constructed residences.
Ch. 386,205 Health and Safety Code
SB 12) Section 386.03 added subsection (b-1), (b-2) allows SECO to adopt new editions of the IECC based on written recommendations from the Laboratory.



■ NON-ATTAINMENT COUNTY
■ AFFECTED COUNTY

© Energy Systems Laboratory 2007

INTEGRATED NOx SAVINGS

IN 2005 TCEQ INITIATED A PROGRAM TO DETERMINE INTEGRATED EMISSIONS SAVINGS (2009 & BEYOND) TO REPORT SAVINGS TO EPA

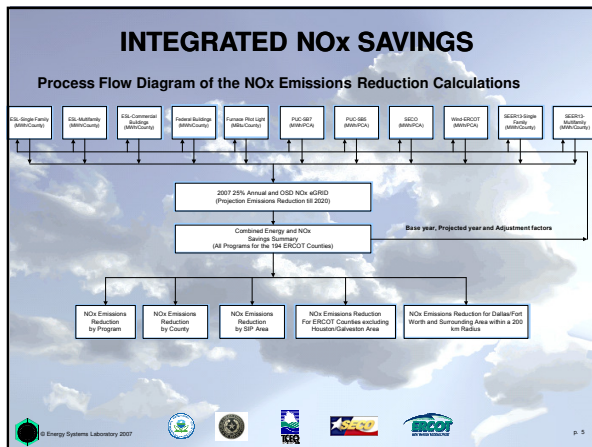
State Agencies included:

- TEES/ESL,
- PUC,
- SECO,
- ERCOT/Wind

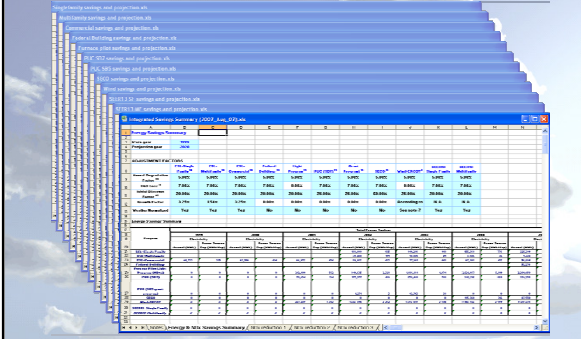
Savings Integration allows:

- Annual, OSD savings
- By County
- By SIP
- By Program
- Integration tool = Adjustable Discount, Degradation, T&D losses

© Energy Systems Laboratory 2007 p. 4



INTEGRATED NOx SAVINGS



Program	County	Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
...

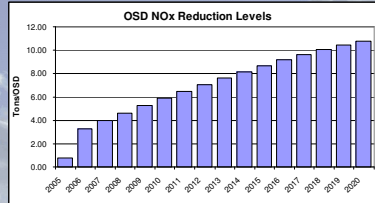
© Energy Systems Laboratory 2007 p. 6

INTEGRATED NOx SAVINGS ADJUSTMENT FACTORS

	ESL- Single Family ⁷	ESL- Multi-family ⁸	ESL- Commercial ⁹	Federal Buildings ¹⁰	Furnace Pilot Light Program ¹¹	PUC (SB7) ¹²	PUC (SBS Grant Program) ¹³	SECO ¹⁴	Wind- ERCOT ¹⁵	SEER10 Single Family	SEER13 Multi-family
Annual Degradation Factor ¹¹	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
T&D Loss ⁹	7.0%	7.0%	7.0%	7.0%	0.0%	7.0%	7.0%	7.0%	0.0%	7.0%	7.0%
Initial Discount Factor ¹²	20%	20%	20%	20%	20%	25%	25%	60%	25%	20%	20%
Growth Factor	3.25%	1.54%	3.25%	0.0%	0.0%	0.0%	0.0%	0.0%	According to 18 20, section 39.904	N.A.	N.A.
Weather Normalized	Yes	Yes	Yes	No	No	No	No	No	See note 7	Yes	Yes

