Beyond the Occupant Scapegoat

Part 1: Energy Performance of New Homes

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October 21, 2014
Modeled energy use for each Standards update Northern CA Inland Climate

Source: California Energy Commission

October 21, 2014
How Much Electricity Does A New California Home Use?

Source: California DSM Measurement Advisory Committee report
How Much Natural Gas Does A New California Home Use?

Source: California DSM Measurement Advisory Committee report
AC Sensible Capacity

Source: California Energy Commission report 500-2012-062
AC Sensible Capacity

Source: California Energy Commission report 500-2012-062 and Rick Chitwood

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AC Sensible Capacity

Source: California Energy Commission report 500-2012-062, Rick Chitwood, and Energy Docs Home Performance

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2005 Home – Heating Energy

Source: California Energy Commission project Stockton Research Houses and Rick Chitwood
Air Leakage Rates and Path

Source: California Energy Commission report 500-2012-062 and Rick Chitwood

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Measured External Static Pressure

Pressure Drop, IWC

Source: California Energy Commission report 500-2012-062 and Rick Chitwood

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Evaporator Coil Air Flow

Source: California Energy Commission report 500-2012-062 and Rick Chitwood

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Air Flow and Fan Watts

Source: California Energy Commission report 500-2012-062 and Rick Chitwood
Total Duct Leakage @ 25 Pa

Leakage/400 CFM per ton

Source: California Energy Commission report 500-2012-062 and Rick Chitwood

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Comfort? ... in a 2014 home

Source: PG&E ET Project field observation
Comfort? ... in a two story zoned home

Start Test: (Lower Floor Only Calling)
Lower Floor Thermostat 68°F
Upper Floor Thermostat 69°F
Upper Floor Ceiling 68.4°F

At 15 Minutes: (Lower Floor Only Calling)
Lower Floor Thermostat 68°F
Upper Floor Thermostat 69°F
Upper Floor Ceiling 85.3°F

Test Ended at 53 Minutes:
Lower Floor Thermostat 72°F
Upper Floor Ceiling 85°F

Source: PG&E E3 Therma Field Observation

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## Current Residential HVAC Design and Installation

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>High</th>
<th>% difference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fan:</strong> watts/square foot</td>
<td>0.13 W/SF</td>
<td>0.92 W/SF</td>
<td>708%</td>
</tr>
<tr>
<td><strong>Heating:</strong> Btu/square foot</td>
<td>9 Btu/SF</td>
<td>110 Btu/SF</td>
<td>1,222%</td>
</tr>
<tr>
<td><strong>Cooling:</strong> square feet/ton</td>
<td>1,739 SF/ton</td>
<td>200 SF/ton</td>
<td>869%</td>
</tr>
<tr>
<td><strong>Air Infiltration:</strong> ACH</td>
<td>0.12 ACH</td>
<td>1.92 ACH</td>
<td></td>
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<tr>
<td></td>
<td><strong>1,600%</strong></td>
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</tr>
</tbody>
</table>

Note: Average air infiltration is 0.25 ACH in new homes (2010 research, Wilcox, Proctor, Chitwood)

Source: California Energy Commission report 500-2012-062
Based on California Research

Average Grade

- Building Enclosure Tightness: F
- Comfort Delivered: F
- Air Handler Static Pressure: F
- HVAC Air Flow: F
- HVAC Fan Watts: F
- HVAC Duct Leakage: F
- Delivered Cooling Performance: F
- Delivered Heating Performance: F
Beyond the Occupant Scapegoat

Part 2: Why Poor Performance (and how to fix it)

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Who’s at Fault for this Poor Energy Performance?

- **Government** and their Energy Standards
- **Home Builders**
- **Energy Feature** **Subcontractors** and their Workers (especially HVAC subs)
- **Home Owners**
Who Do We Focus on to Improve Energy Performance?

- Government and their Energy Standards
- Home Builders
- Energy Feature Subcontractors and their Workers (especially HVAC subs)
- Home Owners
**Government** and their Energy Standards?

- Too much focus on: Licensing, bonding, certifications, HERS verification, and equipment efficiencies
- Standards are not performance based
- Standards are minimums – not goals
- Too many believe:
  - homes perform as modeled
  - the energy code is too strict and expensive now
  - all homes perform the same (so only shop price)
  - just add solar to get to ZNE

October 21, 2014
Home Builders?

- Shareholder focused corporate capitalism with no focus on the other stakeholders:
  - workers
  - homeowners
  - the environment

- “Quality Control” not part of the construction process

- The lower the HVAC “bid” the more the shareholders profit
Energy Feature **Subcontractors** and their Workers (especially HVAC subs)?

- Directly responsible for **poor** HVAC system performance
- Doing **great** at what their employer asks them to do; being low bidder, and meeting code minimums
- Equipment manufacturers’ control the “performance” narrative (no focus on installation quality – it is all about the “box”)
- HVAC workforce skill in extremely low
- Worker training not in the low bid
Energy Feature **Subcontractors** and their Workers (especially HVAC subs)?

- “Quality Control” not part of the HVAC installation process

- **Air conditioner efficiency losses add up:**
  - Duct Leakage 7%
  - Duct Conductive Losses 12%
  - Refrigerant Charge and Contamination 8%
  - Low Air Flow (high latent removal) 14%
  - Equipment Oversizing 4%
  - Room Air Delivery and Mixing 5%
  - Total Loss 50%

- The un-learning curve is hard to overcome
Homeowners?

- Homeowners have little impact on heating/cooling costs if the energy standards, builders, and subcontractors do their job well.
To Move Forward and To Meet Our 2020 ZNE Goals We Must “Change the Paradigm”

1. Deliver (and verify) true performance in all energy feature categories (especially HVAC)

2. Incentivize homes and systems that really perform (but nothing else)
Energy Feature Subcontractors Must Incorporate True “Quality Control”

- Insulation Subcontractors
  - Blower Door test
  - IR Camera inspection

- HVAC Subcontractors
  - BTU’s at the supply grilles compared performance tables
  - Record run time to confirm sizing
  - Duct leakage to outside less than 5 CFM$_{25}$
  - Fan watt draw less than 0.2 watts/CFM
  - Delivery velocities above 500 FPM
Certify/Verify all HVAC Systems that Deliver High Performance

1. First use certification program on utility pilot programs; ZNE, ET, & CAHP
2. Make Certification a prescriptive measure in the 2019 Standards
3. Certification a mandatory measure in 2022
Can we get technicians to do this job correctly 100% of the time? Yes! ...but only with 100% QC testing