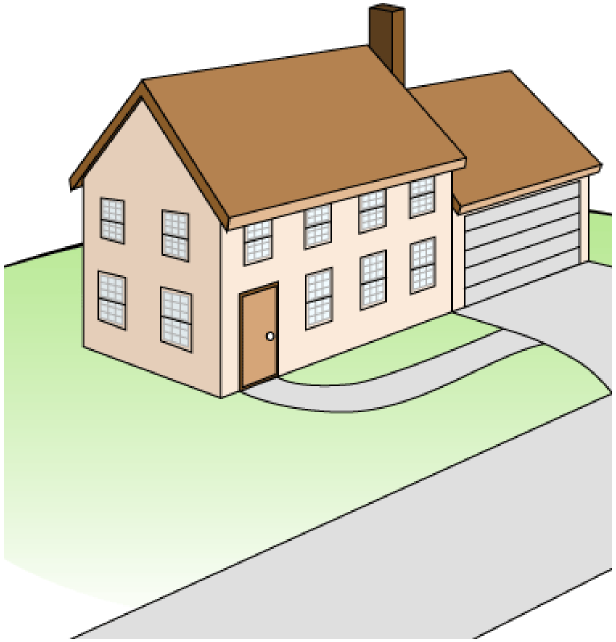
A Comparative Analysis of Residential Energy Use for 2009 IECC Compliance & 2001IECC Compliance for Selected Climate Zones in Texas



Jaya Mukhopadhyay
Zi Liu
Mini Malhotra
Sandeep Kota
Sheila Blake
Jeff Haberl
Charles Culp
Bahman Yazdani

Energy Systems Laboratory
Texas A&M University System
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ACKNOWLEDGEMENT

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STRUCTURE

BACKGROUND

SIMULATION SUITE

CLIMATE ZONE DECRIPTION

BASE-CASE HOUSE DESCRIPTION

RESULTS

CONCLUSIONS

BACKGROUND

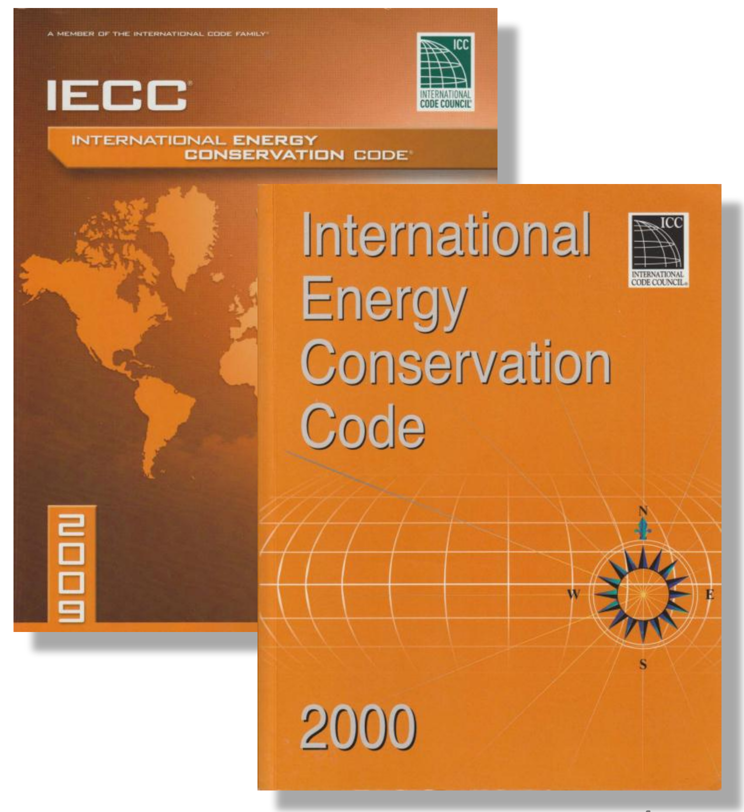
Proposal to adopt the 2009 IECC for the State of Texas

A 2009 code-compliant house is compared to a 2001 code-compliant house in order to assess stringency

Analysis performed using ResNet-certified DOE-2 simulation tool developed by ESL

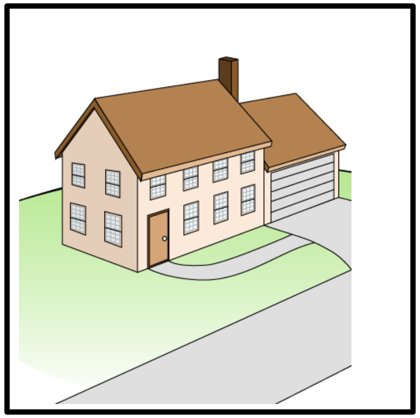
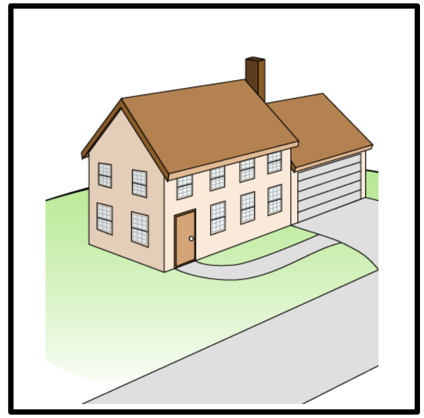
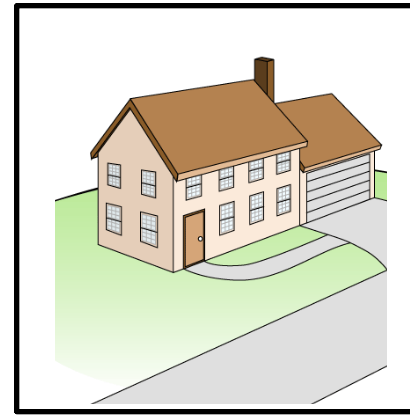
Five locations in Texas selected:

- Houston
- Brownsville
- Dallas/Fort Worth
- El Paso
- Amarillo



SIMULATION SUITE

Using DOE-2.1e simulation tool for analysis

Three sets of simulation models :

- 2001 IECC code-compliant house
- 2001 IECC code-compliant house with modifications
- 2009 IECC code-compliant house

The models were prepared for:

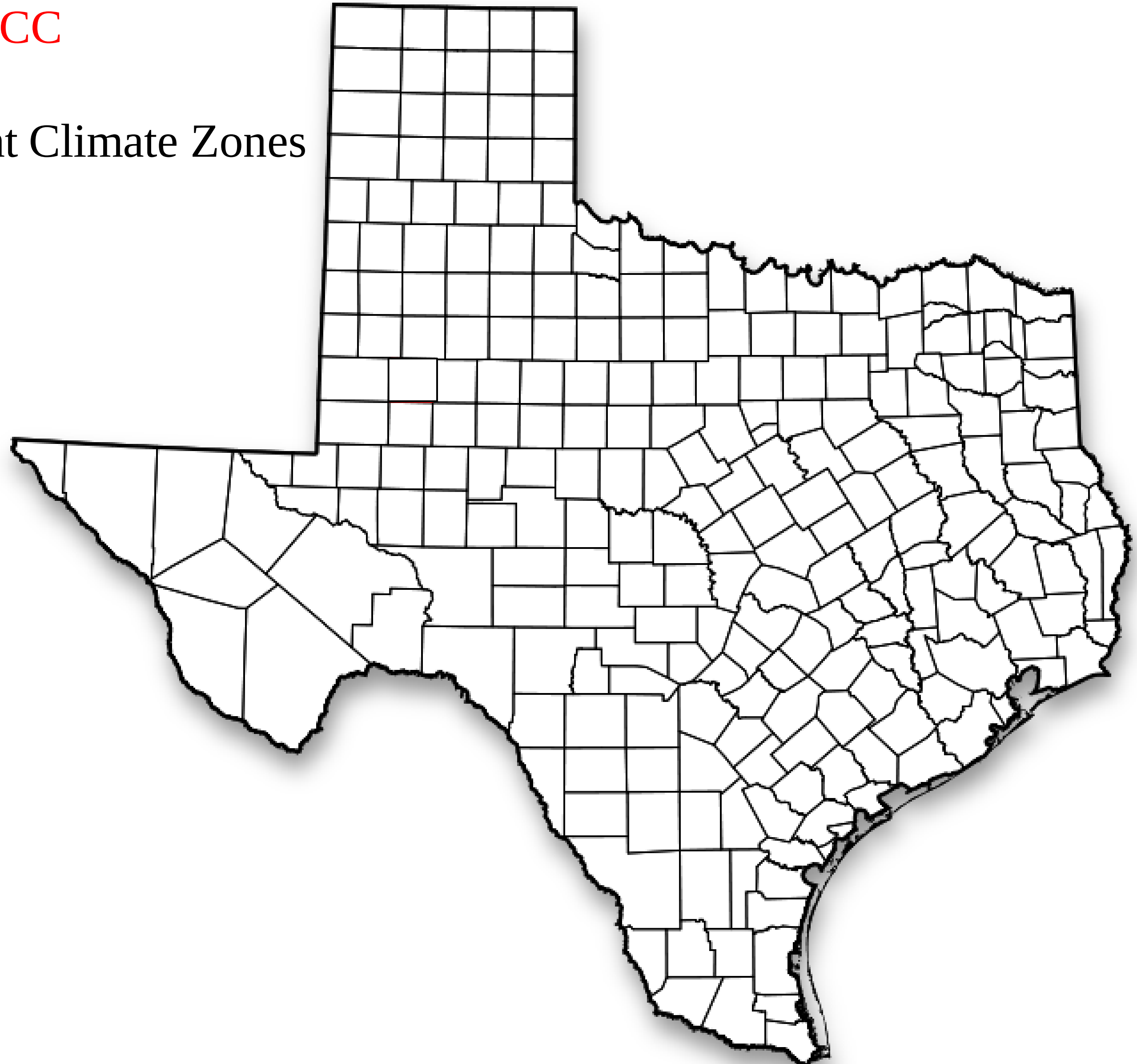
- A house with Electric Cooling , Natural Gas Heating & DHW
- A house with Electric Cooling, Heat-Pump Heating & DHW

Results were obtained for both source and site energy consumption

COMPARING CLIMATE ZONES

The State of Texas has been divided into climate zones for the 2001 IECC & 2009 IECC

Each code has different Climate Zones specifications

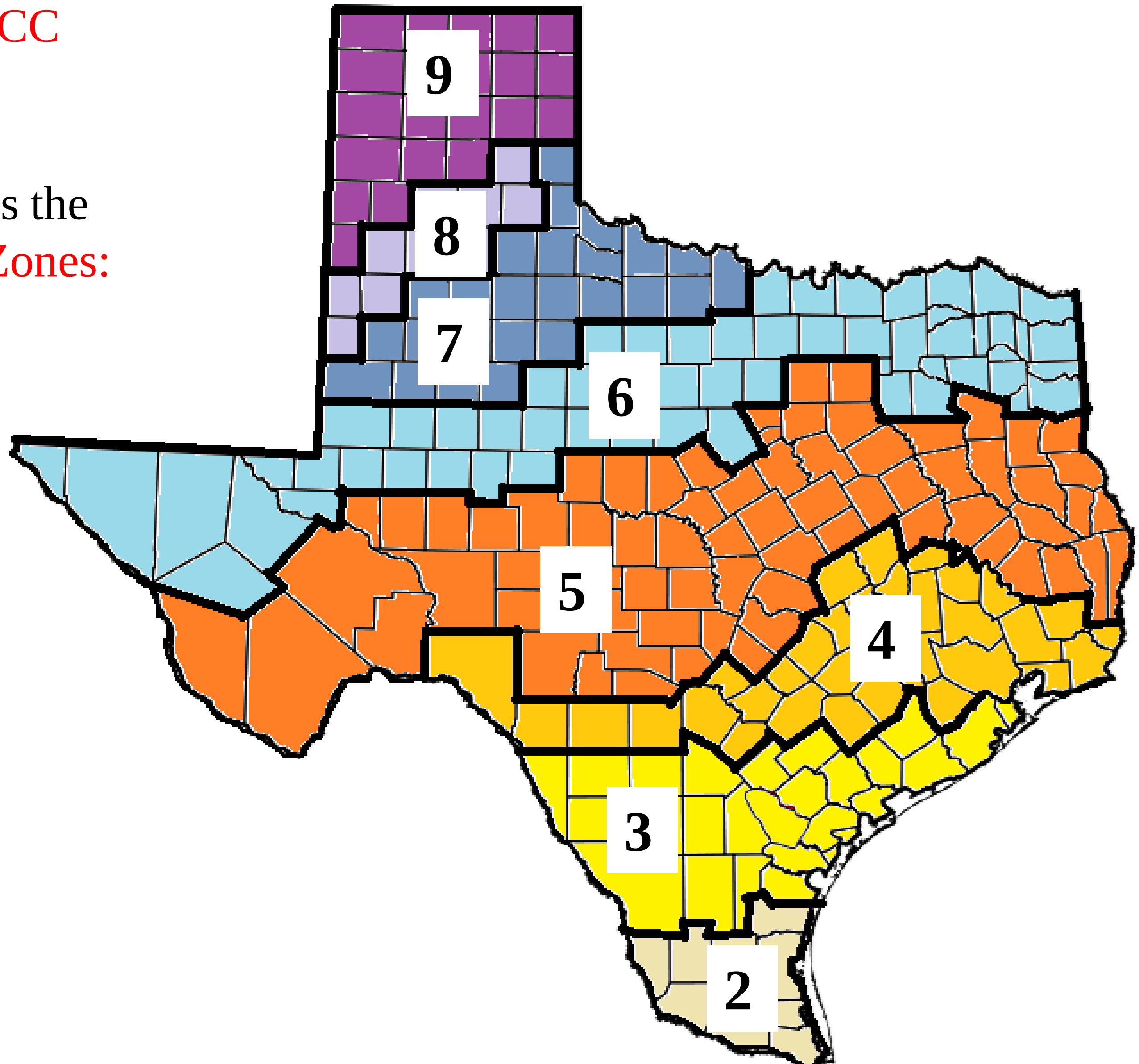


COMPARING CLIMATE ZONES

The State of Texas has been divided into climate zones for the 2001 IECC & 2009 IECC

The 2001 IECC divides the State of Texas into 8 Zones:

- Zone 2
- Zone 3
- Zone 4
- Zone 5
- Zone 6
- Zone 7
- Zone 8
- Zone 9

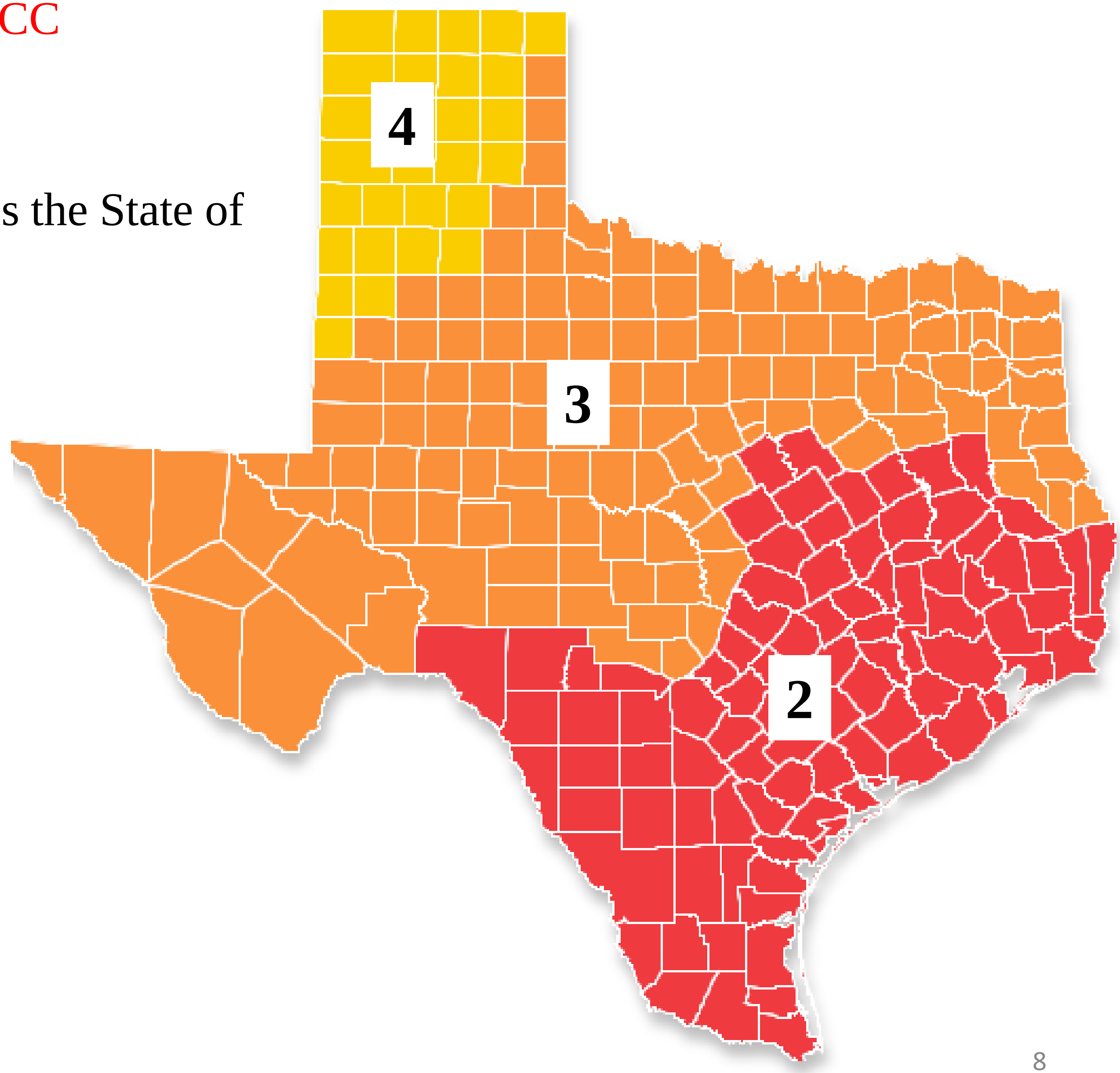


COMPARING CLIMATE ZONES

The State of Texas has been divided into climate zones for the 2001 IECC & 2009 IECC

The 2009 IECC divides the State of Texas into 3 Zones

- Zone 2
- Zone 3
- Zone 4

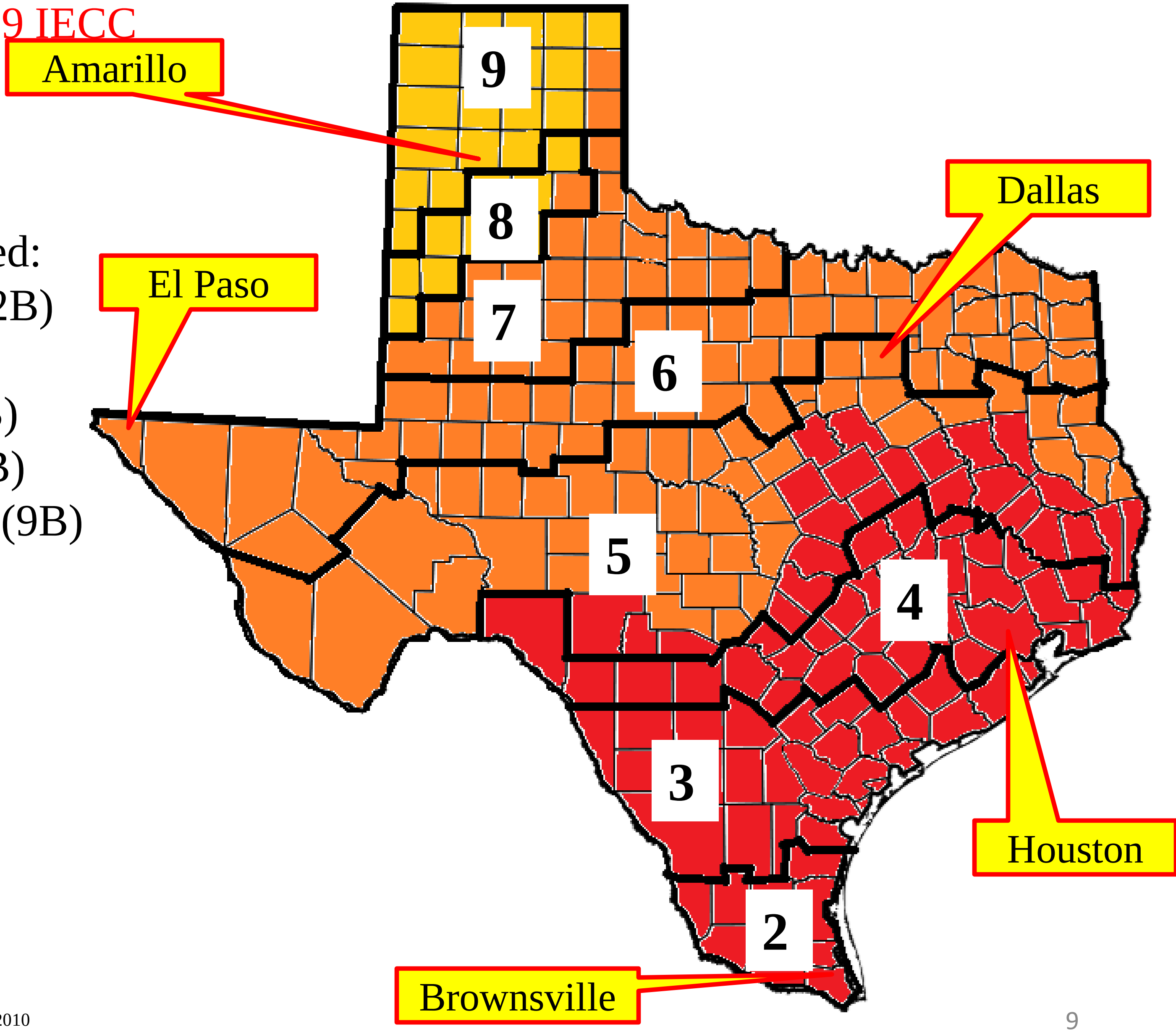


COMPARING CLIMATE ZONES

The State of Texas has been divided into climate zones for the 2001 IECC & 2009 IECC

5 Counties Selected:

- Cameron (2B)
- Harris (4B)
- Tarrant (5B)
- El Paso (6B)
- Armstrong (9B)