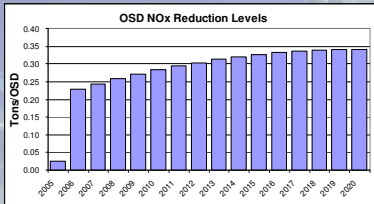
7) For Wind-ERCOT (2005), the OSD energy consumption is the average daily consumption of the measured data in the months of July, August and September of 2005.
 8) For the Wind calculation there are two scenarios for the growth in Wind energy: a) annual growth rates from 0% to 25%, b) Annual growth rates mimicking the yearly goals set forth by the Senate Bill 20, Section 39.904, Utilities Code.
 9) T&D losses for Wind-ERCOT are 0.00% or negative since Wind is displacing the power produced by conventional plants which already have a T&D Loss associated with them.
 11) The 5% annual degradation factor for all programs has been taken from Kats, G.H. et al. (1996) "Energy Efficiency as a Commodity," ACEEE.
 12) The initial discount factor for each program should be chosen to reflect the accuracy of the reported numbers.
 15) The growth factor for Federal Buildings, Furnace pilot lights, PUC(SB7), PUC(SBS) and SECO is 0%, since it is being assumed that the future year savings will be at the same level as 2005.
 16) Growth factors for single-family (3.25%) and multi-family residential (1.54%) construction values represent the average growth rate for these housing types from the U.S. Census data for Texas

INTEGRATED NOx SAVINGS: Single Family Savings and Projection



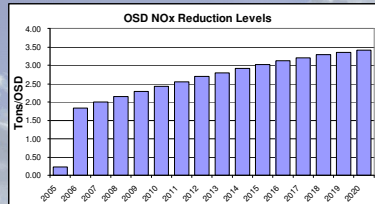
- Single- and multi-family programs include the energy savings attained by constructing new residences in Texas according to the IECC 2000/2001 building code (IECC 2000).
- Electricity Savings due to the code adoption for new SF & MF residences were estimated using DOE-2.1 simulation program. Pre-code houses : average new house built in 1999 in Texas.
- It was assumed that the same amount of electricity savings from the code-complaint construction would be achieved for each year after 2006 through 2020. This would include the appropriate discount and degradation factors for each year

INTEGRATED NOx SAVINGS: Multi-Family Savings and Projection



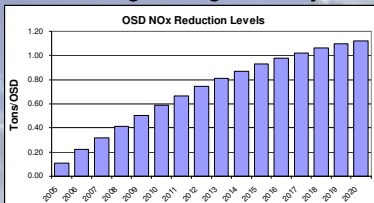
- Single- and multi-family programs include the energy savings attained by constructing new residences in Texas according to the IECC 2000/2001 building code (IECC 2000).
- Electricity Savings due to the code adoption for new SF & MF residences were estimated using DOE-2.1 simulation program. Pre-code houses : average new house built in 1999 in Texas.
- It was assumed that the same amount of electricity savings from the code-complaint construction would be achieved for each year after 2006 through 2020. This would include the appropriate discount and degradation factors for each year

INTEGRATED NOx SAVINGS: Commercial Savings and Projection



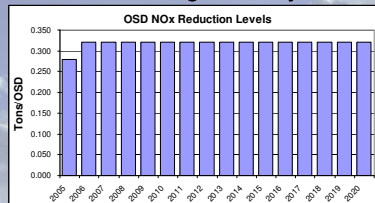
- These savings include new construction in office, assembly, education, retail, food, lodging and warehouse construction as defined by Dodge building type (Dodge 1995, 1999, 2003), using energy savings from the Pacific Northwest National Laboratory (USDOE 2005), and data from CBECS (2005).
- Electricity Savings due to the code adoption for new commercial buildings were estimated using DOE-2.1 simulation program.
- Pre-code buildings: the ASHRAE standard 90.1-1989 compliant building.
- Code compliant buildings: the ASHRAE standard 90.1-1999 compliant building.

