"Green is Mainstream: Building Codes, Energy Efficiency, and Best Practices in Green Building"

Best Practices In Residential Green Building Technology









Problems of Housing (1944).mpg







US DEPARTMENT OF ENERGY



ENERGY SYSTEMS LAB. TEXAS A&M UNIVERSITY

Special thanks to:

Felix Lopez, P.E. State Energy Conservation Office (SECO) & Department of Energy (DOE) & Bahman Yazdani, P.E. TAMU Energy Systems Laboratory (ESL)









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Best Practices In Residential Green Building Technology A Road-Map to Sustainable Economic & Community Development

Presented by Fred Bastani, PhD Jose Solis, PhD International Texas A&M University, & Polytechnic Institute (*IPI*), Inc. College of Architecture Supported by State Energy Conservation Office (SECO) Through a Grant from the US **D**epartment of **E**nergy (**DOE**) in collaboration with Energy Systems Laboratory (ESL) at Texas A&M University & Texas Association of Builders (TAB)



AGENDA

- Introduction
- Building Codes
- Site Work
- Design & Orientation
- Foundation
- Short Break
- Structure/Framing
- Roof Systems/Overhangs
- Building Envelope
- Exterior Covering Systems
- Short Break
- Mechanical & Electrical Systems
- Insulation
- Interior Finishing Systems
- Fixtures & Appliances
- Landscaping









2006 vs 2009 IECC













There are over 70 changes to the code that affect current code Sections

13 or more apply to all structures, Residential and Commercial

28 or more apply to Residential construction only

29 or more apply to Commercial construction only







Existing Requirements

EXAMPLE

Section 101.4.3 Additions, alterations, renovations or repairs.

Added four additional exceptions

- Reroofing
- Replacement of existing doors that separate conditioned space from the exterior
- Alterations that replace luminaries or bulb and ballast within existing luminaries



• There are over 47 changes to the code that insert new code Sections

- 22 or more apply to all structures, Residential and Commercial
- 7 or more apply to Residential construction only
- 18 or more apply to Commercial construction only



New RegulationsEXAMPLE

Section 402.4.2 Air Sealing and insulation

Building envelope air tightness and insulation shall be demonstrated to comply with one of the following options given by Section 402.4.2.1 or 402.4.2.2.

402.4.2.1Testing option

 Building envelope tightness and insulation shall be considered acceptable when tested air leakage is less than seven air changes per hour when tested with a blower door at a pressure of 33.5 psf (50 Pa).

402.4.2.2 Visual inspection option









Additional Information

Details on the majority of these code changes may be found in the ICC 2009 **IECC** Update INTERNATIONAL CODE COUNCIL



International Energy Conservation Code

International Energy Conservation Code

The International Energy Conservation Code® (IECC®) is recognized as the national model energy code of choice for U.S. cities, counties and states that adopt codes. The IECC and its predecessor, the Model Energy Code (MEC), are cited throughout Federal law for national private and public housing initiatives. For instance, Title III of the Energy Conservation and Production Act, as amended (ECPA), establishes requirements for the U.S. Department of Energy (DOE) to review each new version of the IECC and determine if it is an improvement in energy efficiency over



previous versions. The IECC also serves as the basis for federal tax credits for energy efficient homes, energy efficiency standards for federal residential buildings² and manufactured housing.³ Under federally insured energy-efficient mortgage programs (FHA and VA) and the conventional secondary mortgage market (Fannie Mae and Freddie Mac), properties meeting the IECC are considered energy efficient and eligible for a two percentage point increase in the applicant's debt-to-income qualifying ratios on loans thereby allowing borrowers to qualify for a larger loan amount and a more energy-efficient home.

Scope

The 2009 edition of the IECC continues to emphasize both prescriptive and performance-related provisions for both commercial and residential Content buildings. Insulation, window and skylight requirements for the thermal envelope for both residential and commercial buildings are based on Chapter 1: Administratio International climate zones. Performance criteria for compliance with residential energy efficiency requirements using simulated energy analysis Chapter 2: Definitions is also addressed

Chapter 3: To a large extent the layout of the 2009 edition remains unchanged. Climate Zo despite the fact that it brings with it more energy efficiency improvements than ever before in the history of the IECC or MEC. The efficient gains set a Chapter 4: Residential new baseline for IECC-compliant homes and buildings, and while, there will be regional variability and uncertainty in the technology penetration, Efficiency Chapter 5: preliminary estimates from U.S. DOE suggest the 2009 IECC will be at Commercia least 18 percent and possibly even 22 percent more energy efficient than the 2006 IECC.⁵ American homes built to the IECC will consume less Efficiency energy, and American families who live in those homes will save energy coste

