On the Trail to NETZERO
On the Trail to NETZERO
Energy

Water

Comfort

Health

Safety

Good For the Environment

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Goals

for the 21st Century
Increase efficiency and comfort
Decrease Complexity
Cost Same or Lower

19th Century
20th Century
21st Century

image source: Albert, Righter and Tittmann Architects
Passive House is on the trail to "netZERO“
(First, reduce the energy usage, Then add Solar.)

http://passipedia.passiv.de/ppediaen/basics/what_is_a_passive_house
The Basic Difference

Passive House vs Conventional Construction
Sizing Mechanical Systems

Design the building, then

Set Energy Goals, then

Size the system to the building

Size the building to the system

Conventional Approach:

Passive House Approach:
Solar Opportunities
What’s the Difference?

Passive Solar vs Active Solar

Passive

“Passively” sit where it is located and is efficient because of its design.

Active

Use mechanical means to capture the Sun’s Energy.

Passive and Active Solar elements are commonly combined.
North America 1970-1980’s

Dr. Shurcliff
Havard/MIT Physicist
Wrote a dozen books on Solar Power

Europe 1988

Bo Adamson, co-originator of the passive house concept.

Wolfgang Feist, co-originator of the passive house concept, and founder of the Passivhaus Institut in Germany.

First Passive House built in Germany 1990

Sweden

Germany

Heating ↓ 90% - All Energy ↓ 80%

1996 the Passivhaus-Institut was founded, in Darmstadt, Germany

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Most DFW Homes are At or below this level
**Solar Capacity Coincides with Passive House Trend**

Passive Houses vs Solar PV Global Capacity

- **USA**: 1,000
- **Europe**: 64,000

<table>
<thead>
<tr>
<th>Country</th>
<th>Passive Houses</th>
<th>Solar PV Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>64,000</td>
<td>80%</td>
</tr>
<tr>
<td>Austria</td>
<td>1,000</td>
<td>X64</td>
</tr>
<tr>
<td>Europe</td>
<td>64,000</td>
<td>X10</td>
</tr>
</tbody>
</table>

---

http://pureenergies.com/us/blog/top-10-countries-using-solar-power/
https://en.wikipedia.org/wiki/Solar_power_by_country
http://www.pass-net.net/situation/index.htm

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300 Times More Energy from the Sun in Texas at Noon

Than from All The World’s Power Plants

780 Tera Watts from the Sun (at noon)

2.59 Tera Watts from all the world's power plants

sunlight falling on Texas at noon is equivalent to 696 TW solar energy + 2.31 TW power plant output = 301 times the output of power plants.

https://ag.tennessee.edu/solar/Pages/What%20is%20Solar%20Energy/Sun%20Energy.aspx
**Cut to the chase Roger .... How Many Solar Panels Do I Need?**

<table>
<thead>
<tr>
<th>Traditional 2,000 SqFt Home</th>
<th>Passive, Net Zero Home</th>
</tr>
</thead>
<tbody>
<tr>
<td>kWh/yr</td>
<td>Sqft</td>
</tr>
<tr>
<td>22,500 (1)</td>
<td>5,800 kWh/yr</td>
</tr>
<tr>
<td>2,000</td>
<td>2,000 Sqft</td>
</tr>
<tr>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>$ 79,998</td>
<td>$ 19,800 at $3 per watt installed</td>
</tr>
</tbody>
</table>

(1) Based on conventional EUI of 38.4 kBtu/sf/yr (USEIA). Energy Use Intensity (EUI) expresses a building’s energy use as a function of energy per square foot per year.
(2) 6,600 is the maximum practical size for an urban setting.
(3) Peak for the example is 43% above the average for summer cooling.
(4) Calculated with 5 hours sun per day, 1.5 subtracted for winter.
### How Many Solar Panels Do I Need?