INTEGRATED NOx SAVINGS: Federal Savings Savings and Projection

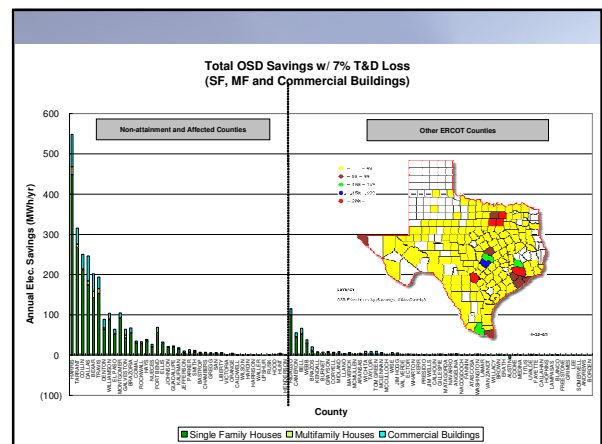
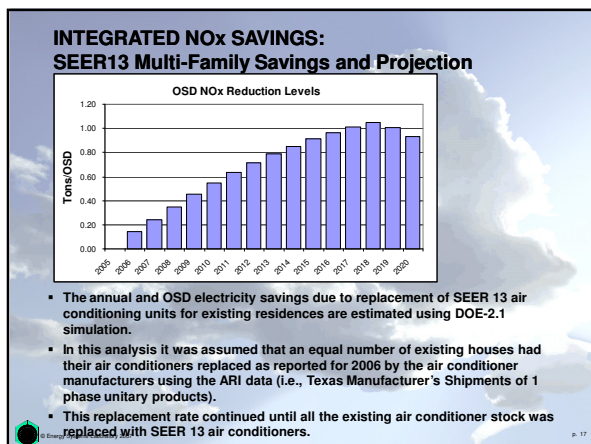
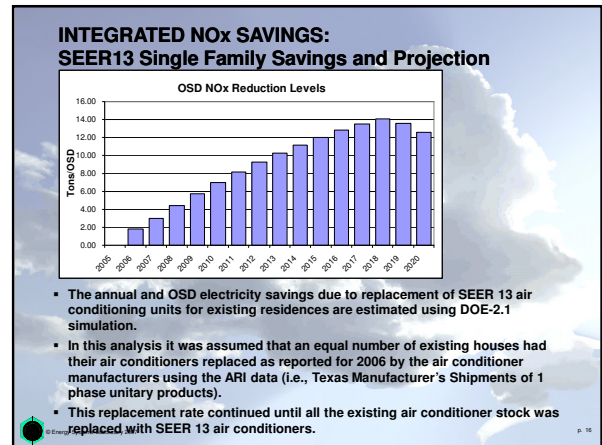
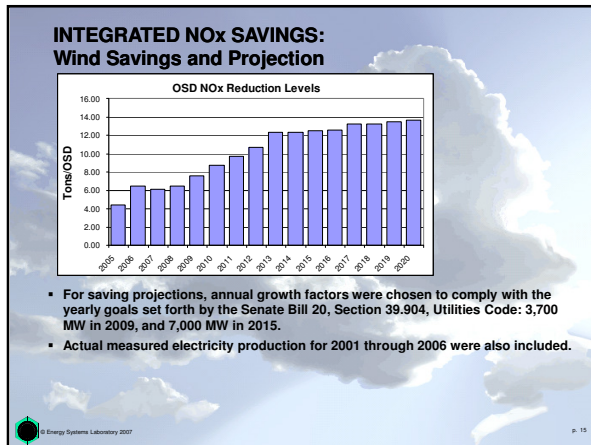
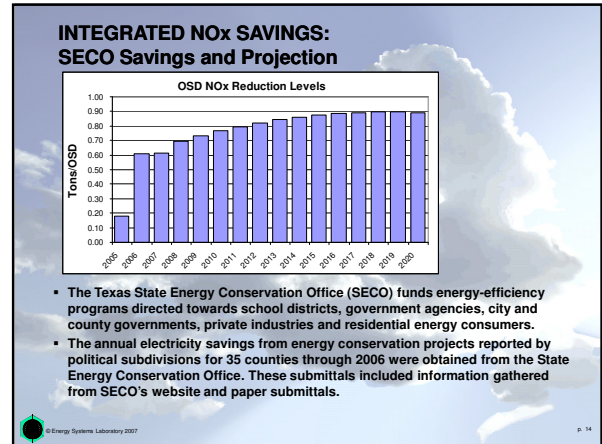
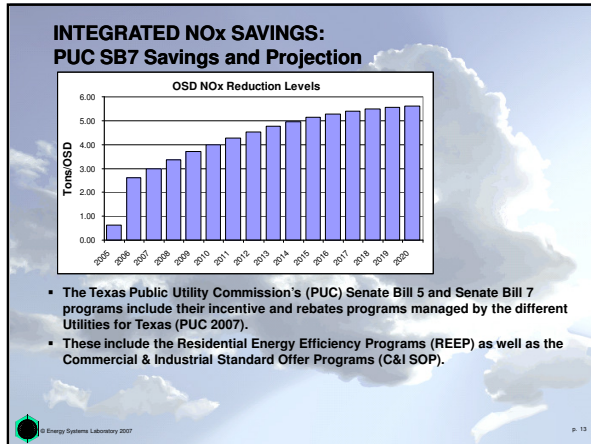


