BetterBuiltNW

Top 10 Best Practices for Today's Homebuilder

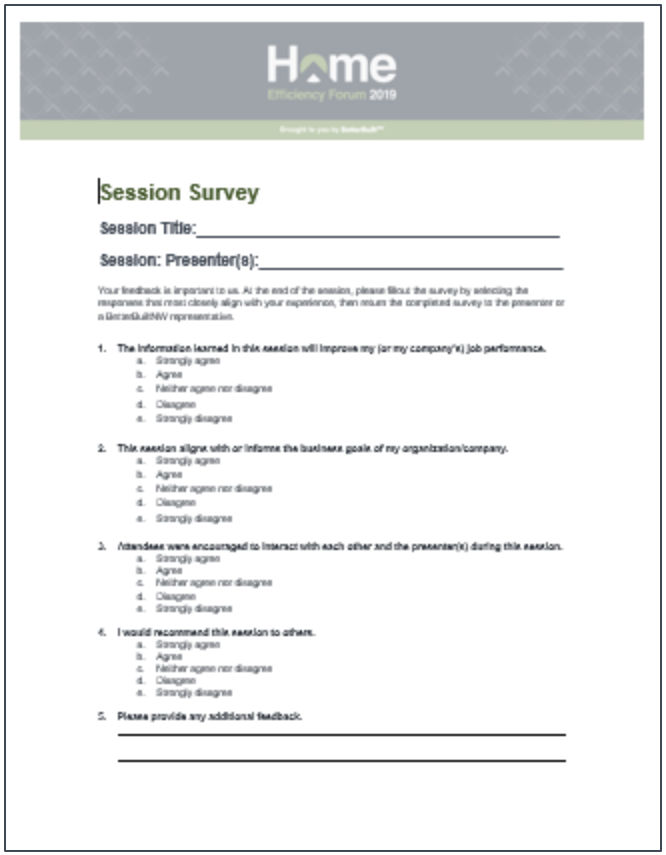
Learn the latest and greatest techniques being used today to build better homes.

October 17, 2019

Session Survey Instructions

At the end of each session, you will be given 5 minutes to complete the session survey.

- Complete the survey using the mobile app or paper versions
- Provide the paper surveys to the room moderator or to the BetterBuiltNW table
- We appreciate your feedback



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Efficiency Forum 2019

Session Survey

Session Title:_____

Session: Presenter(s):_____

Your feedback is important to us. At the end of the session, please fill out the survey by selecting the responses that most closely align with your experience, then return the completed survey to the presenter or a BetterBuiltNW representative.

1. The information learned in this session will improve my (or my company's) job performance.
   a. Strongly agree
   b. Agree
   c. Neither agree nor disagree
   d. Disagree
   e. Strongly disagree

2. This session aligns with or informs the business goals of my organization/company.
   a. Strongly agree
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   d. Disagree
   e. Strongly disagree

3. Attendees were encouraged to interact with each other and the presenter(s) during this session.
   a. Strongly agree
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   d. Disagree
   e. Strongly disagree

4. I would recommend this session to others.
   a. Strongly agree
   b. Agree
   c. Neither agree nor disagree
   d. Disagree
   e. Strongly disagree