<table>
<thead>
<tr>
<th>Traditional 2,000 SqFt Home</th>
<th>Passive, Net Zero Home</th>
</tr>
</thead>
<tbody>
<tr>
<td>22,500 kWh/yr</td>
<td>5,800 kWh/yr</td>
</tr>
<tr>
<td>2,000 Sqft</td>
<td>2,000</td>
</tr>
<tr>
<td>1,875 avg kWh/mo</td>
<td>483 avg kWh/mo</td>
</tr>
<tr>
<td>2,800 Peak kWh/mo, Summer</td>
<td>693 Peak kWh/mo, Summer</td>
</tr>
<tr>
<td>26,666 Watt System</td>
<td>6,600 Watt System</td>
</tr>
<tr>
<td>200 Watts per Panel</td>
<td>200 Watts per Panel</td>
</tr>
<tr>
<td>134 Number of Solar Panels</td>
<td>33 Number of Solar Panels</td>
</tr>
<tr>
<td>$ 80,000 at $3 per watt installed</td>
<td>$ 20,000 at $3 per watt installed</td>
</tr>
</tbody>
</table>

**WOW!**

- Cut to the chase Roger ....
- Bigger than the house
- 4 Times the Cost
- Traditional 2,000 SqFt Home
- Passive, Net Zero Home
- 2,500 600

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First: Reduce Usage, Then Add Solar

1. **90% Reduction in Heating & Cooling**
   - Conventional House (38.4 kBtu/sf/yr)
   - After HVAC Reduction

2. **64% Reduction in Hot Water, Appliances, Electronics**
   - Practical for Urban Zero Energy Solar Panels (6.6kW PV Array)

**Usage** is from EIA (part of the U.S. Department of Energy.)

**NOTE:** Net Zero calculations based on onsite generation from a 6.6kW PV array (typically the max practical size for SFHs in urban settings) for a 2000SF house. Based on conventional EUI of 38.4 kBtu/sf/yr (USEIA).
Why Passive House?

Energy

Water

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Population = Needs for Natural Resources

Energy & Water are FINITE

$$$

Population Increasing

↑ Population = ↑ Needs for Natural Resources

$$$

Cost of Alternatives

↑ $$$$ to build new Power Plants and Water Desalination Plants

© DwellGreen of Dallas 2016
Solutions

- Build Efficient Buildings
- Increase Renewable Energy
- **STOP BURNING STUFF** (Coal, Oil, Natural Gas)
- Water Conservation

Energy & Water are FINITE

Population = Needs for Natural Resources

$$ to build new Power Plants and Water Desalination Plants

New ideas and inventions
Where it’s going ...  

20% World’s Energy Consumed by 4% of the People

10% World’s Energy Consumed by USA Buildings
the Plan ...

1. Savings from Efficient Buildings

2. Increase Renewable Energy

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Design Principles
Design Principles

- Strategic Design and Planning
- Climate Specific, Site Specific, Sizing
- Advanced Windows and Doors
- Energy Recovery Ventilation
- Super Insulated Envelope
- Thermal Bridge Free
- Air Tight Envelope, Vapor Diffusion Open
- Passive Heating and Cooling
Strategic Design and Planning

A Integrated Design/Build Process
(single most important point per Paul Westbrook)

B Criteria for Passive House Certification

C Software Modeling to confirm design
Integrated Design/Build Strategy

Critical to the Success of Passive House Construction
Passive House Success Depends On:

**PEOPLE**
- Occupant, Architect, Builder
- Trained
- Common Goals
- Continuous Communication

**MATERIALS**
- Selection is critical
- Modular Components

**PROCESS**
- Integrated Design Build

**TECHNOLOGY**
- Building Science
- ERV, PV, Automation
- Software modeling

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Thermal Comfort Definition of PHIUS

**Summer 77°F**  **Winter 68°F**

Personal Comfort Factors and Preferences

- Activity (Met)
- Clothing (Clo)
- Individual Differences

![Clo = 0.155 m²K/W](image)

- Owner/Occupant
- Architect/Builder/Engineers
- Trades Sub-Contractors
Process - Design/Build Approaches