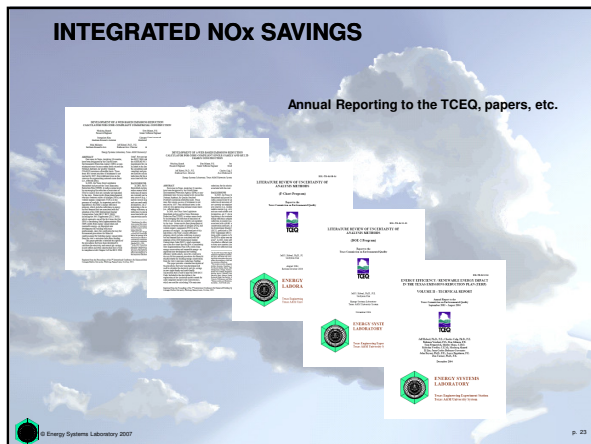
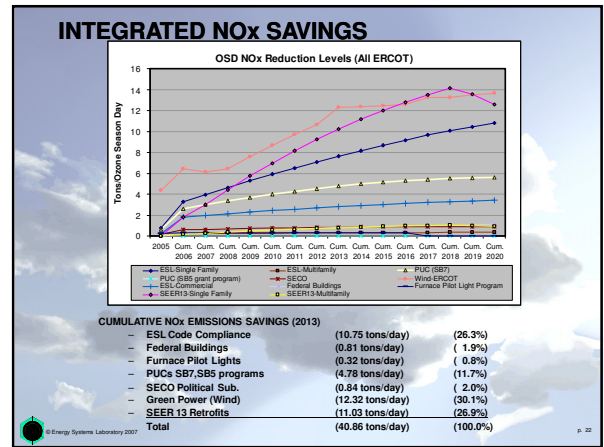
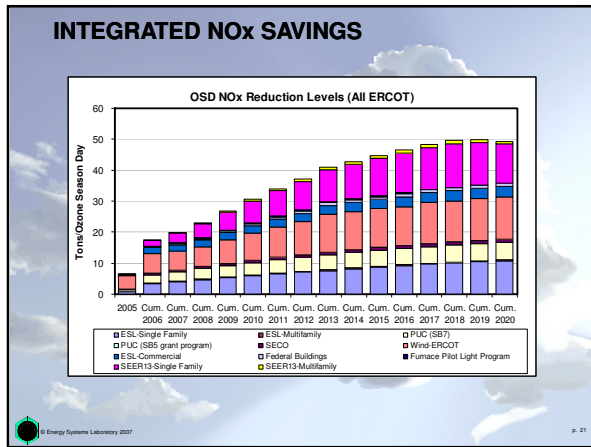
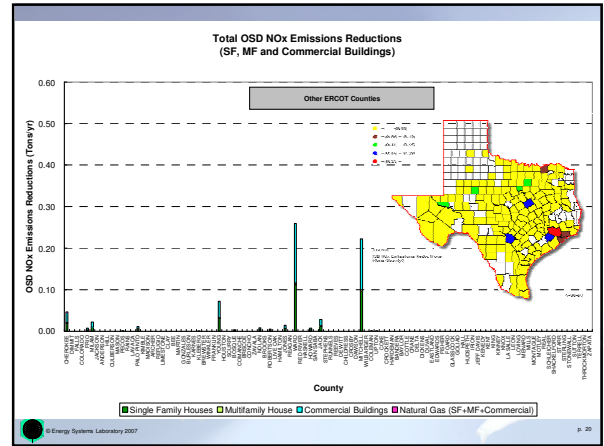
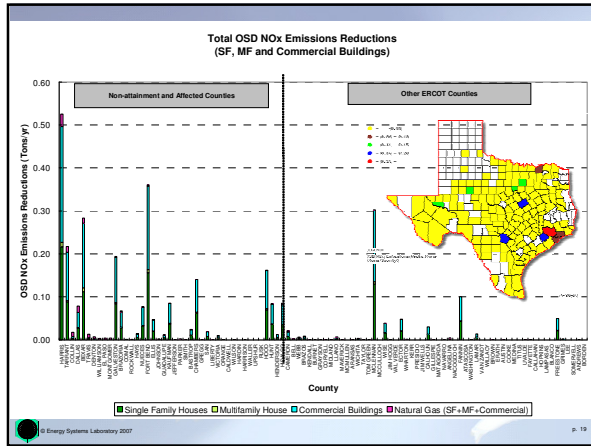
- The 2006 savings include projects implemented in 14 Federal buildings reported by the regional office of the Department of Energy.
- It was assumed that the electricity savings from 2005 would also be achieved for each year from 2006 through 2020 after the appropriate degradation factors were applied

