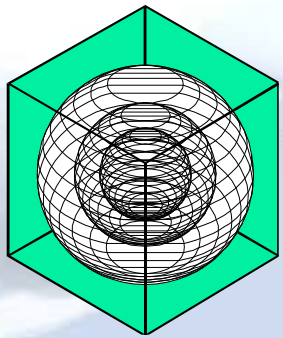
TEXAS EMISSIONS REDUCTIONS PROGRAM (TERP) ENERGY EFFICIENCY/RENEWABLE ENERGY (EE/RE) UPDATE

November 2011

Jeff Haberl, Bahman Yazdani, Charles Culp

Energy Systems Laboratory

Texas A&M University



CATEE 2011, Dallas, Texas, Nov. 7 – 9, 2011

ACKNOWLEDGEMENTS

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TPUC: Theresa Gross, Jess Totten

SECO: Dub Taylor, Felix Lopez

ERCOT: Warren Lasher

USEPA: Art Diem, Julie Rosenberg

LEGISLATIVE RESPONSE

Legislation passed to reduce energy/emissions

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 1365) Sec. 388.009. 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 3693) Sec. 388.003 added subsection (b-1), (b-2), (b-3) that allows SECO to adopt new editions of the IECC based on written recommendations from the Laboratory.

(HB 3693) Sec. 388.008 Development of Standardized report formats for newly constructed residences.

Ch. 386.252 Health and and Safety Code

(SB 12) Section 388.03 added subsection (b-1), (b-2) allows SECO to adopt new editions of the IECC based on written recommendations from the Laboratory.

TERP Amended (81st Legislature, 2009)

Ch. 382. Health and Safety Code

(HB 1796) Section 23 amends Sec. 386.252 (a) and (b) extends date of TERP to 2019 and requires Commission to contract with Laboratory for creditable EE/RE emissions reductions.

TERP Amended (82nd Legislature, 2011)

Ch. 477.004 Health and Safety Code

HB 51 Section 2, b-2, establishes advisory committee, which including the Laboratory

Section 3 & 4 amends review of municipal's amendments.

Ch. 388.003e & 388.007c,d Health and Safety Code

HB 51 Section 3 & 4 amends review of municipal's amendments.

Ch. 388.006 Health and Safety Code

SB 898 Section 2, requires the Laboratory to calculate energy savings and emissions reductions for political subdivisions reporting to SECO.

Ch. 39.9051 Utilities Code

SB 924 Section 1g,h and Section 2c,d requires the Laboratory to calculate energy savings and emissions reductions for political subdivisions reporting to SECO.

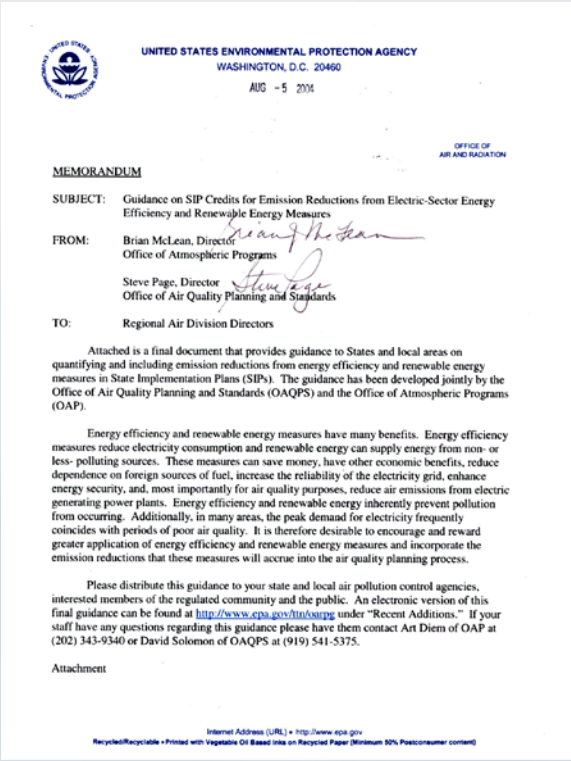
EPA CRITERIA FOR SIP CREDITS (2004)

Quantifiable: The emission reductions generated by measures to reduce emissions must be quantifiable and include procedures to evaluate and verify over time the level of emission reductions actually achieved.

Surplus: Emission reductions are surplus as long as they are not otherwise relied on to meet air quality attainment requirements in air quality programs related to your SIP.

Enforceability: Measures that reduce emissions from electricity generation may be: (1) Enforceable directly against a source; (2) Enforceable against another party responsible for the energy efficiency or renewable energy activity; or (3) Included under our *voluntary measures* policy.

Record Keeping: The measure should be permanent throughout the term for which the credit is granted unless it is replaced by another measure or the State demonstrates in a SIP revision that the emission reductions from the measure are no longer needed to meet applicable requirements.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460
AUG - 5 2004

OFFICE OF
AIR AND RADIATION

MEMORANDUM

SUBJECT: Guidance on SIP Credits for Emission Reductions from Electric-Sector Energy Efficiency and Renewable Energy Measures

FROM: Brian McLean, Director
Office of Atmospheric Programs

Steve Page, Director
Office of Air Quality Planning and Standards

TO: Regional Air Division Directors

Attached is a final document that provides guidance to States and local areas on quantifying and including emission reductions from energy efficiency and renewable energy measures in State Implementation Plans (SIPs). The guidance has been developed jointly by the Office of Air Quality Planning and Standards (OAQPS) and the Office of Atmospheric Programs (OAP).

Energy efficiency and renewable energy measures have many benefits. Energy efficiency measures reduce electricity consumption and renewable energy can supply energy from non- or less- polluting sources. These measures can save money, have other economic benefits, reduce dependence on foreign sources of fuel, increase the reliability of the electricity grid, enhance energy security, and, most importantly for air quality purposes, reduce air emissions from electric generating power plants. Energy efficiency and renewable energy inherently prevent pollution from occurring. Additionally, in many areas, the peak demand for electricity frequently coincides with periods of poor air quality. It is therefore desirable to encourage and reward greater application of energy efficiency and renewable energy measures and incorporate the emission reductions that these measures will accrue into the air quality planning process.

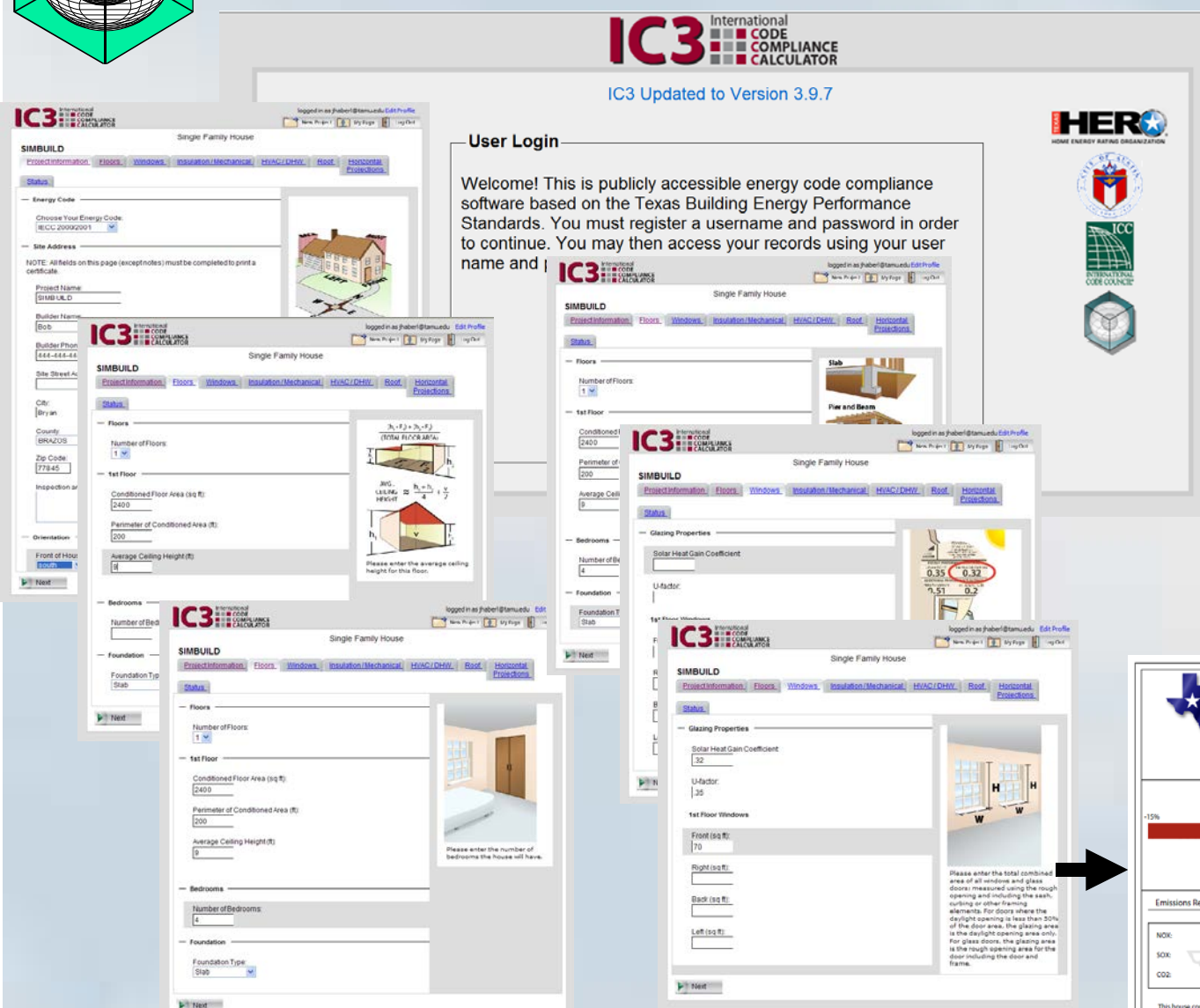
Please distribute this guidance to your state and local air pollution control agencies, interested members of the regulated community and the public. An electronic version of this final guidance can be found at http://www.epa.gov/ttn/oarpg under "Recent Additions." If your staff have any questions regarding this guidance please have them contact Art Diem of OAP at (202) 343-9340 or David Solomon of OAQPS at (919) 541-5375.