Traditional Design / Bid / Build - or - Team Build (No Bid), Cost Plus

Passive House Projects
Are more successful with Integrated Project Delivery
Eliminate Mis-Communication Delays
Speed up Design and Build
1 Statement of Work
1 Schedule
1 Change Management System
1 Definition for Success

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Retrofit or New Construction, Integrated Design/Build Team

ONE TEAM

ONE SCHEDULE

ONE POINT OF CONTROL
Concept and Plan → Pre-Certify → Draft Design → Detail Design

Detail

Material and Product Selection → Update Certification Models → Step by Step Construction Details → Prepare Contract and Schedules

Deliver

Construction Inspections, Testing → Update Certification Models → Complete Final Inspections, Testing → Final Certification

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Criteria for Passive House Certification

(a brief introduction)
3 Pillars of a Certified Passive House

Requirements

1. Annual and Peak Heating/Cooling Load
2. Air Tightness
3. Primary Energy

Pass/Fail Criteria

Curtesy of PHIUS

© DwellGreen of Dallas 2016
### Climate Specific Annual and Peak Heating/Cooling Load

<table>
<thead>
<tr>
<th></th>
<th>Dallas Texas, Love Field, IECC Zone 3A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Annual</strong></td>
<td></td>
</tr>
<tr>
<td>Heat Demand</td>
<td>2.2</td>
</tr>
<tr>
<td>Cooling Demand</td>
<td>12.1</td>
</tr>
<tr>
<td><strong>Peak</strong></td>
<td></td>
</tr>
<tr>
<td>Heat Load</td>
<td>3.3</td>
</tr>
<tr>
<td>Cooling Load</td>
<td>6.1</td>
</tr>
</tbody>
</table>

Use iCFA (internal Conditioned Floor Area) to calculate, not external house dimensions.
Air Tightness
Dallas Texas, IECC Zone 3A

At 50 Pascals

Air Tightness 0.05 cfm/ft² envelope

Gross ft² = external dimensions to the outside of the thermal boundary

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Primary Energy a.k.a. Source Energy

\[ \text{Total Energy Usage in Home} \times 3.16 \leq 6,200 \text{ kWh per Person per Square Foot per year} \]

- **Primary** sources of energy: Fossil fuels (coal, oil and gas), biofuels, wind, waves, solar radiation and nuclear fuels
- **Secondary** energy source is one that is made using a primary resource. Electricity is Secondary.
- **Average** factor in United States is 3.16.

<table>
<thead>
<tr>
<th></th>
<th>France</th>
<th>Germany</th>
<th>NL</th>
<th>Poland</th>
<th>Spain</th>
<th>Sweden</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEF</td>
<td>2.58</td>
<td>2.6</td>
<td>2.56</td>
<td>3</td>
<td>2.6</td>
<td>2</td>
<td>2.92</td>
</tr>
</tbody>
</table>

**Limit** = \(((\text{Bedrooms}+1) \times (6200 \text{ kWh} \times 3.412 \text{ kBTU/kWh})) / \text{iCFA}\)

**Home Energy Calculation** = \((\text{Annual kBTU (Heating + Cooling + Water Heating + Appliances + 80\% } \times \text{ RESNET Misc Electrical Load's & Lighting)} \times 3.16 \text{ Factor}) / \text{iCFA}\)

Curtesy of PHIUS

© DwellGreen of Dallas 2016
Software Modeling with WUFI

Pre-Certification Thru Final

WUFI (the name stands for Wärme und Feuchte Instationär, or “Transient Heat and Moisture Transport”) is endorsed by the Department of Energy, the National Institute of Building Sciences, and the National Building Enclosure Councils.
Step 1: Solve the Partial Differential Equations for the Flow of Heat and Moisture (so you don’t have to)