5. Please provide any additional feedback.

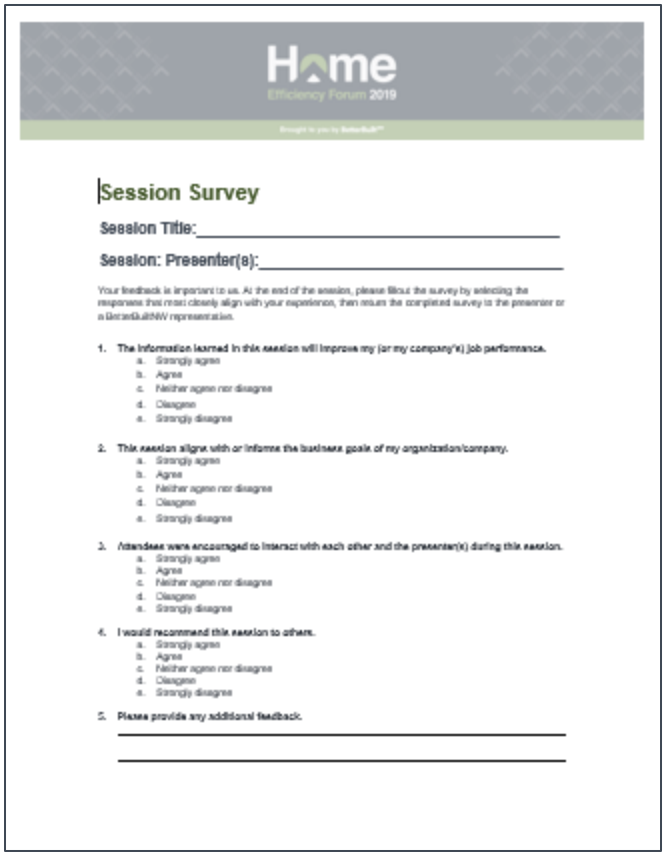
_____

_____

Complete the Session Survey

Top 10 Best Practices for Today's Homebuilder

- John Spillman



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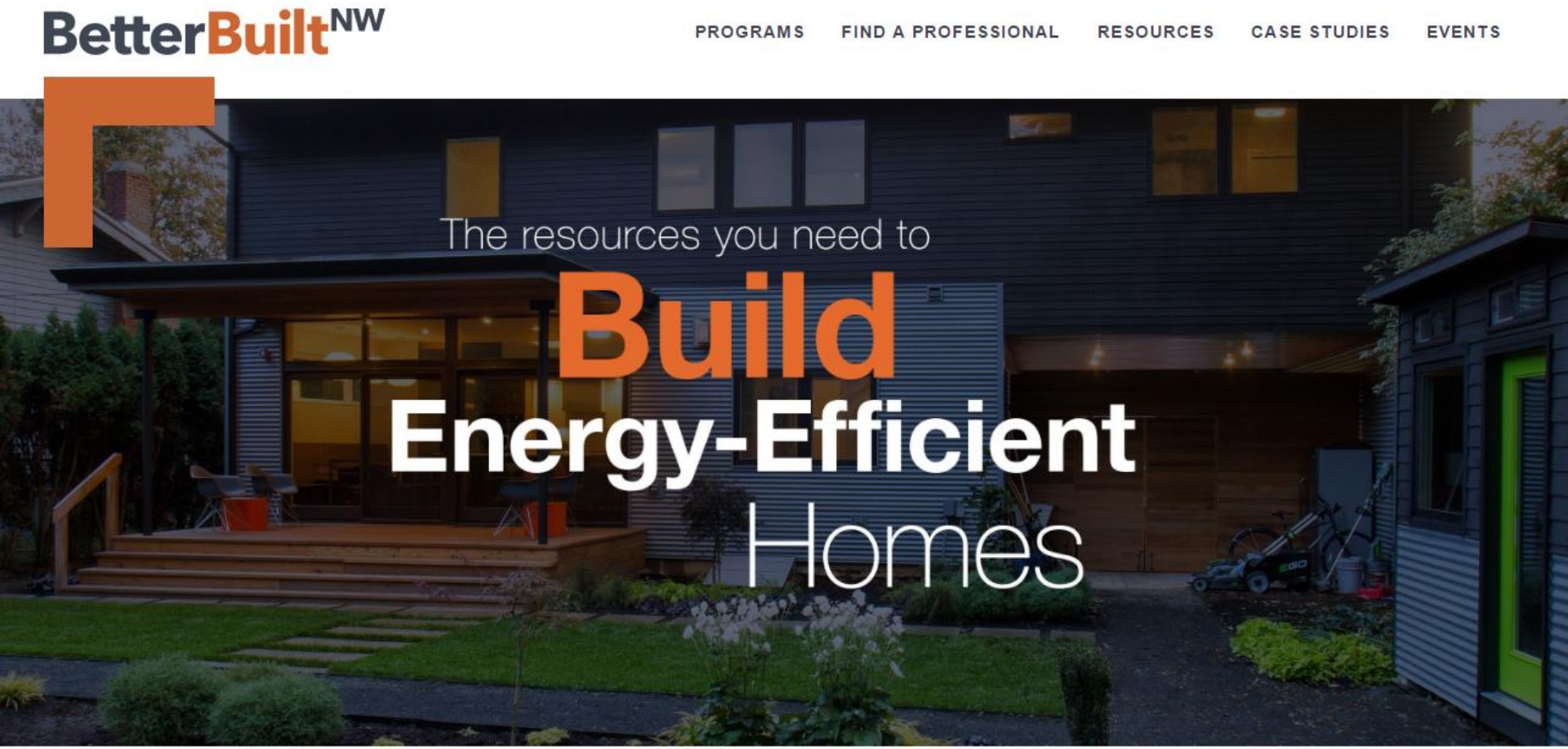
   _____
   _____
   _____