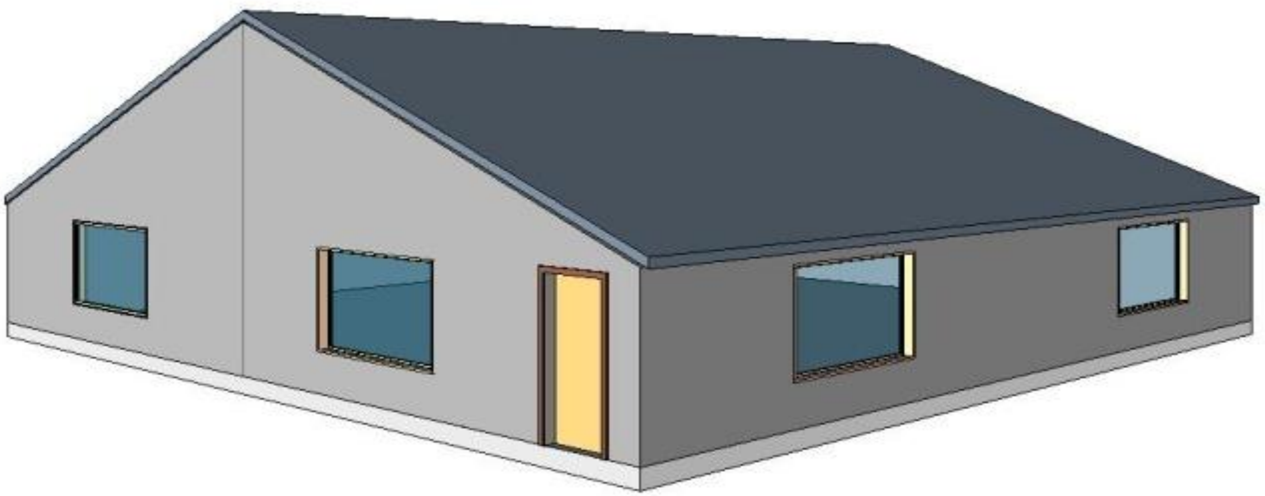


THE BASE CASE

Assumptions based on the "Standard Design" as defined in Chapter 4 of the 2001 IECC & 2009 IECC

GENERAL CHARACTERISTICS

- Single story; 2500 sq. ft. house; 4 bedrooms
- No exterior shading
- Slab-on-grade floor
- Ducts in the unconditioned space
- Vented attic



THE BASE CASE

Assumptions based on the “Standard Design” as defined in Chapter 4 of the 2001 IECC & 2009 IECC

BUILDING ENVELOPE

For 2001 IECC

- Wall R-values obtained from Table 402.1.1(1)
- Fenestration U-values obtained from Table 402.1.1(2)
- Specifications for roof / ceiling and floor obtained from prescriptive tables: Table 502.2.4

For 2009 IECC

- The building envelope no longer uses WWAR as basis for specification
- Specifications for all the building components were obtained from Table 402.1.3


Source: http://www.buildingscience.com/documents/case-studies/cs-ma-westford-hfh


Source: http://1272main.wordpress.com/

THE BASE CASE

Assumptions based on the "Standard Design" as defined in Chapter 4 of the 2001 IECC & 2009 IECC

BUILDING ENVELOPE

Building Components	2000/2001 IECC					2009 IECC				
	CAM 2B	**HAR 4B**	**TAR 5B**	**ELP 6B**	**ARM 9B**	**CAM 2A**	**HAR 2A**	**TAR 3A**	**ELP 3B**	**ARM 4B**
Walls U-factor	0.085	0.085	0.085	0.08	0.064	0.082	0.082	0.082	0.082	0.082
Ceilings R-value /U-factor	R-30	R-30	R-38	R-38	R-38	0.035 R-27.84	0.035 R-27.84	0.035 R-27.84	0.035 R-27.84	0.03 R-32.51
Glazing U-factor	0.47	0.47	0.47	0.44	0.41	0.65	0.65	0.5	0.5	0.35
Glazing SHGC	0.4	0.4	0.4	0.68	0.68	0.3	0.3	0.3	0.3	0.4

THE BASE CASE

Assumptions based on the “Standard Design” as defined in Chapter 4 of the 2001 IECC & 2009 IECC

GLAZING AREA

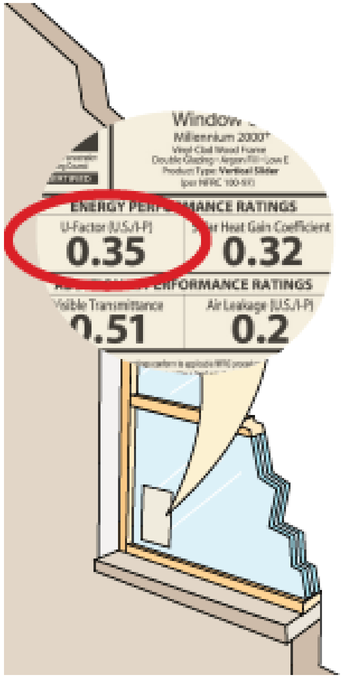
The glazing area in both the 2001 & 2009 IECC codes was specified in terms of window-to-floor area ratio (WFAR)

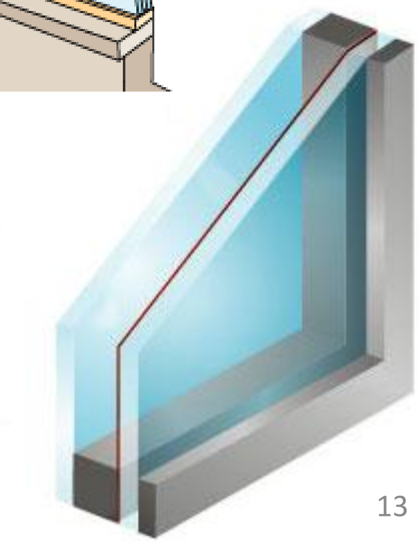
For 2001 IECC

- The WFAR was fixed at **18%** for the 2001 IECC

For 2009 IECC

- The WFAR is equal to that of the proposed building if the window area of the proposed design is less than **15%** of the floor area.
- In case the WFAR of the proposed building exceeds 15% of the floor area, the WFAR of the base-case house is fixed at 15%





Source: http://www.propertycert.net/Mainpages/tips3.php

THE BASE CASE

Assumptions based on the “Standard Design” as defined in Chapter 4 of the 2001 IECC & 2009 IECC

<u>DOORS</u>

For 2001 IECC

- U-value - 0.2 Btu/hr-sq-ft-F
- Two doors are assumed, one each on the front and the back of the house

For 2009 IECC

- U-value of the door same as the specifications for fenestration U-values
- Two doors were assumed on the North

Source: http://www.mondialtrade.net/ItemDetail.aspx?itemId=INTERIOR_DOORS_01

THE BASE CASE

Assumptions based on the “Standard Design” as defined in Chapter 4 of the 2001 IECC & 2009 IECC

<u>ATTIC INFILTRATION</u>

For 2001 IECC & 2009 IECC

Fractional leakage area of 0.0033 was assumed for both the codes

<u>AIR EXCHANGE RATE FOR CONDITONED SPACE</u>

For 2001 IECC

The values are dependent on the number of stories when using the Sherman-Grimsrud model

Fractional leakage area was set at 0.00057

For 2009 IECC

Fractional leakage area was set at 0.00036

Source: http://buildersguild.net/projects.php?cat_id=101

Source: usenergyaudit.org

THE BASE CASE

Assumptions based on the “Standard Design” as defined in Chapter 4 of the 2001 IECC & 2009 IECC