Heat

\[
\frac{\partial H}{\partial T} \cdot \frac{\partial T}{\partial t} = \nabla \cdot (\lambda \nabla T) + h_v \nabla \cdot \left( \delta_p \nabla \left( \phi \ p_{\text{sat}} \right) \right)
\]

Moisture

\[
\frac{\partial w}{\partial \phi} \cdot \frac{\partial \phi}{\partial t} = \nabla \cdot \left( D_{\phi} \nabla \phi + \delta_p \nabla \left( \phi \ p_{\text{sat}} \right) \right)
\]

\[U_w = \frac{(U_g \cdot A_g) + (U_f \cdot A_f) + (\psi_{\text{spacer}} \cdot L_g)}{A_w}\]

\(U_g = U\)-value glass
\(A_g = \) Area glass
\(U_f = U\)-value frame
\(A_f = \) Area frame
\(\psi_{\text{spacer}} = \) psi
\(L_g = \) Length spacer
\(A_w = \) Area Window

© DwellGreen of Dallas 2016
Step 2: Enter Extremely Detailed Construction Plan Data and See if it will Pass.
Step 3: Dynamic Modeling (a video) over Time
(movement of heat and moisture in each separate component)
Characteristics of a Passive House

(a brief review)
Location/Orientation

Large Windows face South
Long axis of the house should be East-West
With shading on the East & West
Orientation

Random Alignment

Align with the SUN

Google Earth Picture of Allen, Texas

© DwellGreen of Dallas 2016
“Right Size”, not “Super Size”

Which one requires more power to operate?

sprawling

right sized

© DwellGreen of Dallas 2016
Source with permission: Paul Westbrook
Shape and orientation can affect energy usage by 30%

‘Shape Factor’ - ratio of the building’s surface area divided by its volume

<table>
<thead>
<tr>
<th></th>
<th>C-Shape</th>
<th>Square</th>
<th>Rectangle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor Area</td>
<td>2,000</td>
<td>2,000</td>
<td>2,000</td>
</tr>
<tr>
<td>Ceiling</td>
<td>9 Ft</td>
<td>9 Ft</td>
<td>9 Ft</td>
</tr>
<tr>
<td>Wall Area</td>
<td>2,205 (+37%)</td>
<td>1,609</td>
<td>1,679 (+4%)</td>
</tr>
<tr>
<td>South Wall Area</td>
<td>360 (-11%)</td>
<td>403</td>
<td>540 (+34%)</td>
</tr>
<tr>
<td>Wall/Floor Ratio</td>
<td>1.10</td>
<td>0.80</td>
<td>0.83</td>
</tr>
</tbody>
</table>

Source with permission: Paul Westbrook
Transmission Heat Gain/Loss Directly Proportional to Area

\[ \Delta T \]

100°F Outside

70°F Inside

R13 Insulation \( \Delta \) Framing = R11

\[ U_{WALL} = \frac{1}{11} = 0.09 \]

- Walls
- Roof
- Floor
- Windows
- Doors
- Ventilation Gain
- Air Leakage Gain
- Internal Gains (People/Appliances)

\[ P_T = A U f_T \Delta \psi \]

↑ Area to outside =

↑ heat gain/loss

© DwellGreen of Dallas 2016
Air Tightness
Air Changes Per Hour (ACH)

<table>
<thead>
<tr>
<th>ACH50</th>
<th>Rating</th>
<th>% of Energy Bill</th>
<th>Ventilation Requirements</th>
<th>Building Standards and Energy Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6</td>
<td>Superb</td>
<td>1%</td>
<td>Constant</td>
<td>Passive House (0.05 CFM/gross sqft)</td>
</tr>
<tr>
<td>2.5</td>
<td>Super</td>
<td>2%</td>
<td>Constant</td>
<td>DOE ZERH (2.5)</td>
</tr>
<tr>
<td>3</td>
<td>Excellent</td>
<td>6%</td>
<td>Occasional</td>
<td>IECC 2012 Code (3)</td>
</tr>
<tr>
<td>5</td>
<td>Better</td>
<td>10%</td>
<td>Occasional</td>
<td>Energy Star Home (5)</td>
</tr>
<tr>
<td>7</td>
<td>Good</td>
<td>14%</td>
<td>No additional</td>
<td>IECC 2009 Code (7)</td>
</tr>
<tr>
<td>10</td>
<td>Fair</td>
<td>10%</td>
<td>None Over-Ventilation</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Bad</td>
<td>20%</td>
<td>Excessive energy loss and over-ventilation</td>
<td></td>
</tr>
</tbody>
</table>