[(§1333, Energy Policy Act of 2005, Pub. L. 109-58 (EPAct 2005)]

- (5305(a), ECPA, Pub. L. 94-385 (1976))
- [§413 Energy Independence and Security Act of 2007 (EISA) Pub. L. 110-140 and HUD's Manufactured Home Construction 8 Safety Standards (24 CFR 3280)
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Water

Air

Land













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Today: Grid dependent



GRID DEPENDENT









Problem of Housing 1944 - DVD Problem of Housing 2009

National Green Building Standard

LEED (Leadership in Energy and Environmental Design)

Energy Star (Appliances)

http://www.leedvisual.com/

http://www.greenmatrix.net/











How to Build an Energy Efficient Home

- Optimize Orientation and Glazing
- Adequate Insulation
- Quality Installation
- Control Air Infiltration
- •A properly Sized and Designed HVAC System
- Properly Installed HVAC System
- •Well Designed Ventilation System
- Energy Efficient Appliances and Lighting

Energy Star Qualified Home

- 1. Effective Insulation
- 2. High Performance Windows
- 3. Tight Construction and Ducts
- 4. Efficient Heating & Cooling Equipment
- 5. Efficient Products

High Performance Homes are ...

Healthy
Safe
Efficient
Durable/Low maintenance
Comfortable

Information Needed on Plans

- Sizes & types of windows/glazed doors
- Window/Door U-value and SHGC
- Caulking and sealing notes
- Insulation *R*-values and protection notes
- Equipment size, types, efficiencies, locations
- Thermostat type
- Duct construction, insulation, location and sealing notes
- HVAC piping insulation
- Low-flow shower head and heat trap notes

Benefits to Communities

- Lowers production of Green House gases
 & particulates
- Decreases need to construct new power plants
- Reduces peak load demand (increases system reliability)
- Keeps energy dollars in communities
- Improves building stock

RESIDENTIAL BUILDING TECHNOLOGY "HIGH-PERFORMANCE HOME"

- 1. Site Work
- 2. Design & Orientation
- 3. Foundation
- 4. Structure/Framing
- 5. Roof Systems/Overhangs
- 6. Building Envelope
- 7. Exterior Covering Systems
- 8. Mechanical & Electrical Systems
- 9. Insulation
- 10. Interior Finishing Systems
- 11. Fixtures & Appliances
- 12. Landscaping

Site Work

Construction Activity Pollution Prevention

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Site Work

Erosion Sedimentation Control (ESC) Plan Objectives of the ESC Plan include:

- Prevent loss of soil during construction by storm water runoff and/or wind erosion, and protect/preserve topsoil by stockpiling for reuse
- 2) Prevent sedimentation of storm sewer, receiving streams
- 3) Prevent polluting the air with dust and particulate matter

Sustainable Site

Design & Orientation Quick Sketch of Sun-Path

Orientation

Tonalacalli Austin TX First LEED Certified Platinum House in Texas; Five Star Austin Green Building Program. 'LEED' and related logo is a trademark owned by the U.S. Green Building Council and is used by permission.

Southern Driveway approach to House photo: LaVerne Williams

Water Supply

Rainwater harvesting 100% rainwater for both indoor and outdoor water consumption; no well or municipal water connection

Development included limited turf, native (drought tolerant) plants, permeable sites with permanent erosion controls (retaining walls and storm water management)

http://www.firstaustinleedhome.com/

West Porch

Photo by Home Owner

All roofing is standing seam metal on foam insulated wood framing.

OVERHANGS

Entry Porch Photo by La Verne Williams

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Size Matters

Small can be beautiful

 Oil, gas and electricity are not going to get cheaper

Outdoor Space

PorchesLiving areas

Create outdoor rooms

to increase living space

Create outdoor rooms

to discourage long-term visitors

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Foundation



Raised Floor Foundation Insulation System











Foundation

Raised Floor











Foundation

Raised Floor



Let's Take a Break,,,



Structure/Framing



Interior Walls Framing











Ladder Framing











Corner Framing



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Alternative framing

Corner framing

(C)

- Allows for insulation
- Structural Support







Benefits to Builders

- Promotes good construction practices
- Increases competitive advantage
- Reduces callbacks
 - Due to properly-installed systems
- Codes provide consistent requirements across jurisdictions



Tax Incentives & Rebates

Photovoltaic Systems (3 kW)