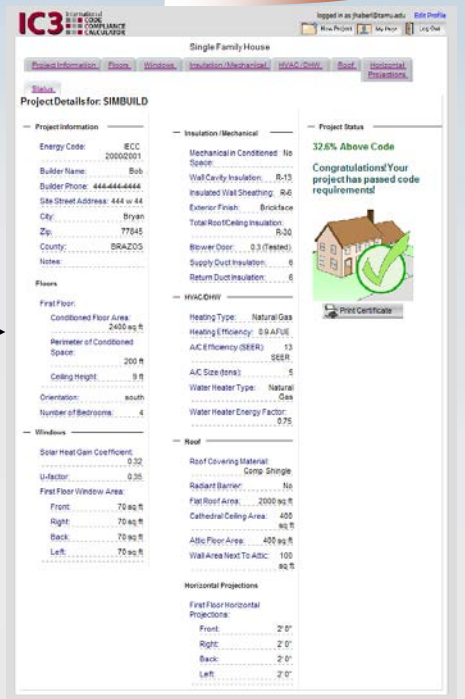
Attachment

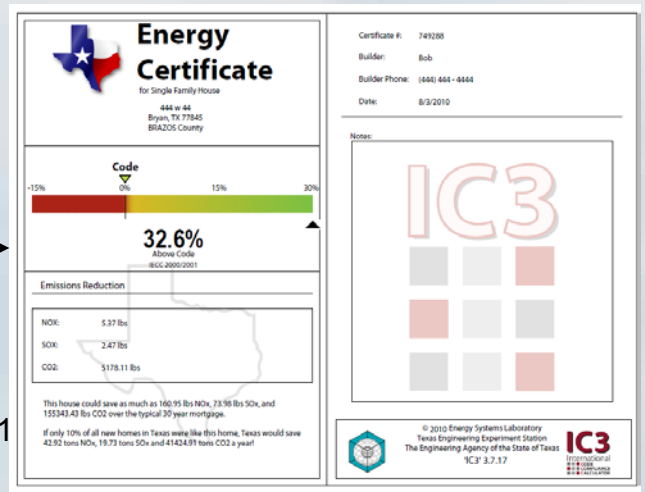
Internet Address (URL) • http://www.epa.gov
Recycled/Recyclable • Printed with Vegetable Oil Based Inks on Recycled Paper (Minimum 50% Postconsumer content)

IC3: UPDATED TO IECC 2009

ESL-KT-11-11-03







CATEE 2011, Dallas, Texas, Nov. 7 – 9, 2011

IC3: REGISTRY OF USAGE

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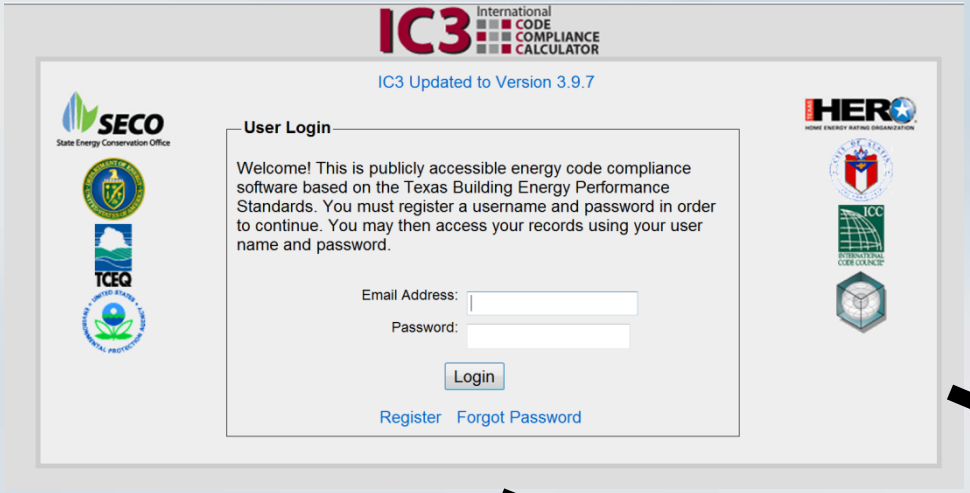
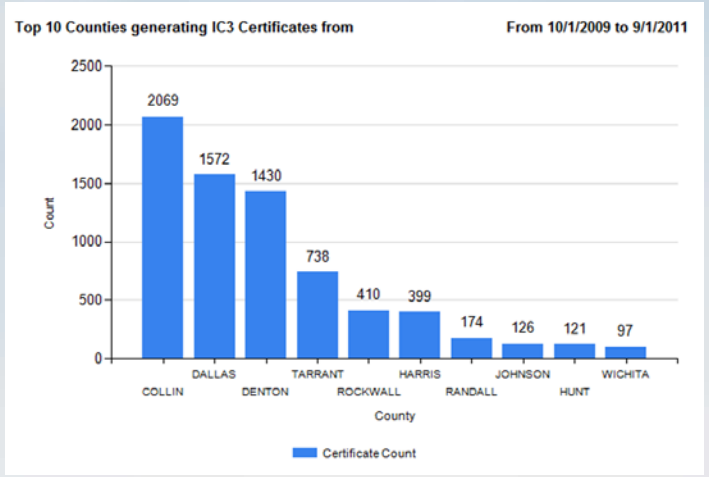
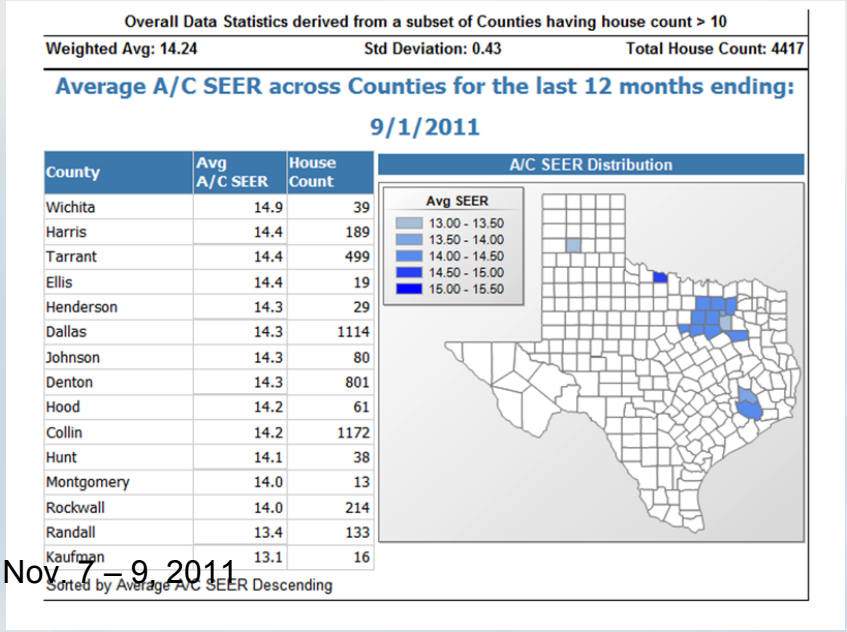




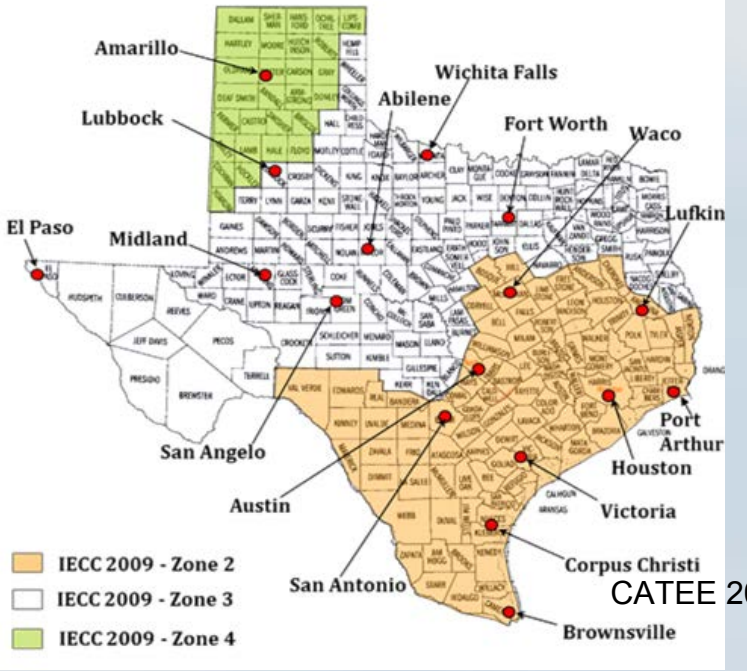
Top 10 Counties generating IC3 Certificates

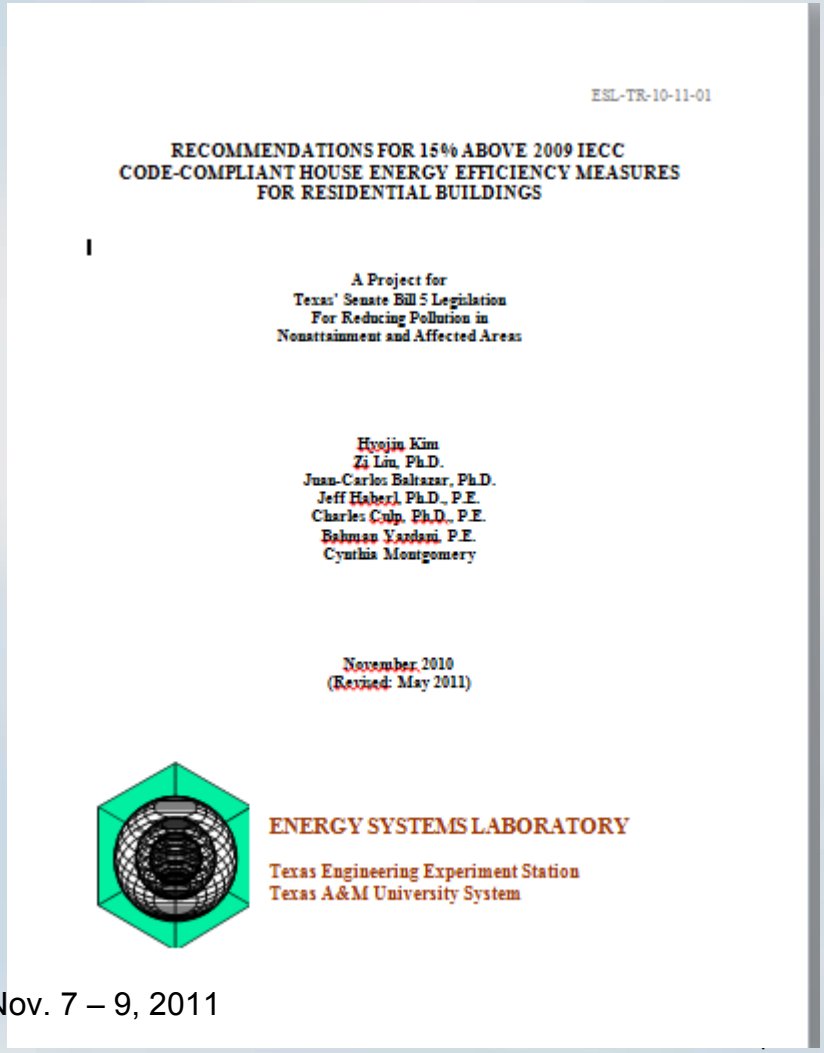
	2010					2011								
					Total									Total
	Sep	Oct	Nov	Dec		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	
COLLIN	51	78	66	94	289	99	110	85	141	106	120	100	122	883
DALLAS	52	52	43	83	230	80	58	123	125	103	130	107	158	884
DENTON	38	46	51	45	180	61	53	70	82	99	96	65	95	621
HARRIS	6	18	10	18	52	16	17	12	18	20	16	18	20	137
HUNT			1	1	2	3	2	9	4	15		1	2	36
JOHNSON	8	6	3	9	26	7	5	9	9	11	5	5	3	54
RANDALL	7	11	7	5	30	11	12	11	20	11	11	11	16	103
ROCKWALL	9	6	10	21	46	24	11	18	18	23	34	23	17	168
TARRANT	20	15	19	17	71	50	44	47	54	48	58	66	61	428
WICHITA	2	4	1	1	8	3	3	1	3	11	7		3	31
Total	193	236	211	294	934	354	315	385	474	447	477	396	497	3345



15% ABOVE 2009 CODE: STATEWIDE

Reports: 17 Counties - Residential





ESL-TR-10-11-01

RECOMMENDATIONS FOR 15% ABOVE 2009 IECC CODE-COMPLIANT HOUSE ENERGY EFFICIENCY MEASURES FOR RESIDENTIAL BUILDINGS

A Project for
Texas' Senate Bill 5 Legislation
For Reducing Pollution in
Nonattainment and Affected Areas

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Jeff Haberl, Ph.D., P.E.
Charles Culp, Ph.D., P.E.
Bahman Yazdani, P.E.
Cynthia Montgomery