21 Times Leakier
Code House

1980’s & 1990’s

50 Pascals = 0.007 psi = 0.2 "w.c. = 1.04 psf = ~20 mph wind
Ventilation

Three forces that move air through a house:

- HVAC equipment & Fans
- Wind
- Stack effect

ERV

ASHRAE 62.2

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ERV - Energy Recovery Ventilation

(Recovers Heat and Humidity Level)
Sizing Mechanical Systems

Conventional Approach:
Size the HVAC System to the Building

Passive House Approach:
Size the Building to the HVAC System
Corners

Thermal Bridge (bad)
- 5" x 4.5 Thermal Bridge
- No corner insulation
- As 2x4's age, Air Leaks

Insulation
- Less Wood
- 2" corner insulation
- As 2x4's age, Air Leaks

Least Thermal Bridging
- Least Thermal Bridging
- 3.5" Insulation
- Still have Air Leaks

Thermal loss is improved with less wood, but take addition measures to eliminate leaks.

© DwellGreen of Dallas 2015
2x4, Fiber Glass Batts

Engineered Wall Assembly

R9 to R11

Wood & Windows, no continuous insulation reduces over all to R9 or less.
Foundation

Wall Assembly
4 Lines
Need To Be Drawn On The Plan
Must Be Continuous (No Gaps In The Line)
Windows

Tilt-Wash Double Hung
- Double Pane
- Glass: Good
- Frame: Not so much
- Drags down overall efficiency (R3)

Tilt and Turn
- Triple Pane
- Passive House windows are:
  - Airtight
  - Triple Pane
  - Highly insulated Frame
  - Available with high SHGC glass

R3 to R20
Doors

**Builder Grade Door**
- Fiber Glass
- Single Lock
- Single gasket, no overlay (w/o Glass): R3 to R5

**Super Insulated Doors**
- Core: polyiso or vacuum-insulated panel
- Multipoint Lock Systems
- Triple gasket overlay
- R13 to R80 range

R3 to R5
R13 to R80
Window R-Value is Tiny
(Energy Star U=0.35)
Things to Watch Out For
Thermal Bridges & the “Red Line” Rule

- **Air Tight Envelope (Red Line)**
- **Insulating Envelope (Yellow)**
- **Critical Joints to Avoid Thermal Bridging**
- **Top Plate and Rim Joist need a “Thermal Break”**
- **Insulated Slab and Edges Avoid Thermal Bridging**

© DwellGreen of Dallas 2016
Thermal Bridging, Wall Studs, Top Plate, Rim Joist, Window & Door Frames. (no continuous insulation),

Thermal Bridging, Porch Slab

Thermal Bridging, Slab Edges
Examples of Passive Houses
Passive building science principles can be applied to all building types -- from single-family homes to apartment building to offices and skyscrapers.

Cornell University, New York when it's completed in 2017, will be the world's tallest and largest passive-house building.
New Dormitory (Hickory Hall)

Emory and Henry College
Emory, Virginia
New Dormitory (Hickory Hall)

Emory and Henry College
Emory, Virginia
Emory and Henry College in Emory, Virginia,

**Hickory Hall** - 40,000 Sq Ft ($118.25 / Sq Ft)
Modular Construction | LEED | **Passivhaus**

**Elm Hall** - 36,000 Sq Ft ($125.00 / Sq Ft)
Modular Construction | LEED

**Energy Consumption**

74% Below Code
62% Below Elm
New Dormitory (Hickory Hall)

Emory and Henry College
Emory, Virginia
57-unit Orchards at Orenco project.