Source: http://blog.greencricket.ca/index.php/author/tsmith/

<u>INTERNAL HEAT GAIN</u>

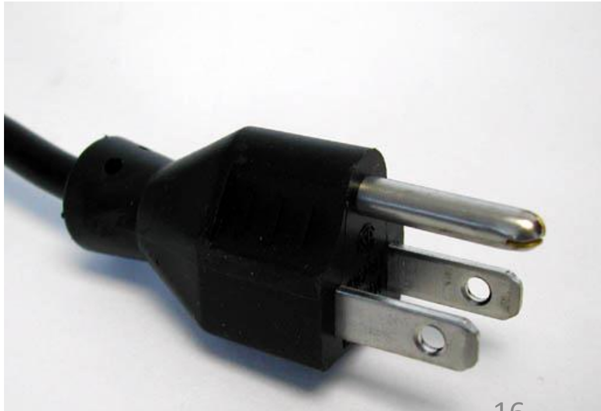
For 2001 IECC
The internal gains were fixed at 3,000 Btu/hr regardless of the house size

For 2001 IECC modified
The values were modified to 3,909 Btu/hr

For 2009 IECC
- Calculated by the equation provided in the code
- The gains are based on the square footage of the conditioned area and number of bedrooms

Igain = 17900+23.8xCFA+4104 x Nbr

Where CFA = Conditioned floor area
Nbr = Number of bedrooms


Source: http://newmediachatter.com/category/shameless-plugs

THE BASE CASE

Assumptions based on the “Standard Design” as defined in Chapter 4 of the 2001 IECC & 2009 IECC

<u>INTERIOR SHADING</u>

For 2001 IECC

- For summer - 0.70
- For winter - 0.90

For 2009 IECC

- For summer - 0.70
- For winter - 0.85

THE BASE CASE

Assumptions based on the "Standard Design" as defined in Chapter 4 of the 2001 IECC & 2009 IECC

THERMOSTAT SETTING

For 2001 IECC

The code requires:

For cooling 78 F

For heating 68 F

Setback 5 F

For 2001 IECC modified & 2009 IECC

The code requires:

For cooling 75 F

For heating 72 F

No setback

Source: http://www.mustknowhow.com/index.php/tag/calibrate-thermostat

THE BASE CASE

Assumptions based on the "Standard Design" as defined in Chapter 4 of the 2001 IECC & 2009 IECC

HEATING & COOLING SYSTEM EFFICIENCY

For both the codes:
Air Conditioners - SEER 13
Furnace efficiency – AFUE 0.78
Heat pump-HSPF 7.7

For 2001 IECC
Trade-offs with envelope ARE allowed

For 2009 IECC
Trade-offs with envelope NOT allowed

Source: ctamotorsports.com

Conclusions
Results
Base-case
Climate Z
Simulation
Background

THE BASE CASE

Assumptions based on the "Standard Design" as defined in Chapter 4 of the 2001 IECC & 2009 IECC

DOMESTIC HOT WATER

For 2001 IECC

The minimum efficiency is specified in Table 504.2

Efficiency is a function of the water heater capacity

For 2009 IECC

Efficiency is THE SAME as proposed design

Source: http://www.alliedboilers.com/indirect_fired_water_heater.php

THE BASE CASE

Assumptions based on the “Standard Design” as defined in Chapter 4 of the 2001 IECC & 2009 IECC

DUCT LEAKAGE

For 2001 IECC
No provisions were given in the code, hence a duct leakage value of 20% assumed

For 2009 IECC
A duct leakage of 8 CFM/100 ft2 of conditioned floor area to outdoor was used , which gives the value of duct leakage equal to 11.1%

DUCT INSULATION

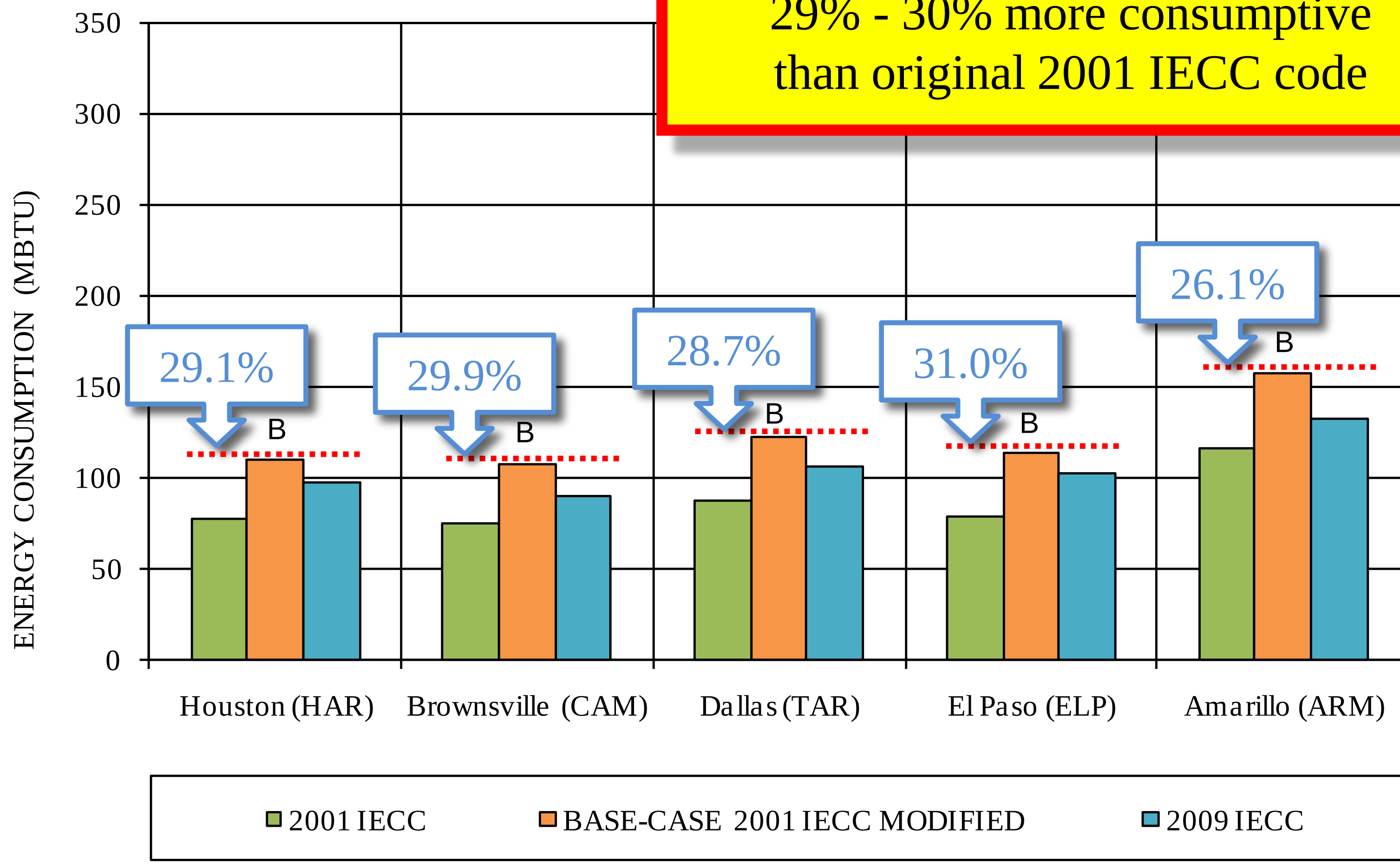
For 2001 IECC
Supply ducts R-values: R-8
Return ducts R-values: R-4

For 2009 IECC
Supply ducts R-values: R-8
Return ducts R-values: R-6

RESULTS

ANNUAL SITE Energy Consumption for a Code-Compliant House with NATURAL GAS Heating and DHW