November 2010
(Revised: May 2011)

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

15% ABOVE CODE: CITY OF ARLINGTON

Residential, Office, Retail, Restaurant

ESL-TR-11-10-01

COST-EFFECTIVE ENERGY EFFICIENCY MEASURES FOR ABOVE CODE (ASHRAE 90.1-2001 and 2007): FOR RESTAURANT BUILDINGS IN THE CITY OF ARLINGTON

A Research Project for the City of Arlington

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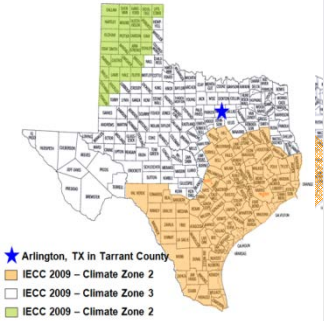
October 2011

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

Description of Individual Measures

	Individual Measures	Annual Energy Savings (%)[1] Site	Source	Annual Energy Savings ($/year)[2]	Estimated Cost ($) Marginal Cost[3]	New System Cost[4]	Simple Estimated Payback (yrs)
A	**Envelope and Fenestration Measures**						
1	Radiant Barrier in Attics (with Ducts in Attics)	1.8%	**2.0%**	$46		$300 - $880	6.6 - 19.2
2	Sealed (Unvented) Attic	7.6%	**5.7%**	$109	$2,000 - $3,500		18.3 - 32.0
3	Window Shading (None to 2 ft. Eaves on All Sides)	0.6%	**2.0%**	$56		$800 - $1,000	14.2 - 17.8
4	Window Shading and Redistribution (22.6% Equal Windows on All Sides with No Shading to S=40.7%, N=22.6%, E/W = 13.6% with 2ft. Eaves on All Sides)	1.9%	**3.0%**	$73		$800 - $1,000	11.0 - 13.7
5	Decreased Window SHGC (from .3 to .2)	-0.6%	**1.5%**	$50	$200 - $400		4.0 - 8.0
6	Decreased Window U Value (from .5 to .3)	4.2%	**4.2%**	$93	$600 - $900		6.4 - 9.6
7	Decreased Window SHGC & U Value (from .3 to .2 SHGC & from .5 to .3 U-Value)	3.3%	**5.6%**	$142	$900 - $1,100		6.3 - 7.8
B	**HVAC System Measures**						
8	Relocate Mechanical Systems within Conditioned Space	9.2%	**8.2%**	$172	$1,000 - $7,000		5.8 - 40.7
9	Improved Air Conditioner SEER (from 13 to 15 SEER)	3.8%	**6.0%**	$150	$900 - $2,500		6.0 - 16.6
10	Improved Furnace Efficiency (from 0.78 to 0.93 AFUE)	4.7%	**2.3%**	$33	$800 - $1,300		24.5 - 39.8
C	**Domestic Hot Water Measures**						
11	Tankless Gas Water Heater (without a Standing Pilot Light)	3.3%	**1.7%**	$23	$900 - $1,400		39.1 - 60.8
12	Removal of Pilot Light from Domestic Hot Water System	1.6%	**0.8%**	$11	$100 - $500		9.2 - 46.0
13	Solar Domestic Hot Water System (32 sq. ft. collector, 65 gal tank)	9.9%	**3.7%**	$32		$2,200 - $3,000	67.7 - 92.4
14	Solar Domestic Hot Water System (64 sq. ft. collector, 80 gal tank)	12.6%	**5.0%**	$51		$3,200 - $4,000	63.2 - 79.0
D	**Lighting Measures**						
15	75% Energy Star Permanent CFL or Fluorescent Indoor Lamps	2.0%	**4.3%**	$112	$25 - $110		0.2 - 1.0
16	100% Energy Star Permanent CFL or Fluorescent Indoor Lamps	4.2%	**8.7%**	$228	$50 - $215		0.2 - 0.9
E	**Renewable Power Measures**						
17	4 kW Photovoltaic Array	19.9%	**28.4%**	$692		$20,000 - $30,000	28.9 - 43.3



Description of Combined Measures

Combination of Measures[5]		Combined Energy Savings (%)[1] Site	Source	Combined Energy Savings ($/year)[2]	Combined Estimated Cost ($) Marginal Cost[3]	New System Cost[4]	Simple Estimated Payback (yrs)	NOx Emissions Savings Annual (lbs/yr)	SO_2 Emissions Savings Annual (lbs/yr)	CO_2 Emissions Savings Annual (tons[6]/yr)
Combination 1										
16	100% Energy Star Permanent CFL or Fluorescent Indoor Lamps	8.6%	**15.8%**	$403	$50 - $215		3.1 - 5.4	5.8	3.9	2.4
7	Decreased Window SHGC & U Value (from .3 to .2 SHGC & from .5 to .3 U-Value)				$900 - $1,100					
1	Radiant Barrier in Attics (with Ducts in Attics)					$300 - $880				
Combination 2										
16	100% Energy Star Permanent CFL or Fluorescent Indoor Lamps	13.1%	**17.0%**	$405	$50 - $215		4.3 - 9.9	5.8	3.6	2.5
9	Improved Air Conditioner SEER (from 13 to 15 SEER)				$900 - $2,500					
10	Improved Furnace Efficiency (from 0.78 to 0.93 AFUE)				$800 - $1,300					
Combination 3										
8	Relocate Mechanical Systems within Conditioned Space	16.0%	**15.0%**	$317	$1,000 - $7,000		8.5 - 29.7	4.6	2.3	2.1
10	Improved Furnace Efficiency (from 0.78 to 0.93 AFUE)				$800 - $1,300					
7	Decreased Window SHGC & U Value (from .3 to .2 SHGC & from .5 to .3 U-Value)				$900 - $1,100					

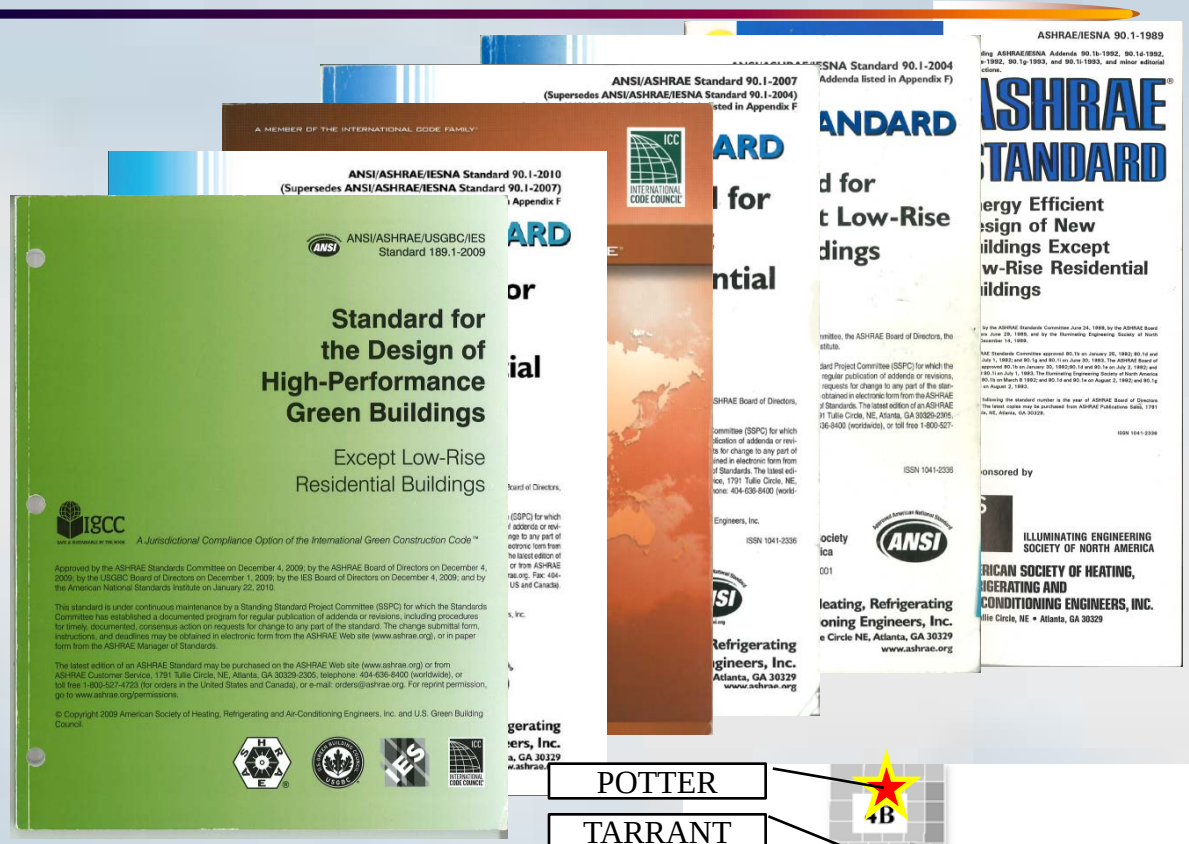
Note:
1. Total energy savings from heating, cooling, lighting, equipment and DHW for emissions reductions determination.
2. Savings depend on fuel mix used.
   * Energy Cost: Electricity = $0.11/kWh
     Natural gas = $0.64/therm
3. Marginal cost = new system cost - original system cost
4. New system cost = new system cost only
5. See individual measures for detailed descriptions
6. Conversion factor: 1 ton = 2,000 lbs

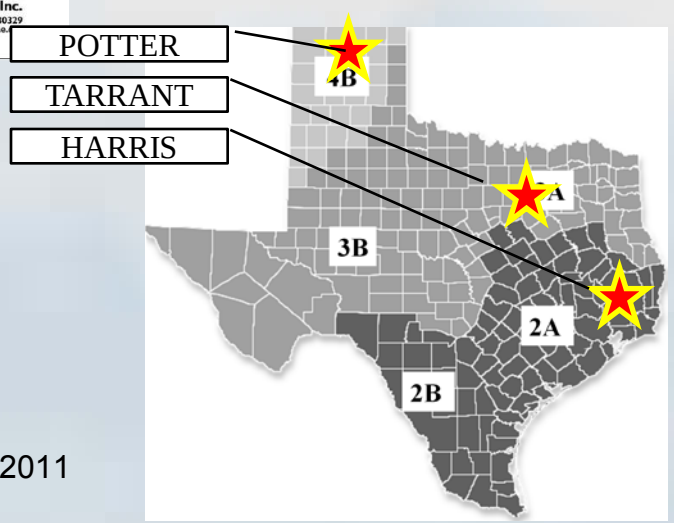
[2009 IECC Code-Compliant House Description]
* Building type: Residential
* Gross area: 2,325 sq-ft
* Building dimension: 48.2ft x 48.2ft x 8ft (WxLxH)
* Number of floors: 1
* Floor-to-floor height: 8ft
* Window-to-floor ratio: 15% (Window-to-wall ratio: 22.6%)
* Lighting: 50% Energy Star permanent CFL or fluorescent lamps
* HVAC system: SEER 13 AC and 0.78 AFUE furnace
* DHW: 0.59 EF NG heater
* Duct Location: Unconditioned, vented attic
* Duct Leakage to Outdoor: 8 cfm/100 sq-ft CFA

COMMERCIAL CODE COMPARISON

Codes compared:

ASHRAE 90.1-1989
ASHRAE 90.1-1999
ASHRAE 90.1-2004
ASHRAE 90.1-2007
ASHRAE 90.1-2010
ASHRAE 189.1-2009
IECC 2009





Three counties selected for analysis

COMMERCIAL CODE COMPARISON

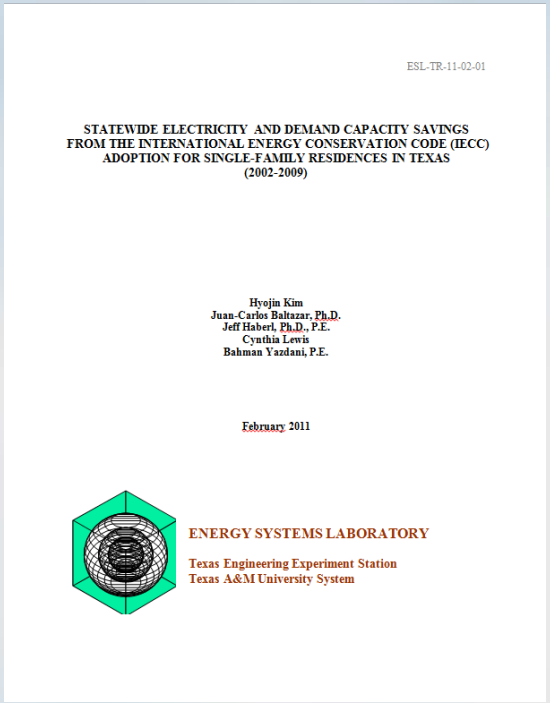
Results: Savings compared to 90.1-1989




	SITE ENERGY	SOURCE ENERGY
ASHRAE 90.1-1999	16.7%-18.6%	14.5%-15.0%
ASHRAE 90.1-2004	22.3%- 32.6%	21.6%-27.2%
ASHRAE 90.1-2007	28.1%-33.9%	23.5%-28.4%
IECC 2009	27.4%-35.3%	23.4%-25.8%
ASHRAE 90.1-2010	42.1%-47.7%	41.8%-45.7%
ASHRAE 189.1-2009	46.9%-51.9%	44.5%-51.8%


STATEWIDE SAVINGS FROM CODE COMPLIANCE

How much electricity has been saved from code compliance for all single family residential housing 2000 -2009?


ESL-TR-11-02-01

STATEWIDE ELECTRICITY AND DEMAND CAPACITY SAVINGS FROM THE INTERNATIONAL ENERGY CONSERVATION CODE (IECC) ADOPTION FOR SINGLE-FAMILY RESIDENCES IN TEXAS (2002-2009)

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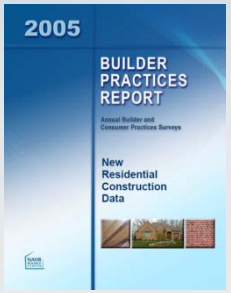
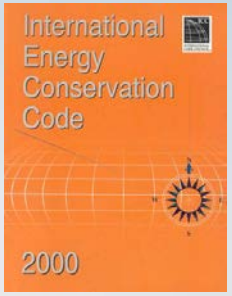
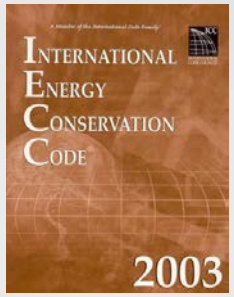
Jeff Haberl, Ph.D., P.E.
Cynthia Lewis
Bahman Yazdani, P.E.

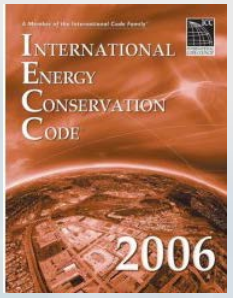
February 2011

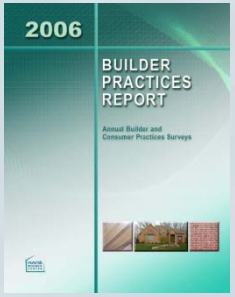
ENERGY SYSTEMS LABORATORY
Texas Engineering Experiment Station
Texas A&M University System

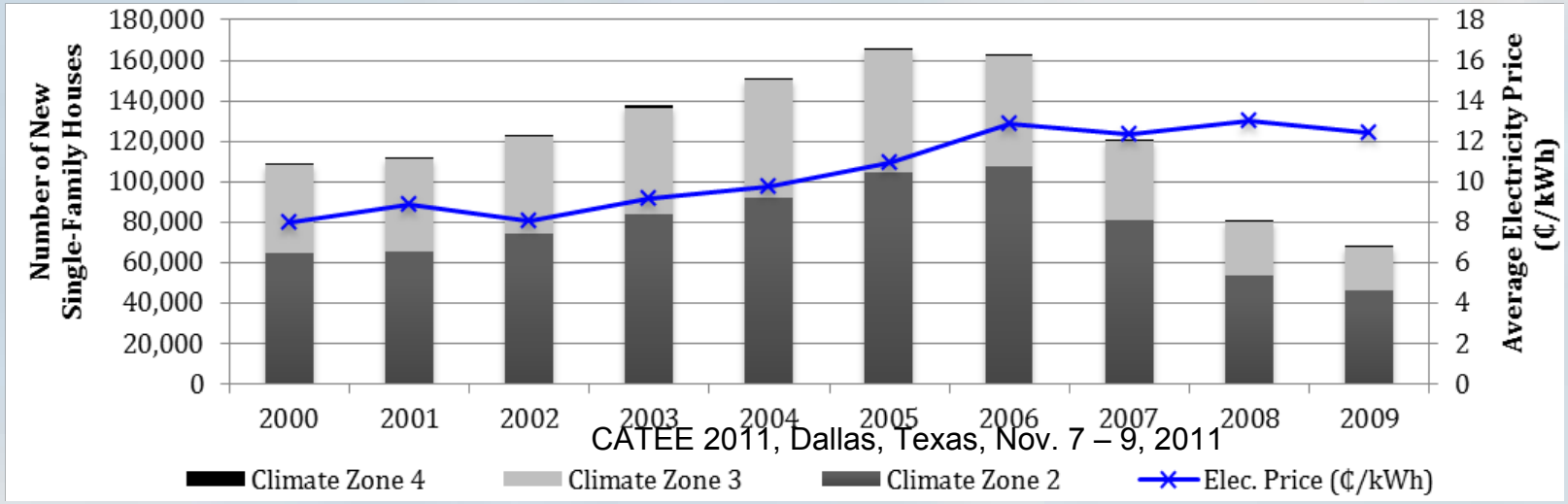






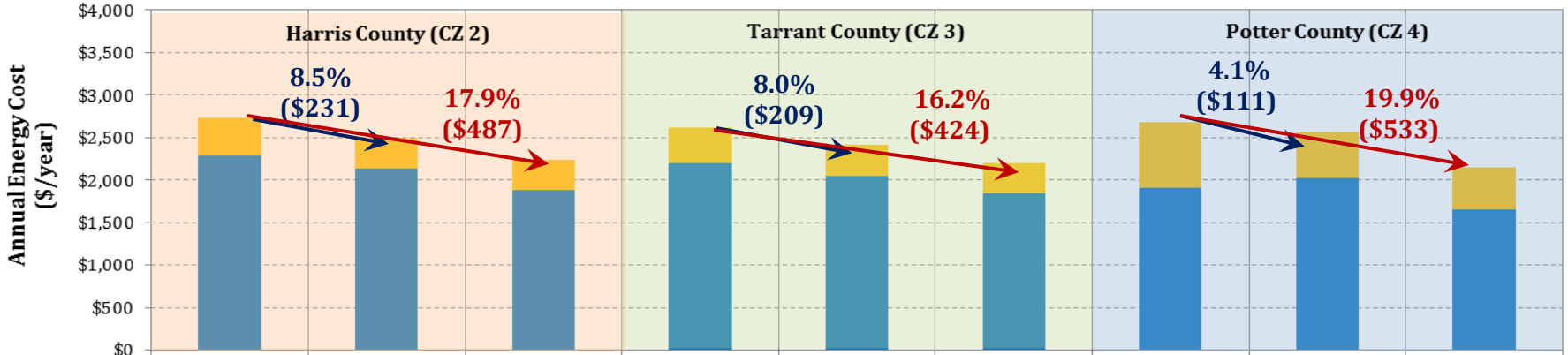






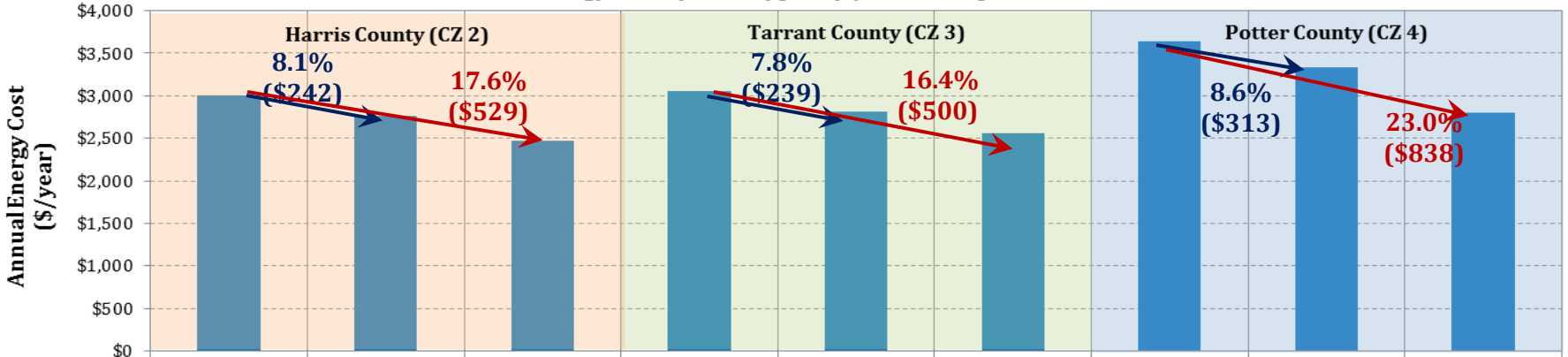
STATEWIDE SAVINGS FROM CODE COMPLIANCE

Annual Energy Cost by Fuel Types: (a) Electric/ Gas House



	Pre-Code 1999	2001 IECC Modified	2006 IECC Modified	Pre-Code 1999	2001 IECC Modified	2006 IECC Modified	Pre-Code 1999	2001 IECC Modified	2006 IECC Modified
Total	$2,724	$2,493	$2,237	$2,617	$2,407	$2,192	$2,679	$2,568	$2,145
NG	$435	$355	$354	$421	$364	$351	$767	$543	$498
Electricity	$2,289	$2,137	$1,883	$2,195	$2,044	$1,841	$1,912	$2,025	$1,647

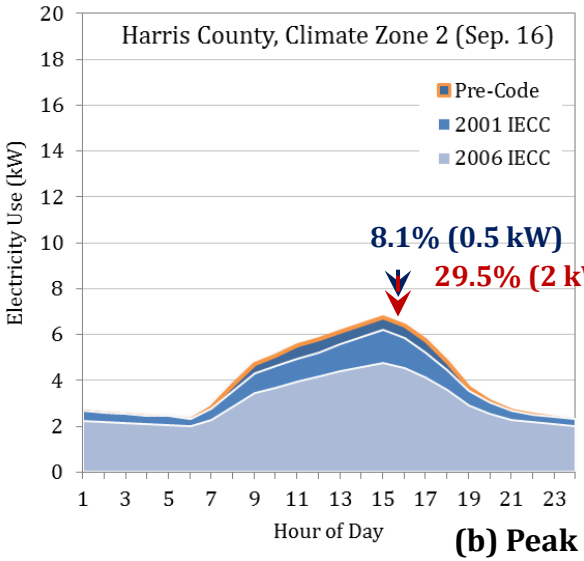
Annual Energy Cost by Fuel Types: (b) Heat Pump House