Welcome

John Spillman

Senior Technical Consultant

Earth Advantage



www.betterbuiltnw.com

Schedule

- Introduction
- Market Trajectory
- Third Party Verification
- Building Science Basics
- Top 10 Good/Better/Best Practices:
    1. Design
    2. Superior Air Sealing
    3. High-R Walls
    4. High-R Ceilings
    5. Windows
    6. Ducts and Distribution
    7. Fresh Air Ventilation
    8. Appliances and Lighting
    9. Mechanical Systems
    10. Solar Energy
- Local Program Info
- Conclusion

Poor Performing Home Scenarios

Durability

Photo Courtesy: Bruce Sullivan

Call Backs & Liability

Health & Indoor Air Quality

Uncomfortable Customers

High Energy Costs

Affordability: Low Income

Affordability: The Next Generation

Where's the Market Headed?

U.S. Building Impact

76% Total U.S. electricity consumption

40% Energy use and carbon emissions

By 2030, building energy use could be cut more than 20% using technologies known to be cost effective today.

Source: U.S. Department of Energy, 2015

Homebuyer Preference

81%

of people who expect to buy a new home in the next two years say higher energy efficiency would cause them to choose one new home over another.

Source: Energy Pulse 2016 ©Shelton Communication Group, Inc.

The State of Green Building

2017 NAHB Green SmartMarket Report

The more green experience a builder has…

- the more they appreciate certifications,
- the easier they think it is to market green, and
- the less they perceive the incremental costs to be.

Zero Energy Home

A home that generates as much energy on site as it uses over the course of a year.