CPHC: Dylan Lamar.
LARGER HOMES

First Passive Home in Wayland, MA

4,400 square feet in area can be heated and cooled by the equivalent of a single burner on a stove.

August 11, 2015
Financial Advantage
## Conventional vs Green Loan Comparison

<table>
<thead>
<tr>
<th>Energy Efficient – Conventional Property</th>
<th>High - Performance Property GEM Loan ®</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>$ 333,334</strong> Purchase Price</td>
<td><strong>$ 366,670</strong> Purchase Price</td>
</tr>
<tr>
<td><strong>33,334</strong> Down Payment</td>
<td><strong>36,667</strong> Down Payment</td>
</tr>
<tr>
<td><strong>$ 300,000</strong> Loan Amount</td>
<td><strong>$ 330,000</strong> Loan Amount</td>
</tr>
<tr>
<td><strong>$ 231,295</strong> Interest Paid</td>
<td><strong>$ 196,315</strong> Interest Paid</td>
</tr>
<tr>
<td>4.25% (4.67% APR)</td>
<td>4.25% (4.67% APR)</td>
</tr>
<tr>
<td><strong>$1475</strong> (Principal &amp; Interest)</td>
<td><strong>$1624</strong> (Principal &amp; Interest)</td>
</tr>
<tr>
<td><strong>$ 170</strong> Energy Costs</td>
<td><strong>$ 25</strong> (Energy Costs) $52,200 savings</td>
</tr>
<tr>
<td><strong>$1645</strong> (PIE)</td>
<td><strong>$1649</strong> (PIE) + 50% of savings</td>
</tr>
<tr>
<td><strong>Payoff – 30 Years</strong></td>
<td><strong>Payoff – 24 Years</strong></td>
</tr>
<tr>
<td><strong>$345,000</strong> Conv. Appraisal</td>
<td><strong>$ 58,110</strong> (Interest Saved)</td>
</tr>
<tr>
<td></td>
<td><strong>$ 24,091</strong> (50% Energy Savings)</td>
</tr>
<tr>
<td></td>
<td><strong>$ 82,201</strong> Savings</td>
</tr>
<tr>
<td></td>
<td><strong>$385,000</strong> Green Appraisal</td>
</tr>
<tr>
<td></td>
<td><strong>$ 18,330</strong> Gain in Value</td>
</tr>
<tr>
<td></td>
<td><strong>$ 100,531</strong> Savings+Gain in Value</td>
</tr>
</tbody>
</table>

Proprietary & Confidential © Green Energy Money, Inc.; EQS, Inc. 2015, All Rights Reserved
Benefits
Extremely Low Energy Use
60-80% Overall Energy Savings

High Quality Indoor Air
Healthy Living Space. Controlled ventilation for a continuous, consistent supply of fresh air

Comfort
Consistent Comfortable Indoor Temperatures, Humidity

Operational and Construction Savings
Reduced utility bills, elimination of conventional HVAC system, small solar systems to reach zero energy, tight building shell for lower maintenance.

Sustainability
15,000+ buildings worldwide, some zero and positive energy. 25 year track record.

Resilient Buildings
Systems approach to modeling, design and construction produces buildings that can withstand storms, earthquakes, wildfire, flooding, extended power outages

Helping the Earth
Reduces Carbon Emissions. Meets the 2030 challenge today!
Improvement Ideas to Existing Homes
Confused about what to do first?

A Few Good Ideas
Good Starting Point ....
Google: DOE Retrofit Air Sealing

Get a Benchmark with
• Blower Door Test and
• Duct Test

Ok, Now What Do I Do?

... Start at the TOP (Stack Effect)

If you have recessed canister lights, start there.

How Does the Air Escape?

Will Your House Float?