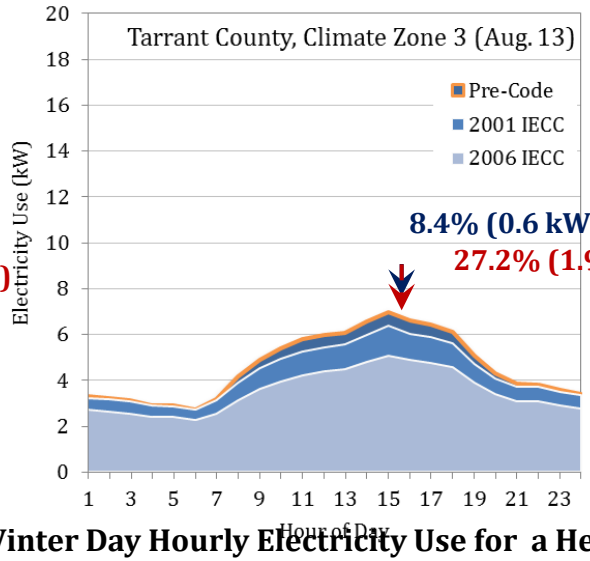


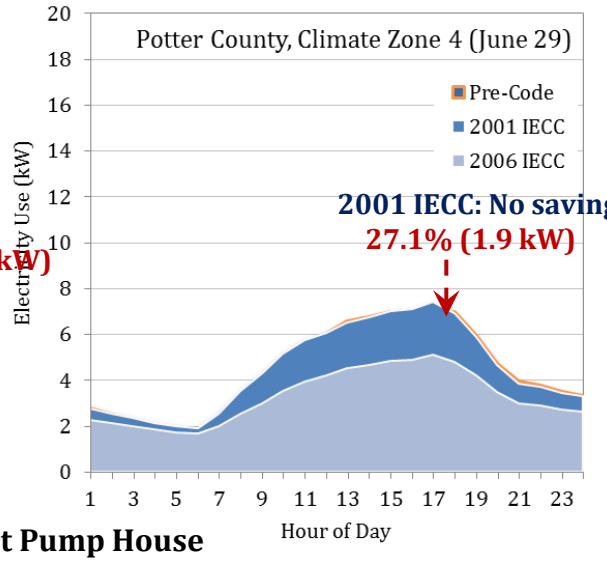
	Pre-Code 1999	2001 IECC Modified	2006 IECC Modified	Pre-Code 1999	2001 IECC Modified	2006 IECC Modified	Pre-Code 1999	2001 IECC Modified	2006 IECC Modified
Total	$3,001	$2,760	$2,473	$3,053	$2,814	$2,553	$3,643	$3,330	$2,805
NG	-	-	-	-	-	-	-	-	-
Electricity	$3,001	$2,760	$2,473	$3,053	$2,814	$2,553	$3,643	$3,330	$2,805

STATEWIDE SAVINGS FROM CODE COMPLIANCE

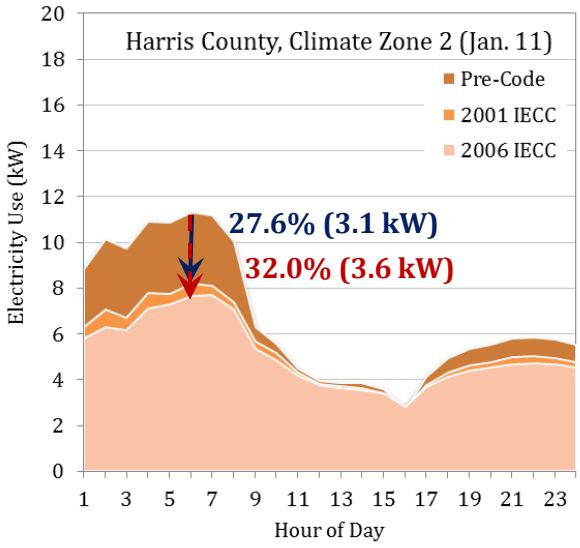
(a) Peak Summer Day Hourly Electricity Use for both Electric/Gas and Heat Pump House

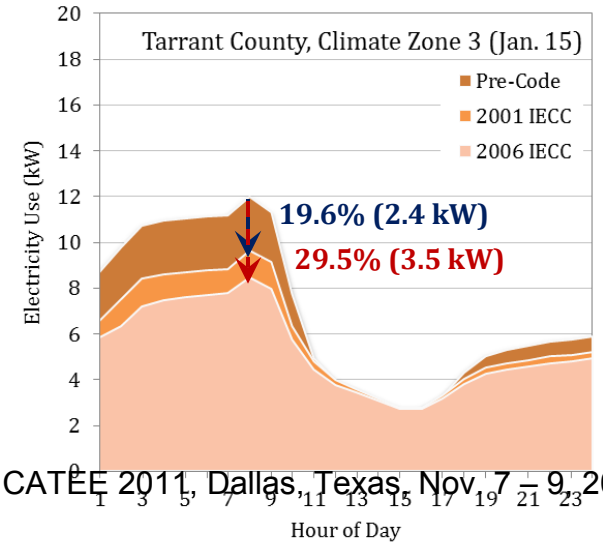


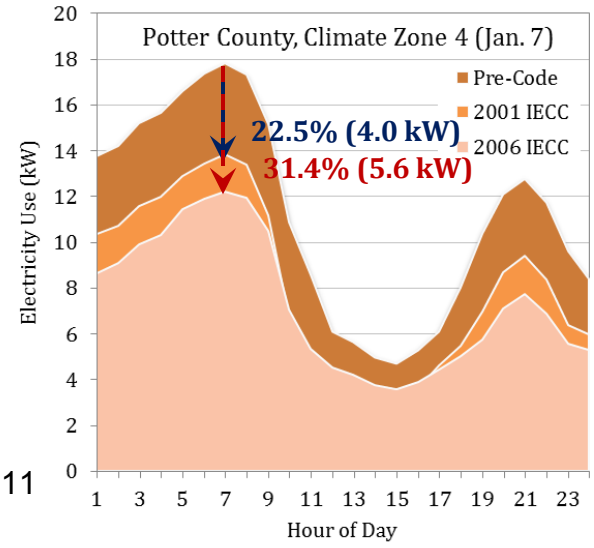




(b) Peak Winter Day Hourly Electricity Use for a Heat Pump House







STATEWIDE SAVINGS FROM CODE COMPLIANCE

Results:

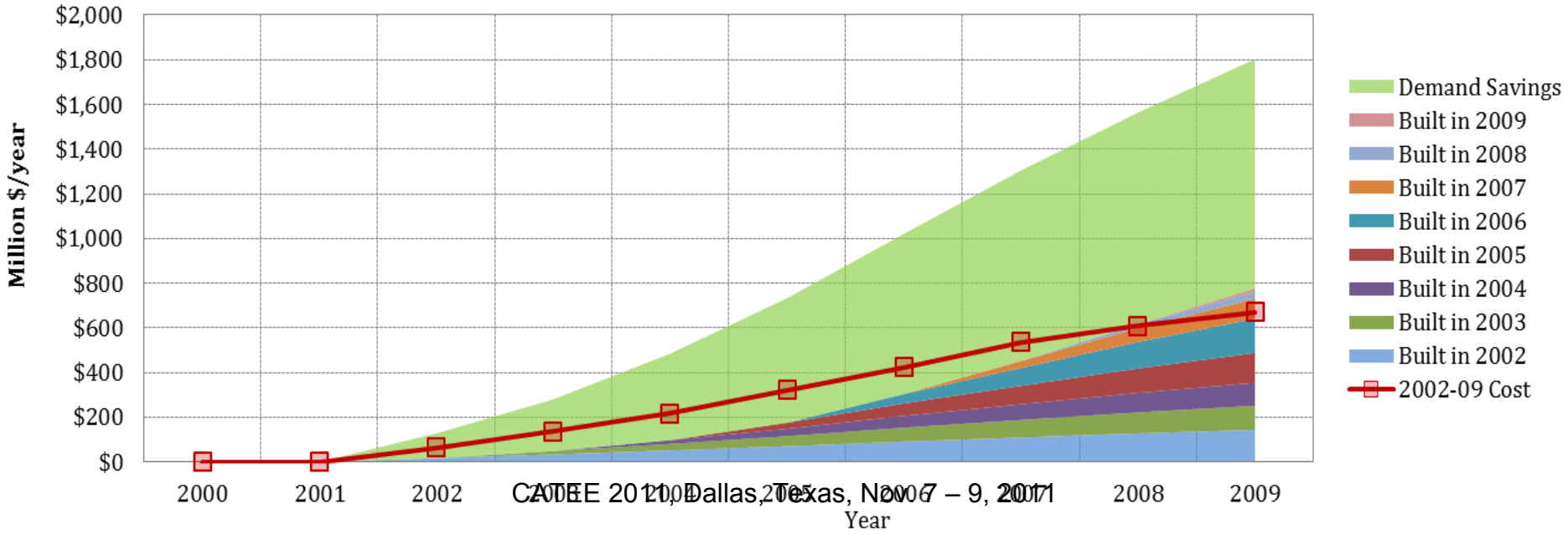
Electricity Savings, Electric Demand Savings and Costs:

Total - $1,808 million

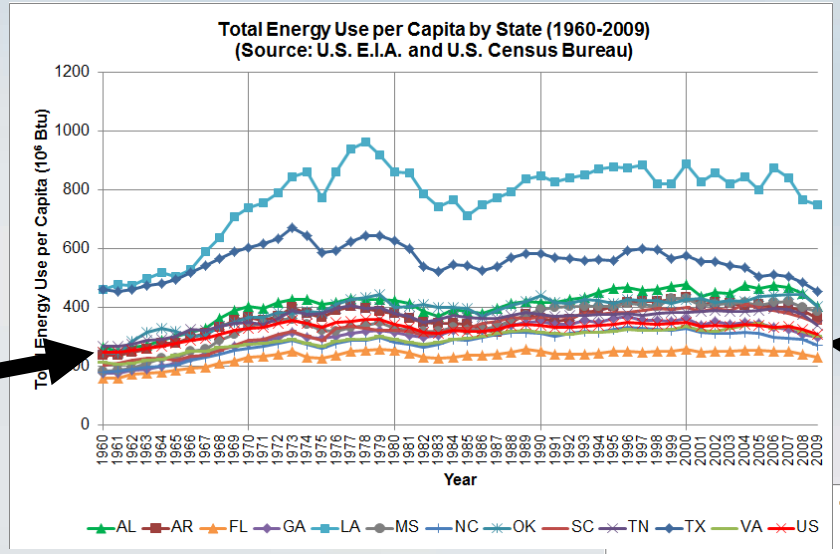
Electricity - $ 776 million

Demand - $1,027 million

Costs - $ 607 million



TOP-DOWN ANALYSIS OF STATE-WIDE ENERGY USE (USEIA data)



USEIA Data Analyzed Top-down to look for reduced Energy use (12 states through 2009).