Rebates: To \$13,500 *Tax Credits: 30% of Cost After Rebate, No Cap*

Solar Water Heaters

Rebates: To \$2,000 Tax Credits: 30% of Cost (to \$2,000)

Central Air Conditioner/Heat Pump

Rebates: To \$650 Tax Credits: To \$300

Heating & Cooling Duct System Repair

Rebates: \$470 Average

Attic Insulation

Rebates: \$328 Average *Tax Credits: To \$500*



Tax Incentives & Rebates

Tank-less Gas Water Heater

Rebates: \$300 Tax Credits: \$300

Windows & Shading

Rebates: \$164 *Tax Credits: To* \$200

Gas Furnace

Rebates: \$75 Tax Credits: \$150 (minimum 95% AFUE)

Compact Fluorescent Light Bulbs

Rebates: \$2 Per Bulb, \$4 Per Package **High Efficiency Gas Water Heater** Incentive: \$40



Tax Incentives & Rebates

Energy and Water Efficient Clothes Washer

Incentive: \$50

Refrigerator Recycling

Incentive: \$50

Gas Heater (For Income-Qualified, Elderly and Disabled) Incentive: Free

Programmable Thermostats

Incentive: Free (For Cycling Privileges)



Roof Systems/Overhangs

- Roofing Materials
- Insulating Roof Systems
 - Foam
 - Fiberglass Bat Insulation



West Porch

Photo by Home Owner



All roofing is standing seam metal on foam insulated wood framing.







External Envelope











Foamed Insulation in Walls & Roof & Beamed Ceiling



The partial second floor and two story vaulted spaces are constructed using 2x6 foam filled walls having textured and painted sheetrock interior walls and stained fiber cement exterior wall finish.











Building Envelope



Annual Water Vapor Transport



Smart Vapor Retarders

- A blend of nylon compounds that becomes more permeable as humidity increases
- A spray-on, cellulose film reinforced with glass fiber, polyethylene, and latex.
 - Intended as a one-way vapor retarder
 - Not yet commercial









Keep Heat Out

- Windows
- Reflective roofing
- **Radiant barriers**
- Shade

(C)

- Insulation
 - Installation quality
 - **Total-fill solutions**
 - Framing alternatives



GRFFN





Control Air Leakage

Bypasses are hidden air passageways that lead from the heated space into the attic.









"Air Infiltration and

Attic Bypasses

Exterior Covering Systems



Thermal & Air Barrier



Mainstream

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Exterior Considerations





Glazing E Coating





Exterior Covering Systems

High Performance Windows



State Energy Conservation Office



Insulation





The blue insulation at the bottom of this foundation wall is clearly visible.



















Wall Insulation



Blown-in









Typical Knee Wall Insulation











Infrared Images of Insulation





Missing baffle

Thin coverage







Check your corners!







Infrared Images of Insulation



Infrared Images of Insulation



Performing

Gap

Missed Soffit








Effective Insulation Techniques for Attic Knee-walls



What are Codes?

What are the IECC and ASHRAE?

 Minimum standards for energy efficiency
The least efficient building legally permissible



What Are Codes Not?

Product specific

- Type of fuel for appliances
- Recycled content
- NOT state-of-the-art criteria
- Do not regulate "cosmetic" items
 - Paint
 - Carpet



Did You Know?

State Energy Conservation Offic

Homes built in the 21st century will be judged by how well they perform

http://www.energystar.gov



Beyond Code: What's Attainable?

- Building to these specifications means 30-50% lower energy consumption
 - USGBC LEED (Leadership in Energy and Environmental Design)
 - NAHB Green Building Standard
 - Energy Star
 - Green Building Initiative







How to Build Above Code

- Establish design philosophy
- Start at pre-design stage
- Use Life-Cycle-Cost Analysis
- Seek technical assistance
- Recruit vendors and suppliers
- Increase capital budget?

Not always







The House..."is a System."

- What makes a building uncomfortable?
 - Drafts
 - Cold surfaces
 - Uneven heating/cooling
 - Moisture extremes
 - Ventilation effectiveness
 - Light/Noise/Vibration
 - Pollutants/Furnishings
 - Occupant diversity









Interior Finishing Systems



Typical Home Air Leakage





Infiltration Controls





















Seal all Penetrations



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Electrical Areas Air Leakage











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Plumbing Areas Air Leakage











Air Tight Recessed Lights















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Let's Take a Break,,,



Mechanical & Electrical Systems



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How We Use Energy In Our Home

(Based on national averages)

The largest portion of a utility bill for a typical house is for heating and cooling, but a close second is lighting and

appliances.