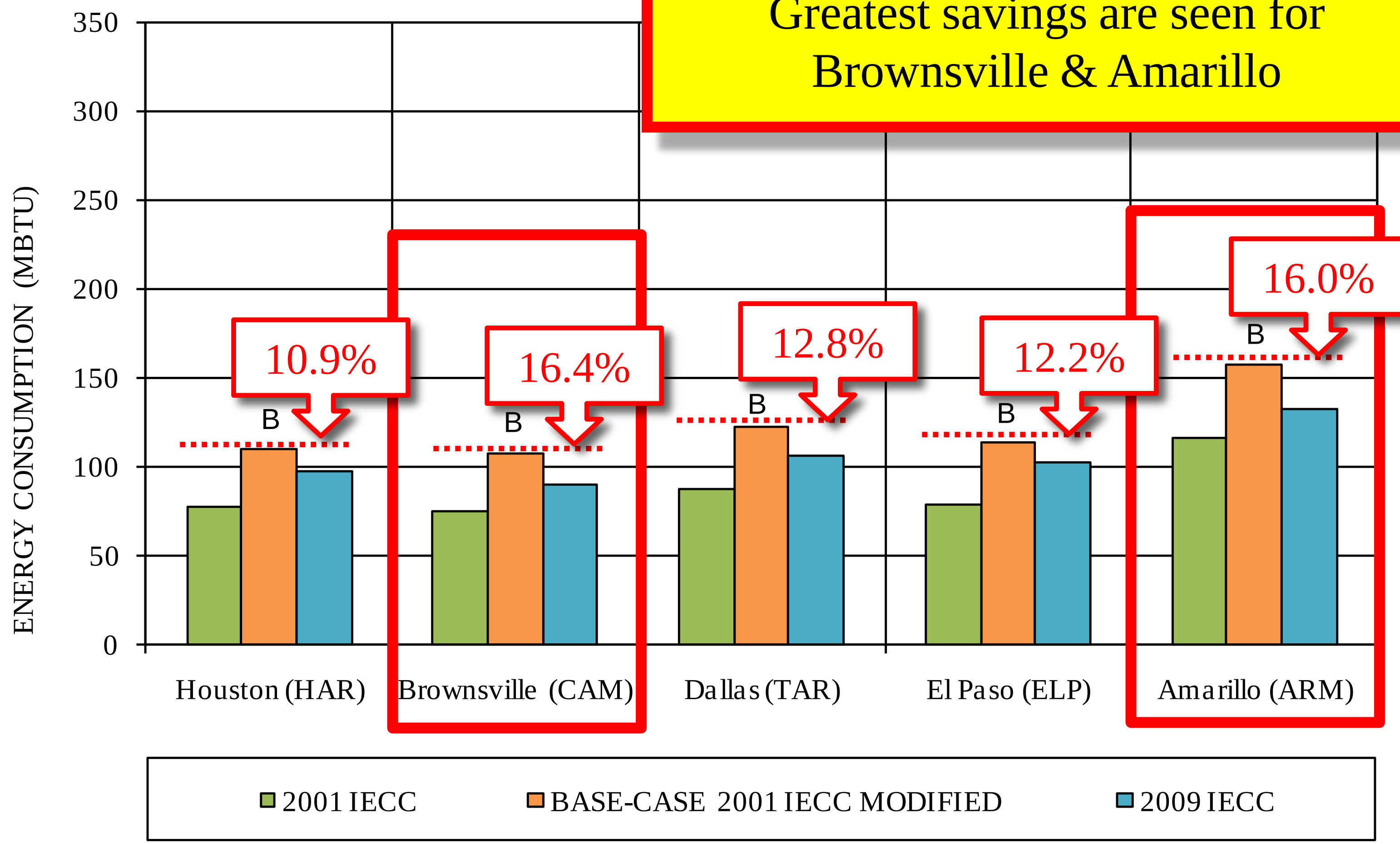
2001 IECC modified
29% - 30% more consumptive
than original 2001 IECC code



RESULTS

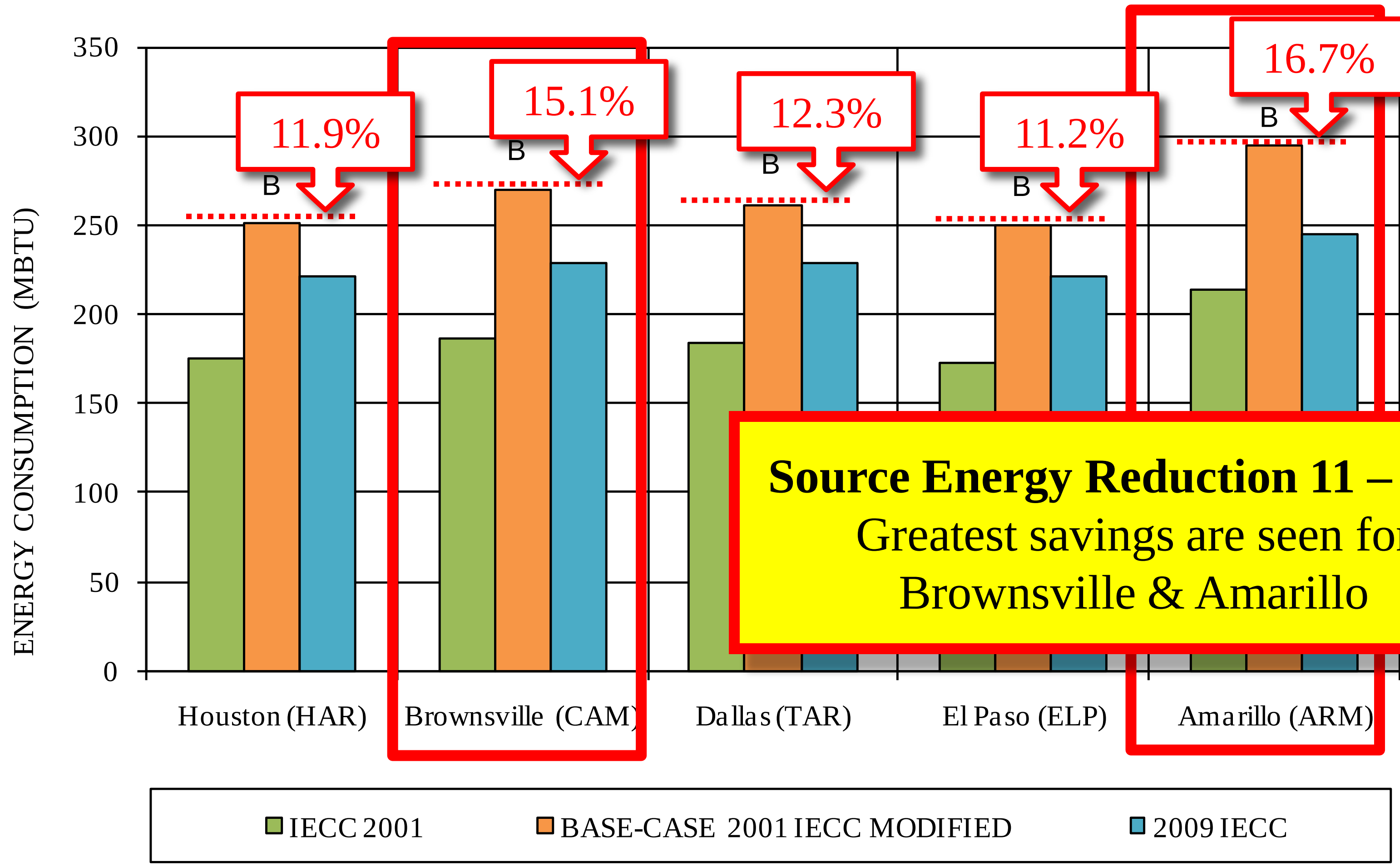
ANNUAL SITE Energy Consumption for a Code-Compliant House with NATURAL GAS Heating and DHW