Overall US Energy Use/Cap = *decreasing*

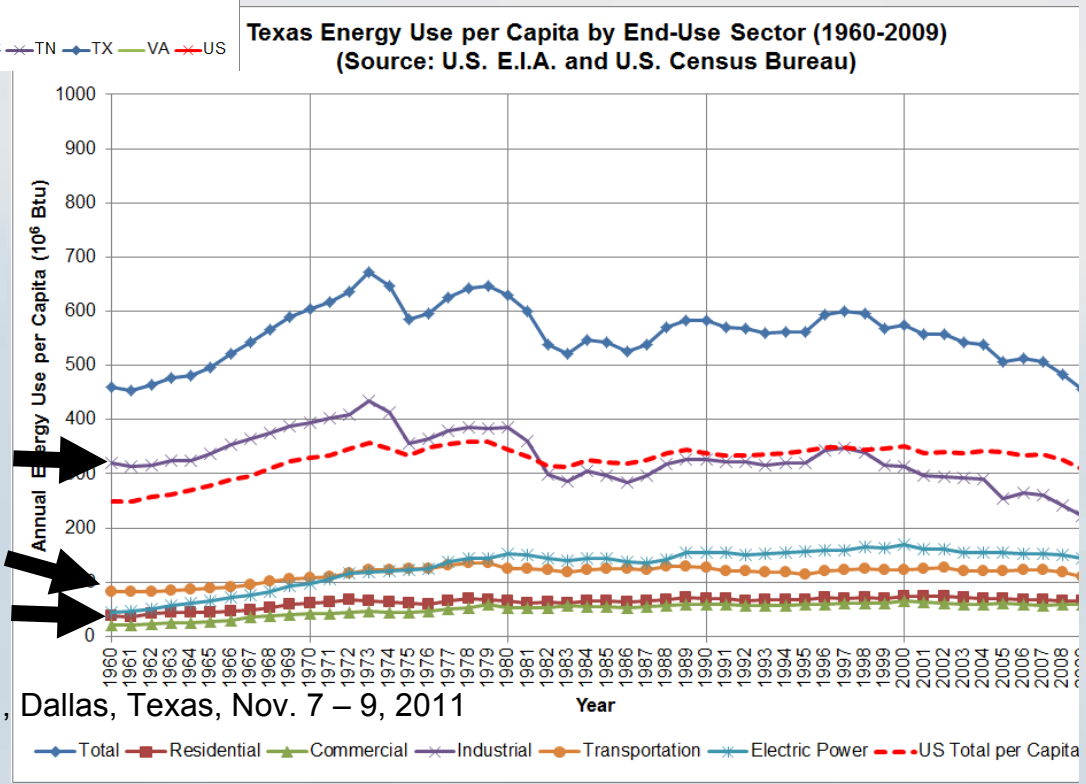
Texas Energy Use/Cap = *decreasing*

USEIA Data Analyzed Top-down to look for reduced Energy use (Texas through 2009).

Industrial energy = *decreasing*

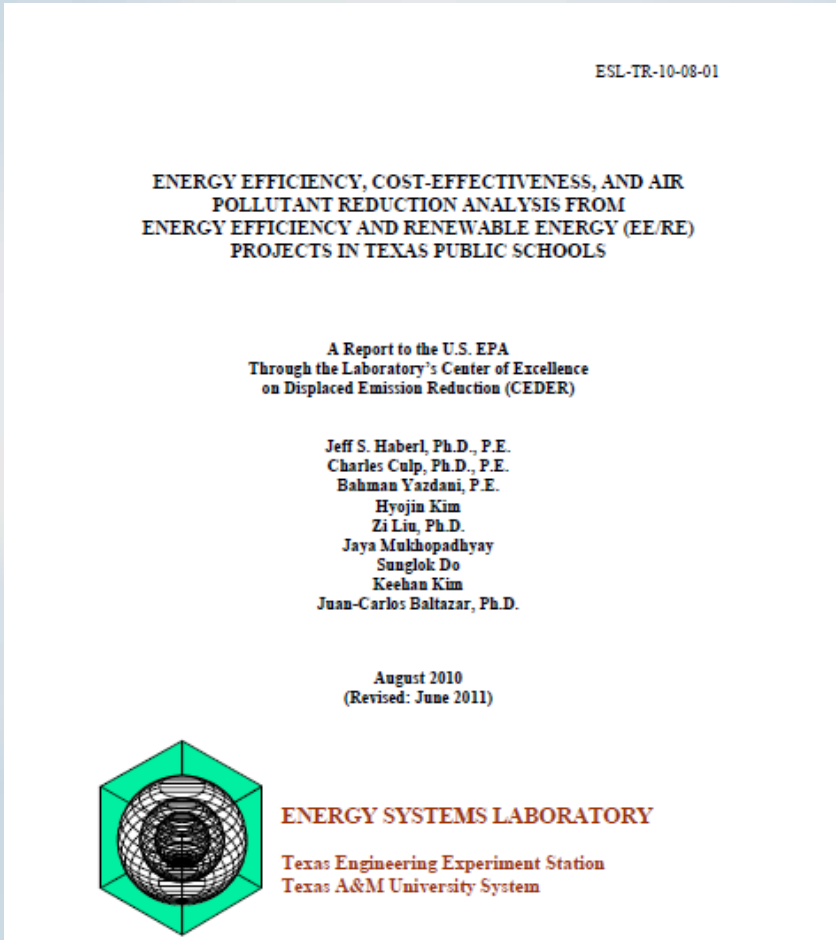
Residential/Commercial = *decreasing*

Transportation/Electricity = *decreasing*



EE/RE IN TEXAS SCHOOLS

In 2010 the U.S.E.P.A. requested study to see how much energy/emissions could be saved if all schools in Texas were upgraded to new energy code.



ESL-TR-10-08-01

ENERGY EFFICIENCY, COST-EFFECTIVENESS, AND AIR POLLUTANT REDUCTION ANALYSIS FROM ENERGY EFFICIENCY AND RENEWABLE ENERGY (EE/RE) PROJECTS IN TEXAS PUBLIC SCHOOLS

A Report to the U.S. EPA
Through the Laboratory's Center of Excellence
on Displaced Emission Reduction (CEDER)

Jeff S. Haberl, Ph.D., P.E.
Charles Culp, Ph.D., P.E.
Bahman Yazdani, P.E.
Hyojin Kim
Zi Liu, Ph.D.
Jaya Mukhopadhyay
Sunglok Do
Keehan Kim
Juan-Carlos Baltazar, Ph.D.

August 2010
(Revised: June 2011)

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

REVIEWED 18 EE/RE MEASURES

Envelope

- Increased Roof Insulation
- Decreased Glazing U-Value
- Decreased Infiltration

Lighting

- Decreased Lighting Power Density
- Occupancy Sensor for Lighting Control
- Daylight Dimming Controls
- Skylights

DHW

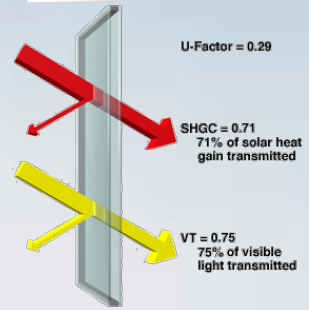
- Improved DHW Heater Efficiency
- Tankless Water Heater

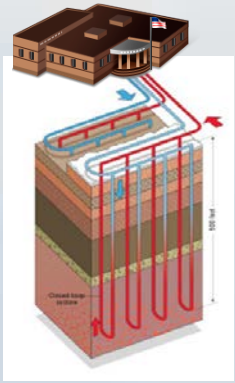
HVAC System

- OA Demand Control
- Improved AC Efficiency (EER)
- Improved Heating System Efficiency
- Decreased Supply Fan Power Consumption
- PVAVS with VFD for Fan Control
- PVAVS with Variable Speed for HW Pump

Renewable

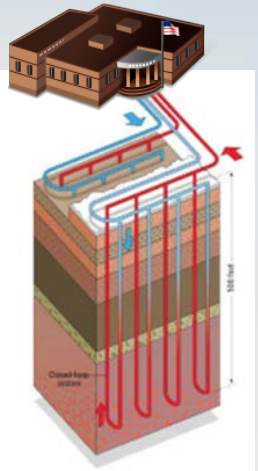
- Solar PV
- Solar DHW
- Ground Source Heat Pump

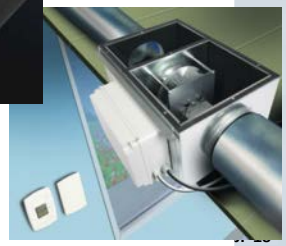




RESULTS: INDIVIDUAL ECMs, DALLAS

Measure	Cost	%Saved	Payback
Solar PV	$1,679,333	21.0%	36 years
Ground source heat pump	$120,000	11.2%	25 years
Daylighting control	$85,085	6.0%	4.4 years
Variable frequency drive in fan control	$39,780	5.5%	3.0 years
Lighting upgrade – change out fixtures and ballast from T12 to T8	$79,430	5.0%	4.7 years
Demand control ventilation	$37,360	4.4%	6.3 years





RESULTS: STATEWIDE, ALL SCHOOLS

Total energy and emissions savings if applied to all new and existing Texas ISDs (700.3 million ft^2) would be:

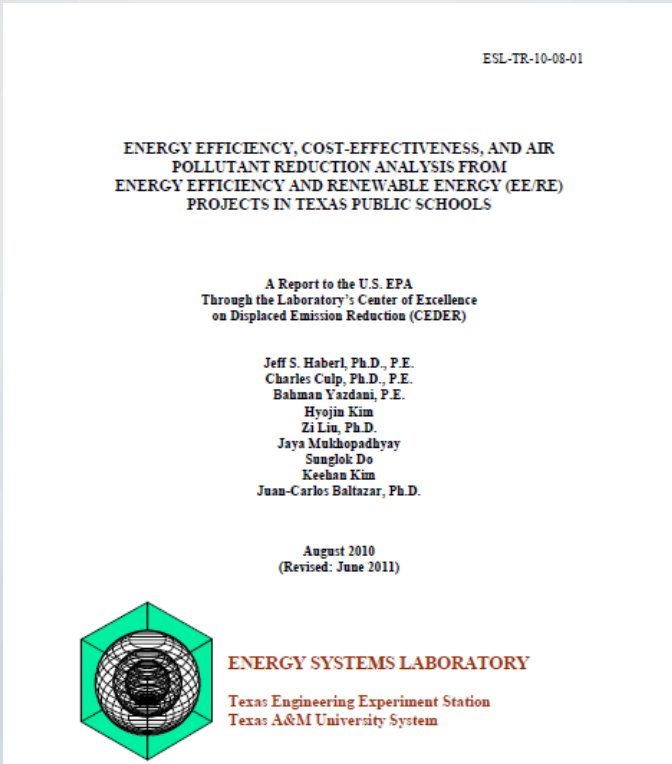
10,520,419 MMBtu/yr (Elec: $338 million/yr)*

-12,172,811 MMBtu/yr (N.G. -$10 million/yr)

2,743 tons/yr for Nox (6.0 tons/OSD)

1,772 tons/yr for SO_2

2,286,012 tons/yr for CO_2


ESL-TR-10-08-01

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Texas Engineering Experiment Station
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* Note $0.095/kWh, $0.65/therm

2012 FEDERAL LIGHTING MANDATE

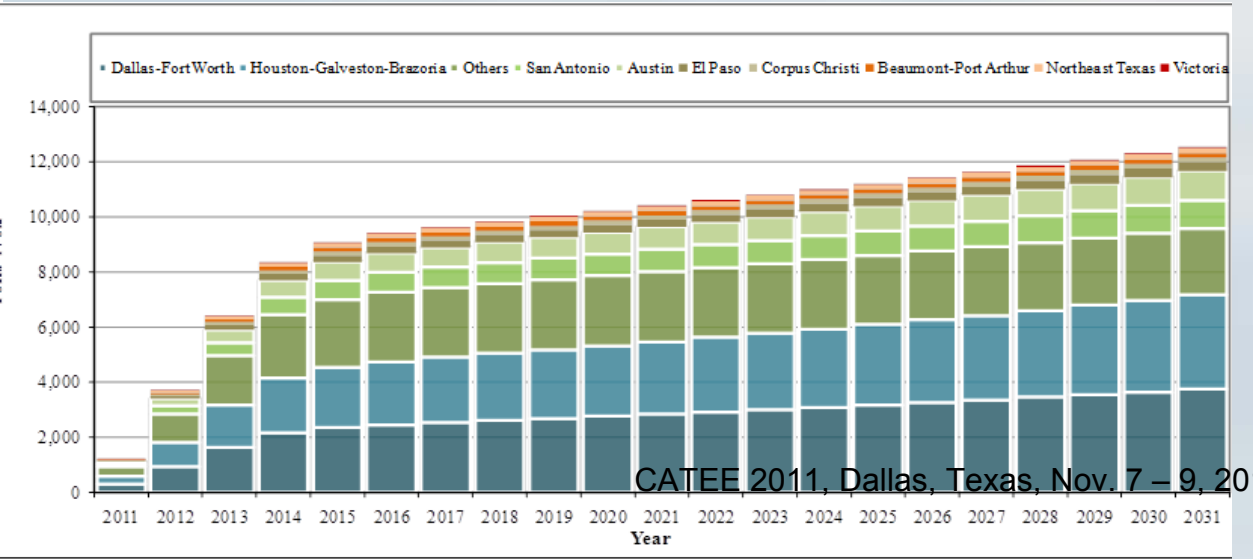
In January 2012 new Federal Lighting Standards will be in place.