Policy Changes

2018 City of Portland Home Energy Score Program

2019 Oregon Home Energy Score

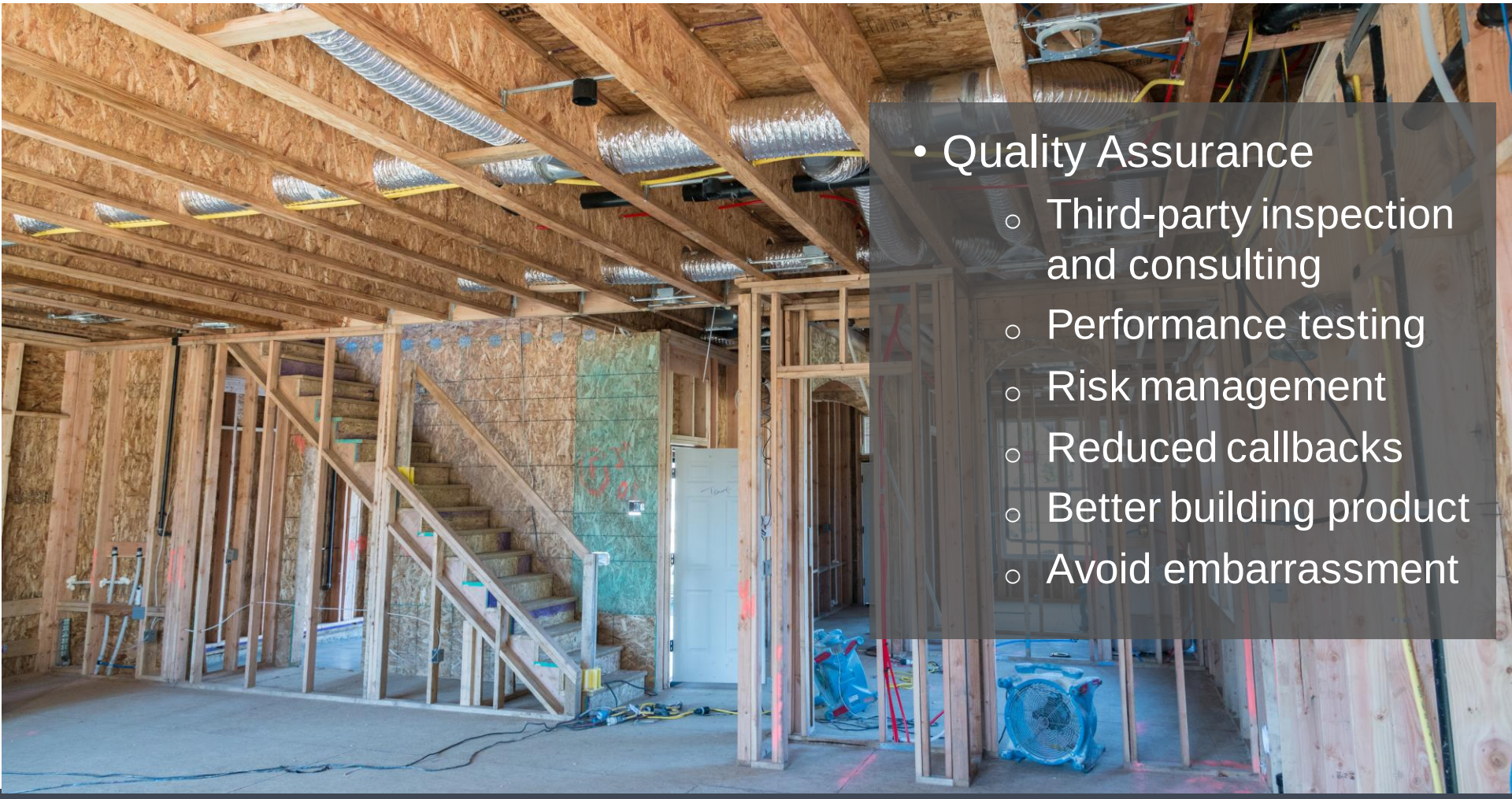
2020 Oregon Code Changes

2023 Oregon Zero Energy Ready

2030 Washington Zero Energy

Benefits of Third Party Verification

Builders & Third Party Verification



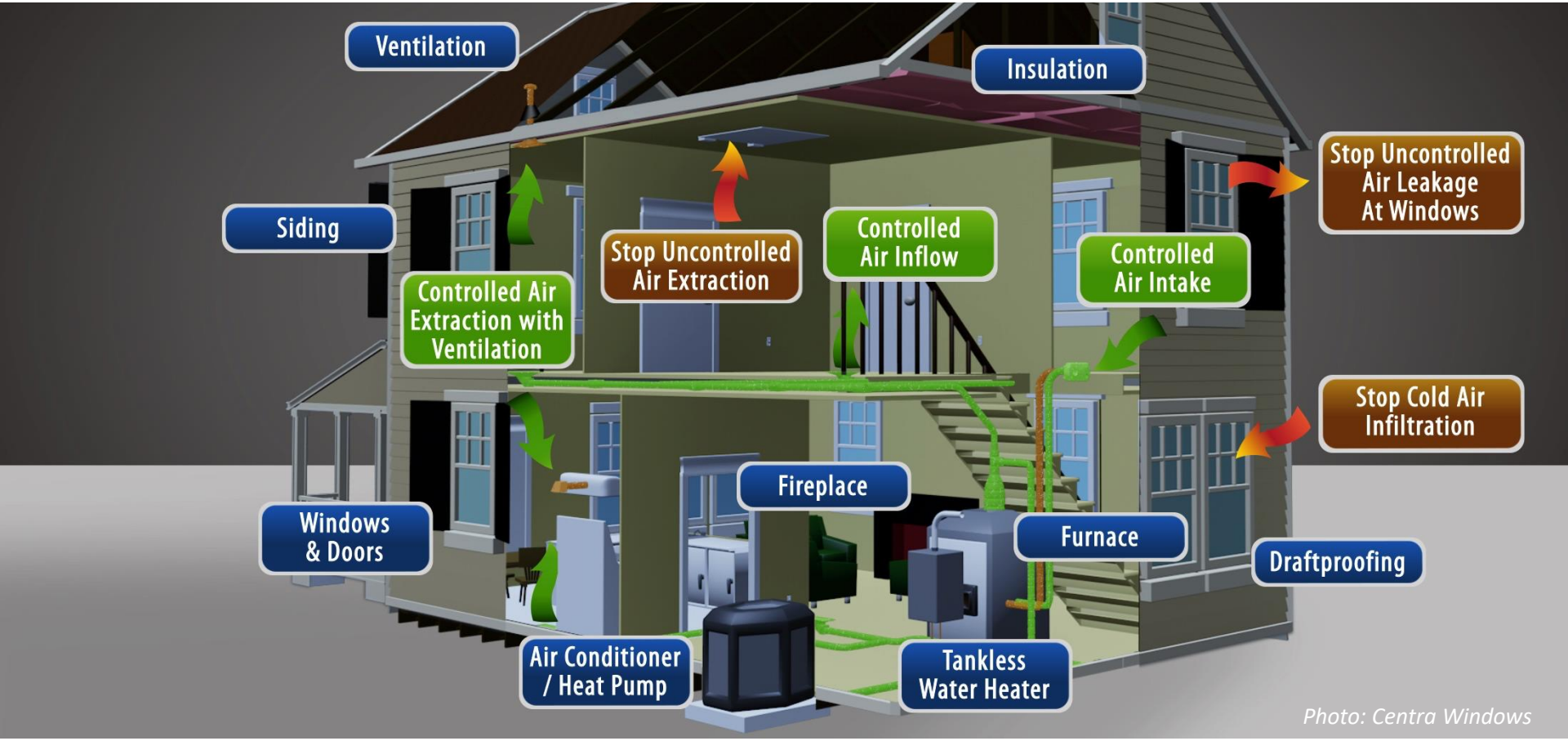
- Quality Assurance
  - Third-party inspection and consulting
  - Performance testing
  - Risk management
  - Reduced callbacks
  - Better building product
  - Avoid embarrassment

Builders & Third Party Verification

- Sales & Marketing Advantage
  - Differentiate your company from others