Site Energy Reduction 10 – 16%
Greatest savings are seen for Brownsville & Amarillo



RESULTS

ANNUAL SOURCE Energy Consumption for a Code-Compliant House with NATURAL GAS Heating and DHW

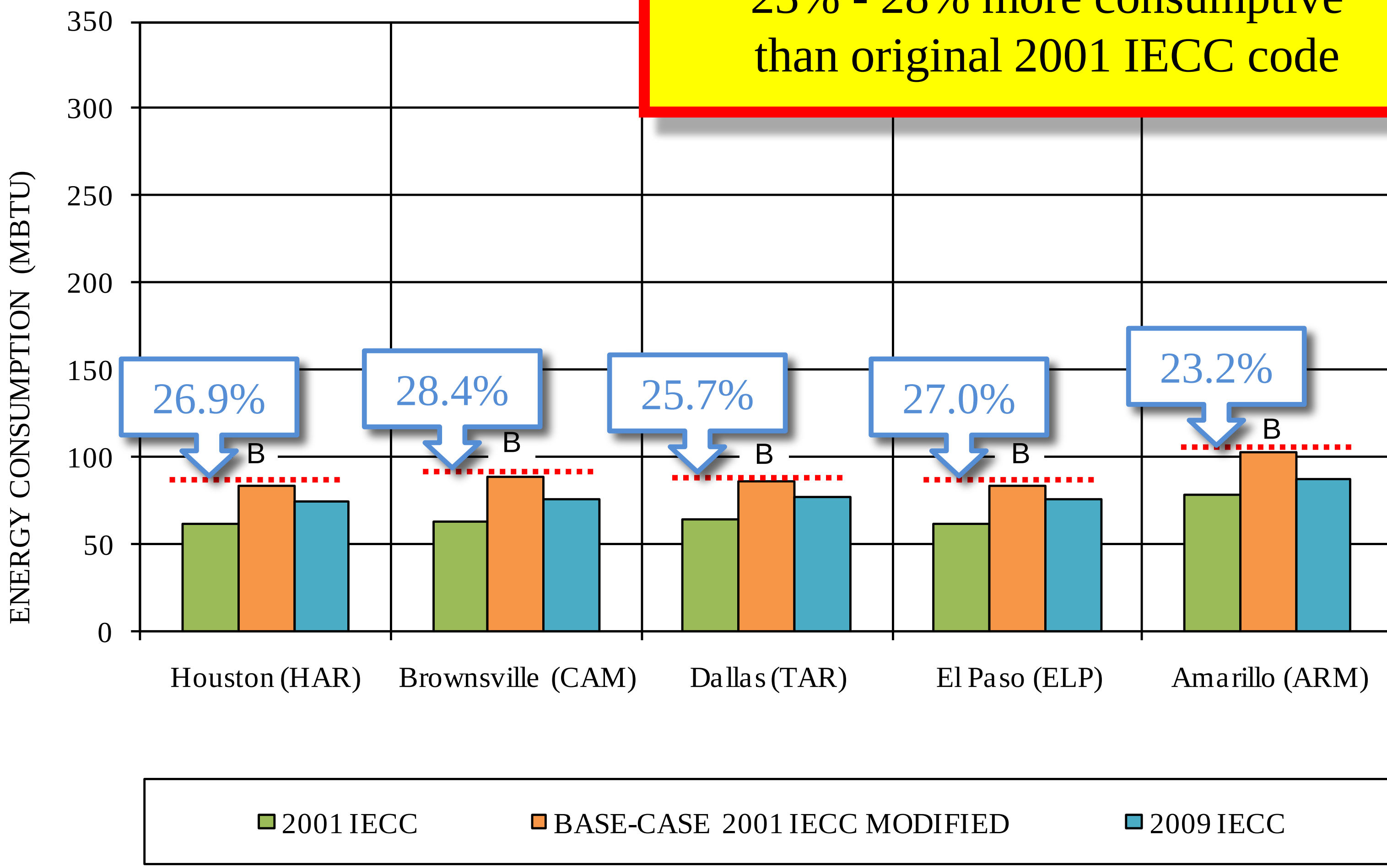


Source Energy Reduction 11 – 17%
Greatest savings are seen for Brownsville & Amarillo

RESULTS

ANNUAL SITE Energy Consumption for a Code-Compliant House with HEAT-PUMP Heating and DHW

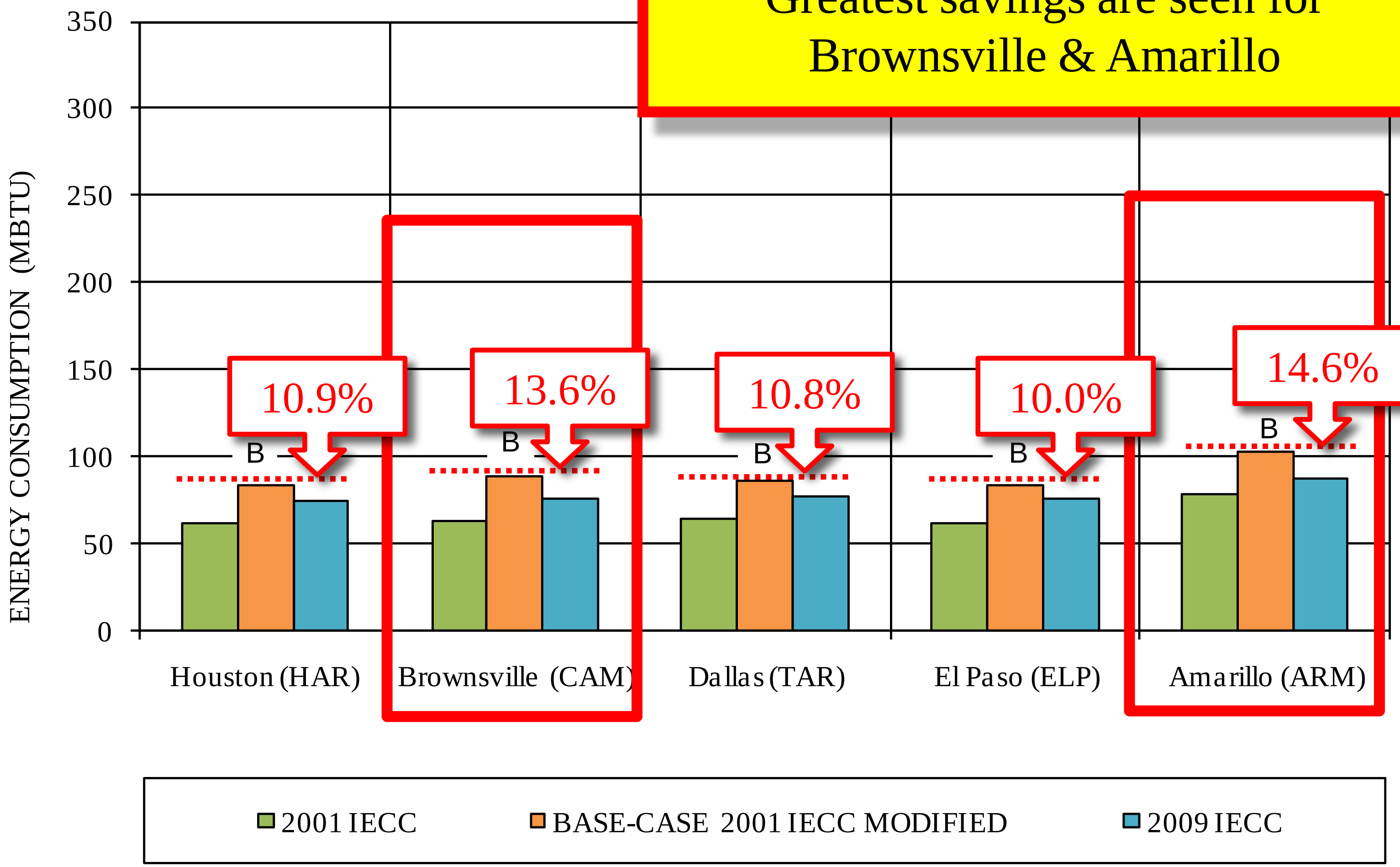
2001 IECC modified
23% - 28% more consumptive
than original 2001 IECC code