INTEGRATED NOx SAVINGS: Furnace Pilot Savings and Projection



- N.G. energy savings achieved by retrofitting existing furnaces in single-family and multi-family residences for the entire residential stock for Texas have been projected until 2020.
- Pilot light removal saves at least 500 Btu/hr of natural gas (Emission rate per pilot light: 0.092 lb-NOx/MMBtu) for each hour of operation for the entire life of the furnace when the furnace is replaced with a code-compliant replacement.
- It is also being assumed that of the total furnaces that were retrofitted, 75% are operational during the Ozone Season Period.





NEW TOOLS TO HELP REDUCE ENERGY AND NOx EMISSIONS

- eCalc Energy & Emissions Calculator
 - Residential, Commercial
 - Municipal buildings, traffic lights, street lights, water
 - Solar thermal, PV, wind
- Synchronous NOx Emissions Calculator
 - Quick results for MWh savings in any county
- International Code Compliance Calculator (ICCC)
 - Calculates code compliance for 2001 IECC + SEER 13
 - Allows for 15% above code compliance calculations
- 15% above-code measures (41 Cos.)
 - Residential – 11 measures
 - Commercial – 10 measures

© Energy Systems Laboratory 2007

INTEGRATED NO_x SAVINGS

Summary

This paper has presented the detailed results at the Laboratory's integrated NO_x emissions reductions calculations, which were developed to satisfy the legislative requirements of Senate Bill 5. Additional information about these procedures can be found in the laboratory's annual Report to the TCEQ.

ESL CONTACT INFORMATION

Jeff Haberl: jeffhaberl@tees.tamus.edu

Bahman Yazdani: bahmanyazdani@tees.tamus.edu

Charles Culp: charlesculp@tees.tamus.edu

<http://eslsb5.tamu.edu>