... or is it a Submarine?
Connections, Corners, Penetrations

Recessed light fixtures
Attic Entrance
Sill Plate, Top Plate
Water and Furnace Flue Ducts
Door, Window Frames
Electrical Outlets, Switches
Plumbing
Corners
Framing Connections
Holes in Air Barrier

Hundreds Punched in Walls and Ceiling

Air Tight Layer

Dry Wall

© DwellGreen of Dallas 2016
A Small Hole Is Bad News!

- In a single heating season, a wall with a 1 square inch hole can take on 30 quarts of water.
- Diffusion through the dry wall is only 1/3 quart.

(4x8 sheet of gypsum board, Interior at 70°F and 40% RH)

Courtesy of Building Science Corporation - http://buildingscience.com/sites/default/files/pr-0510c_bb05_moisture_control.pdf
Holes in the Exterior Air Barrier

**Exterior Walls and Ceilings**

<table>
<thead>
<tr>
<th></th>
<th>Doors</th>
<th>Windows</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>4</td>
<td>25</td>
<td>29</td>
</tr>
<tr>
<td>CFM per</td>
<td>12</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Total CFM</td>
<td>48</td>
<td>150</td>
<td>198</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Outlets</th>
<th>Switches</th>
<th>Light Fixtures</th>
<th>Can Lights</th>
<th>HVAC supply</th>
<th>HVAC Return</th>
<th>exhaust fan</th>
<th>Plumbing</th>
<th>Fireplace</th>
<th>Attic Hatch</th>
<th>Skylight</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>37</td>
<td>8</td>
<td>24</td>
<td>45</td>
<td>19</td>
<td>10</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>161</td>
</tr>
<tr>
<td>CFM per</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>11</td>
<td>10</td>
<td>40</td>
<td>20</td>
<td>6</td>
<td>200</td>
<td>100</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Total CFM</td>
<td>222</td>
<td>48</td>
<td>144</td>
<td>495</td>
<td>190</td>
<td>400</td>
<td>100</td>
<td>30</td>
<td>400</td>
<td>100</td>
<td>40</td>
<td>2,169</td>
</tr>
</tbody>
</table>

Count things.

Find biggest impact with the lowest effort.

(Stack Effect First)
“Stack Effect” 3 Easy Fixes

Attic Access

Recessed Canister Lights

Fire Place

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Move That Hole Out of Your House
... to the Garage
Seal Attic Access

The only air tight IECC 2012 compliant attic ladder cover on the market.

The other options are either a low R-value or do not seal the opening air tight.

Eleven times the Insulation Value of Attic Tent (R3.2 vs R38)

http://www.atticzipper.com/
Sealed Fire Place Can Heat 1,500 Square Feet With NO Air Leakage
• Seal Holes in Ceiling
• LED saves Electricity

Ecosmart 6” Canister Light Inserts

Silicon Caulk – Does NOT get hard and brittle

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Calculation for 23 **Canister Recessed Incandescent** Lights

Shows Monthly Savings of changing all incandescent lights to CFL or LED. Savings will vary depending on the average usage per day. This assumes an average of all lights, so it may be less if some lights are never used.
22 Times more expensive in with dark shingles, in attic

- Dark shingle roof, attic contains leaky ducts, attic floor not sealed
- Dark shingle roof, attic floor sealed, ducts with 4% leakage, wrapped with R-8
- Dark shingle roof, attic floor sealed, ducts in conditioned space
- Cool color shingle, new attic design, ducts in conditioned space

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No Ducts in the Attic

Would you put a refrigerator in the Oven?
For 45 years, highly efficient homes have been built in the USA

• We have the technology.
• We have the knowledge.
• The cost of ownership is about the same as traditional construction.
• Design, techniques, and materials are only slightly different now than the 1970’s.

Why are we all not living in highly efficient homes?
Thank You for Attending
DwellGreen of Dallas
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- Permit Plan Review
- Energy Code Inspection
- Consulting for New and Existing Homes
- Energy Audits
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