RESULTS

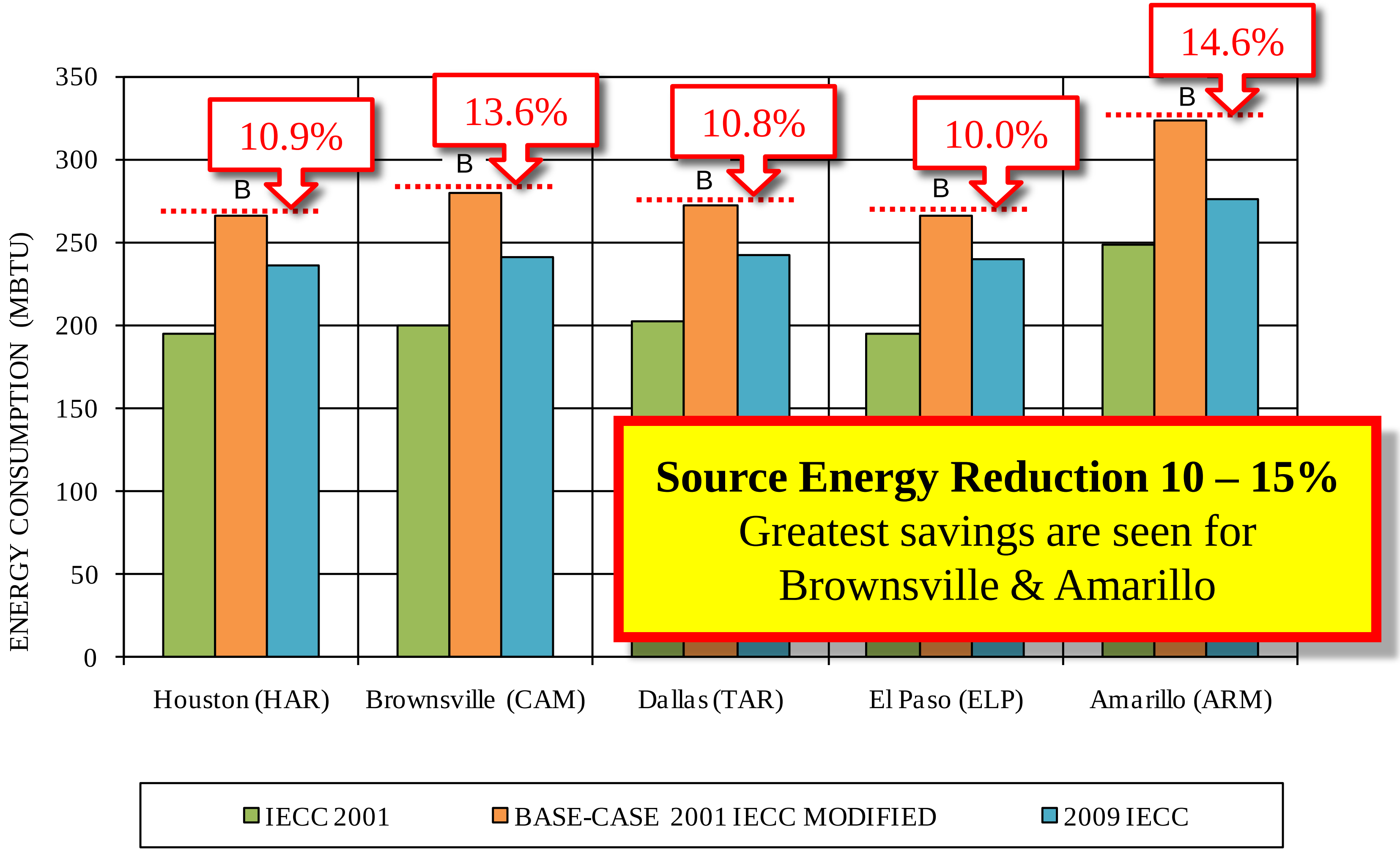
ANNUAL SITE Energy Consumption for a Code-Compliant House with HEAT-PUMP Heating and DHW

Site Energy Reduction 10 – 15%
Greatest savings are seen for Brownsville & Amarillo



RESULTS

ANNUAL SOURCE Energy Consumption for a Code-Compliant House with HEAT-PUMP Heating and DHW



RESULTS

Summary of Comparison between 2001 IECC Performance Path vs. 2009 IECC Performance Path

County	IECC 2009 Weather Zones	Energy Type	Total Annual Savings IECC 2009 Performance Path compared to the IECC 2000/2001 (%)	
			Gas Heating, DHW	Heat Pump Heating, Electric DHW
Houston (HAR)	2A	Site	10.9 %	10.9 %
		Source	11.9 %	10.9 %
Brownsville (CAM)	2B	Site	16.4 %	13.6 %
		Source	15.1 %	13.6 %
Dallas (TAR)	3A	Site	12.8 %	10.8 %
		Source	12.3 %	10.8 %
El Paso (ELP)	3B	Site	10.2 %	10.0 %
		Source	11.2 %	10.0 %
Amarillo (ARM)	4B	Site	16.0 %	14.6 %
		Source	16.7 %	14.6 %

SUMMARY

For a house with a natural gas heating and natural gas DHW:

A house built as per 2009 IECC specifications uses **10-16%** less **site & source** energy annually than a house built as per 2001 IECC specifications

For a house with a heat-pump heating and electric DHW:

A 2009 code compliant house with a heat pump uses **10-14%** less **site & source** energy annually than a house built as per 2001 IECC specifications

Thank you…

RESULTS

For all the sites simulated, the total energy use increases for the modified 2001 IECC house as compared to the 2001 IECC house. This is due to the reduced settings of internal energy gains and thermostat settings on switching from the 2001 code to the 2001 modified code.

▪This increase in annual energy use comes from an increase in energy use from lights and miscellaneous equipment as well as from space heating and cooling. The corresponding 2001 IECC simulations consume much less energy than the 2009 IECC simulations.

▪ On switching from the modified 2001 code to the 2009 code resulted in the reduction in annual energy consumption. This reduction in energy consumption is primarily due to change in space heating and cooling energy consumption as well as change in domestic water heating energy consumption.

▪Results of the comparison of the 2001 IECC with the values obtained from implementing the 2009 IECC performance path, when considering gas heating, the site energy savings are in the range of 10.9% to 16.4%. The source energy savings are in the range of 11.9% to 16.7%.

▪When considering the heat pump option, both the site and source energy savings are in the range of 10.9% to 14.6%.

▪Houses in Amarillo saved the most energy on going from modified 2001 IECC to 2009 IECC by saving over 16% in site and source energy for houses with gas heating and 14% in site and source energy for houses with heat pump heating.

▪Houses in El Paso saved the least energy on going from modified 2001 IECC to 2009 IECC by saving 10%-11% in site and source energy respectively for houses with gas heating and 10% in both site and source energy for houses with heat pump heating.