Calculated Savings:

2011

1,848,000 MWh

3 tons/OSD



2016

14,377,000 MWh

24 tons/OSD

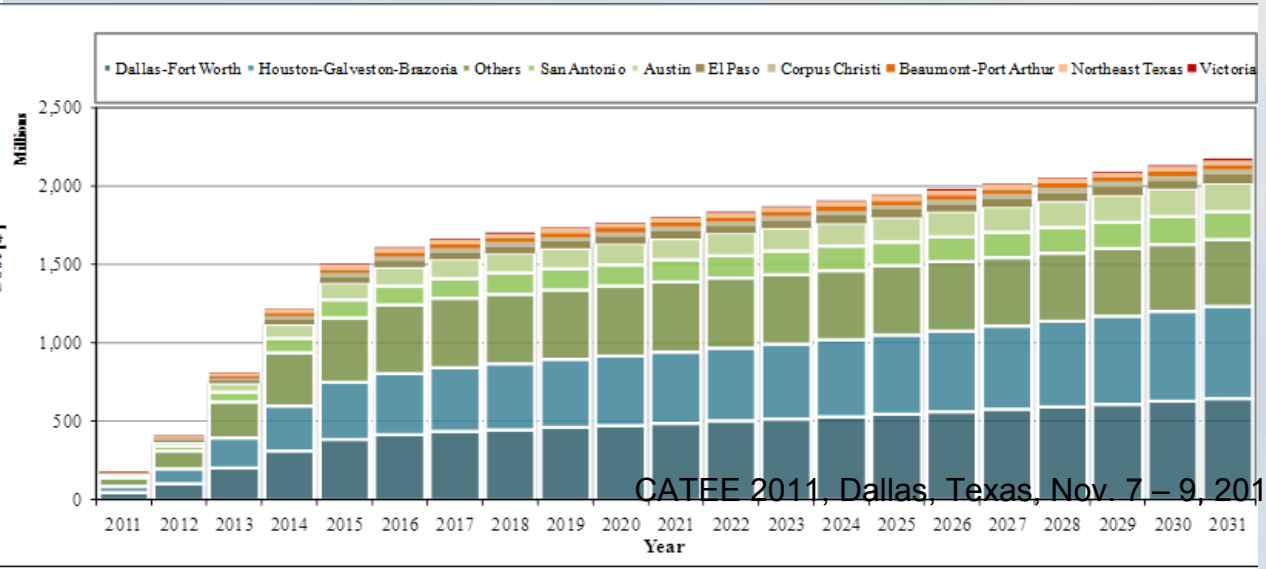
2012 FEDERAL LIGHTING MANDATE

In January 2012 new Federal Lighting Standards will be in place.

Calculated Savings:

2011

- 1,848,000 MWh
- 3 tons/OSD
- $ 250 million
- $ 25/household

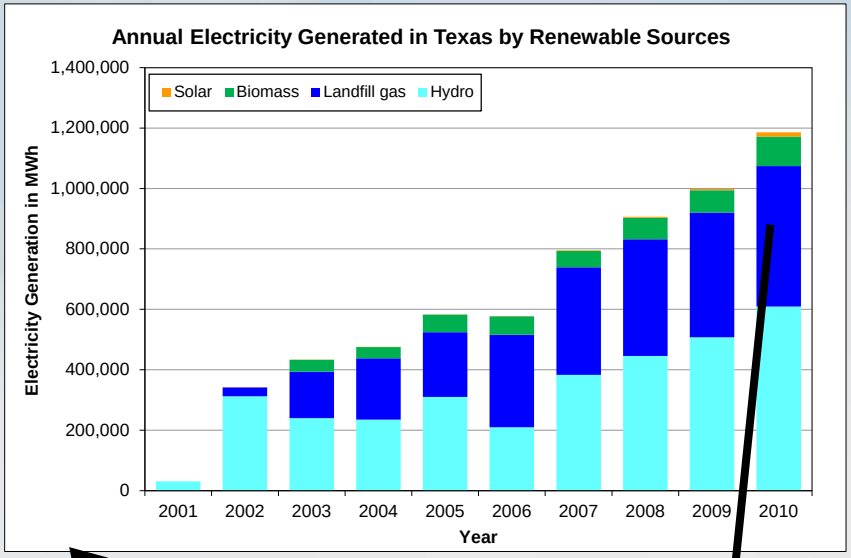


2016

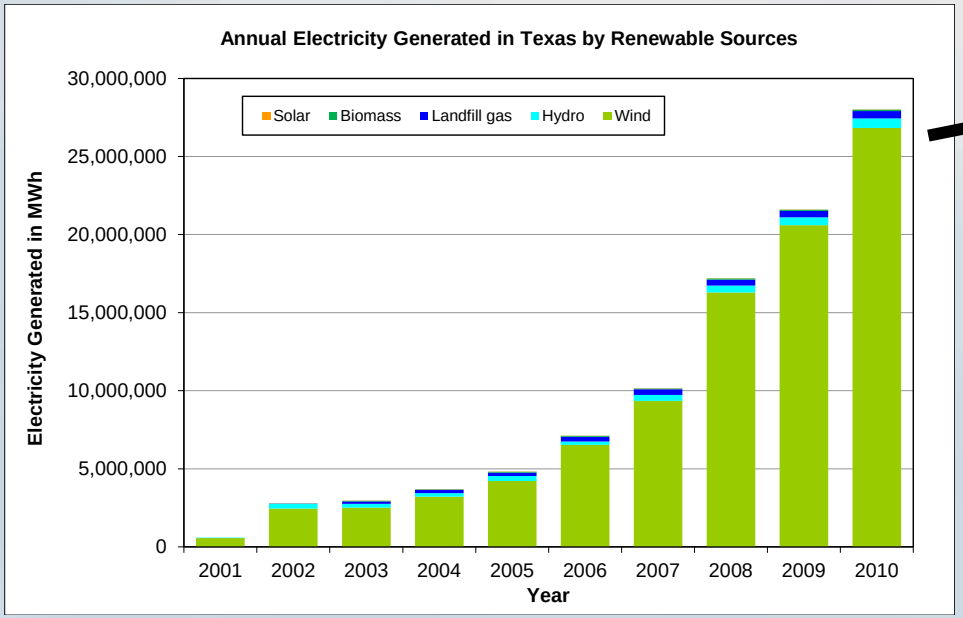
- 14,377,000 MWh
- 24 tons/OSD
- $1,600 million
- $160/household

RENEWABLES: WHAT ARE THEY?

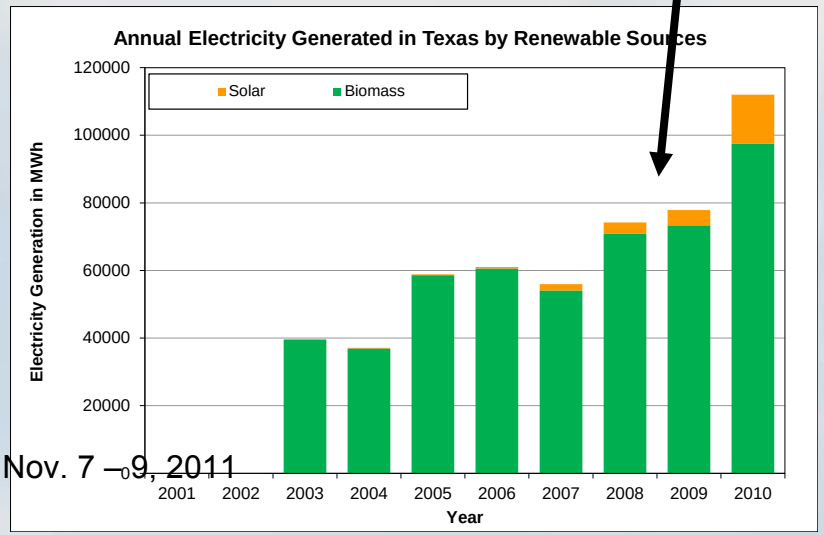
Landfill gas, hydro are next.



Wind energy is the largest portion.

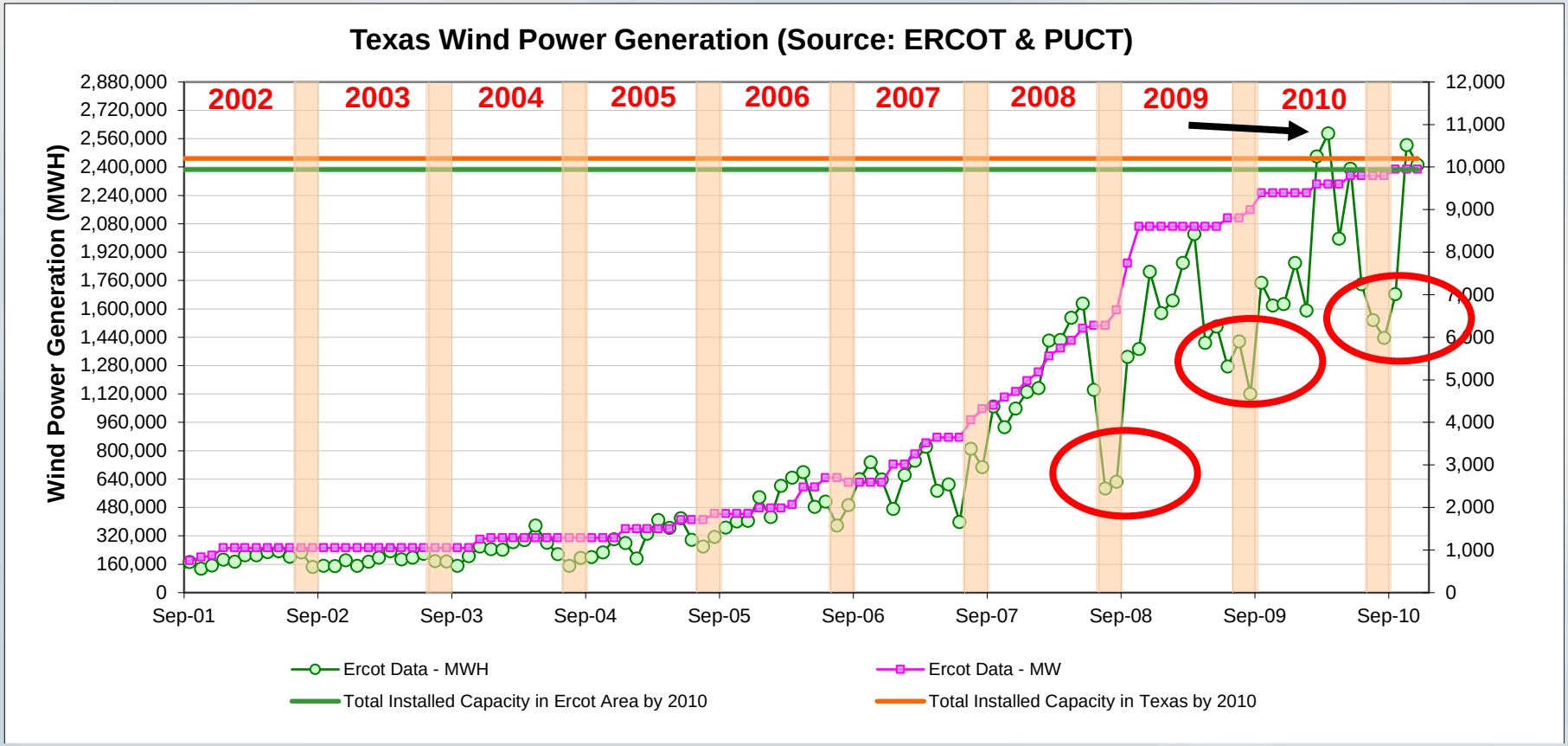


Biomass, solar are smallest



WIND PROJECTS IN TEXAS (2010)