HVAC System Loads

State Energy Conservation Office



Load Calculation

- Reduced initial cost
- Improved comfort
- Better IAQ, filtration, moisture control
- Less noise
- Lower utility bills/electrical demand



How to Use Your "Rule-of-Thumb" Load Calculator

Directions:

- 1) Cut out on dotted lines.
- 2) Stand on curb.
- 3) Look through holes to match the house
 - with the proposed load.
- 4) When in doubt go to next largest house.







Bigger is Not Better

- Most A/C's are oversized for the house
- Resulting in short cycling
 - Reduces equipment life
 - Reduces efficiency (SEER)
 - Results in poor dehumidification
 - Reduces filter effectiveness



Equipment Sizing Case Study



Average AC size $_{\sim}$ 2x what's needed









System Optimization

- Natural ventilation where AC is not critical
- <u>Dedicated exhaust</u> for areas in the building such as bathrooms, chemical storage, office work rooms
- <u>Energy Recovery Ventilation</u> -cost effective in almost all building types
- <u>System commissioning</u> during entire project, recommission in a year
- Night flush eliminate contaminants and pre-cool building



Mechanical Systems

Advanced Controls Selection

Demand Controlled Ventilation

- Using CO2 Sensors and Variable Fan Drive OR
- Occupancy based on/off control











HVAC Piping Insulation













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Ducts

- Sealing
- Short, straight runs
- Inside conditioned space



1 Ez



Proper Installation













GREEN

Duct Sealing

- Leakage can increase required HVAC size by about 40%
- Supply leaks draw in hot, moist air negative pressure
- Return leaks bring air from attic, crawlspace, bypass filter grille
- Cause dust, discomfort, backdrafting, high bills, mold

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HVAC Duct Sealing











Return Duct Sealing











HVAC Duct Sealing











HVAC Duct Sealing - Bad



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HVAC Duct Sealing - Good











HVAC Duct Sealing- NOT











Proper Duct Installation










HVAC Duct Installation- Bad



© 2009 Bastani & Solis









No comment necessary!!











Repairs to Duct and Chases

















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Fixtures & Appliances



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Minimize Additional Loads

- Energy Star appliances
- Compact fluorescent lights
- Occupant sensors













Energy Star® Electronics

- Consume as much as 75% less energy when switched "off" than other models
- Computers have sleep mode

Annually, Americans spend more to power home audio and DVD products when turned off than when actually in use (over \$1 billion)









Lighting

How can we do *better* than the code?

- Daylight it's free
- Control the lights
 - Occupancy sensors
 - Daylight sensors
 - Timers
 - Bi-level switching
- Advanced technology









Daylighting















L.E.D. – Light Emitting Diode

• Pros:

- Energy Efficient
- Super-Long Life 100,000 hrs
- Ons:
 - Expensive
 - Difficult to Produce "White" Light
 - Icing in outdoor applications















Water Heating Systems

Water heating efficiency

- Heat traps/Pipe insulation
- Avoid electric resistance (heat pump, gas or solar)
- No pilot lights (electronic ignition)
- Highest Energy Factor (EF) you can afford









Landscaping Potential Technologies and Strategies

- Perform a soil/climate analysis to determine appropriate plant material and landscape with native/adapted plants.
 - High-efficiency irrigation strategies include micro-irrigation, moisture sensors, and evapotranspiration controllers.
 - Drip systems use 30-50% less water than sprinklers.











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Water Efficiency











Summary

- For any building energy efficiency project to meet goals of significant energy savings and a high level of energy code compliance we must:
 - Continue to work together, as a team and in partnership
 - Maintain quality communication
 - □ Share goals, information and technology
 - Learn from regional, national and international experiences





- Every Building Has Two Price Tags!
- 1. The purchase price
- 2. The cost to operate the building over its lifetime

When adding the two price tags, energy efficient buildings cost much less!













The Star Thrower

There was a man who was walking along a sandy beach where thousands of starfish had been washed up on the shore.

He noticed a boy picking up the starfish one by

one and throwing them back into the ocean.

The man observed the boy for a few minutes

and then asked what he was doing?

The boy said that he was returning the starfish to the sea, otherwise they would die! The man asked how saving a few, when so many were doomed, would make any difference whatsoever?

The boy picked up a starfish and threw it back into the ocean and said:

"Made a difference to that one..."

The man left the boy and went home, deep in thought about what the boy had said. He soon returned to the beach and spent the rest of the day helping the boy throw starfish into the sea....



Everyone Can Make A Difference!



Thanks for your Participation!