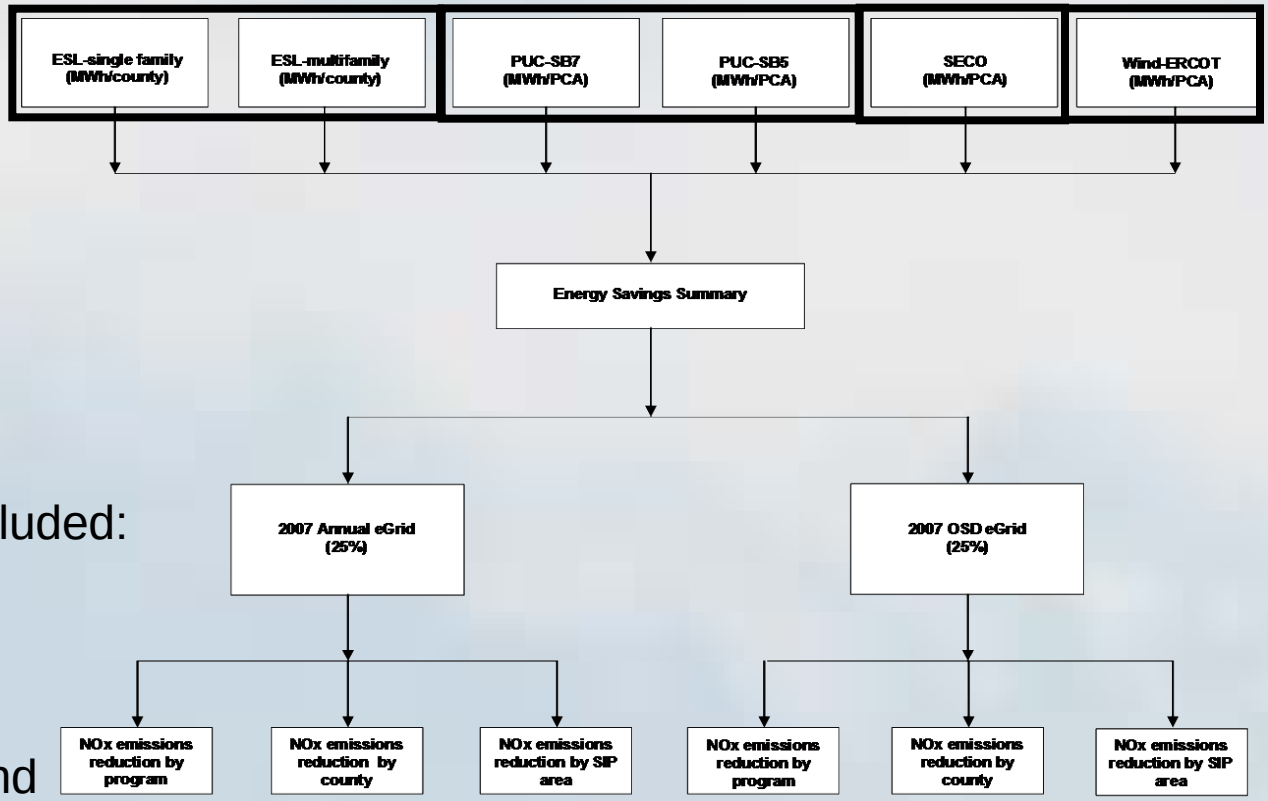
Substantial increases in measured electricity from wind energy.



However, wind generation during Ozone Season Period less than other periods.

INTEGRATED NOx SAVINGS

Integrated Emissions Savings Across Agencies (2010 & Beyond) To Report Savings To TCEQ and EPA



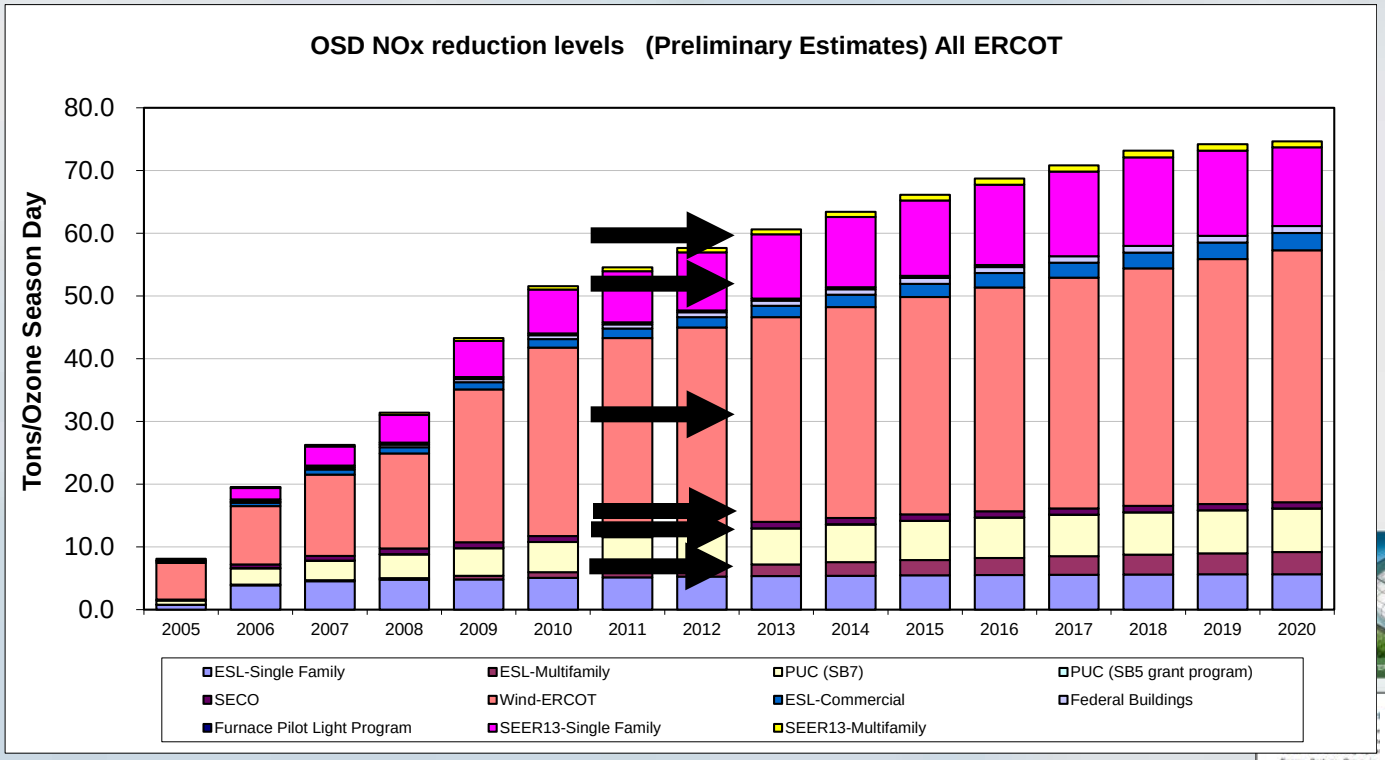
State Agencies included:

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

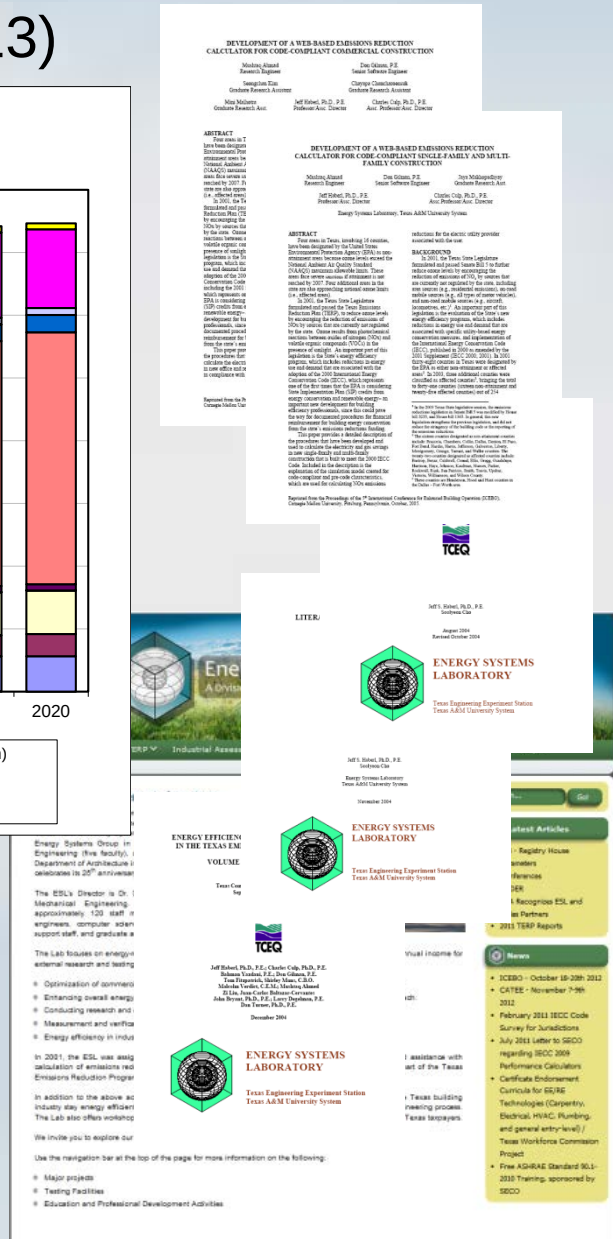
CATEE 2011, Dallas, Texas, Nov. 7 – 9, 2011

INTEGRATED NOx SAVINGS

2010 Integrated Emissions Savings (2013)



ESL Code Compliance	(9.03 tons/day)
PUC SB5,SB7 programs	(5.78 tons/day)
SECO Political Sub.	(1.01 tons/day)
Green Power (Wind)	(32.63 tons/day)
Residential AC Retrofits	(11.03 tons/day)
Total	**(60.61 tons/day)**



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