  - Understand and address younger consumers
  - Meet current/future market demand
- Business Evolution
  - Housing is changing
  - Manage the future
  - Technical assistance

Building Science Fundamentals

Building Science



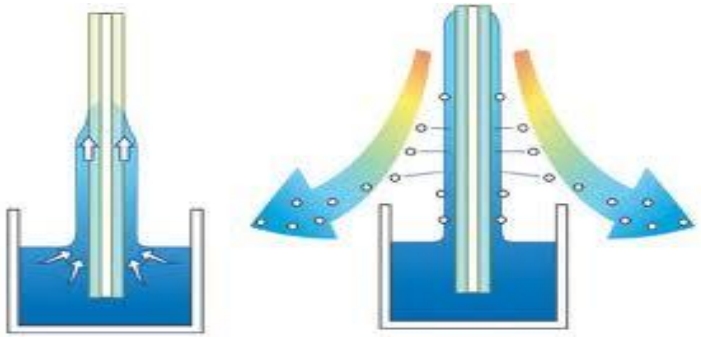
Building science studies the interactions of people, components and systems, and the physical phenomena affecting a building.

Moisture Flows

Moisture Flows: Moisture Movement

- Liquid water moves by gravity or pressure differences
- Liquid water moves by capillary action
- Water vapor is transported via air movement
- Water vapor diffuses through building assemblies

Rainfall



Capillary Action

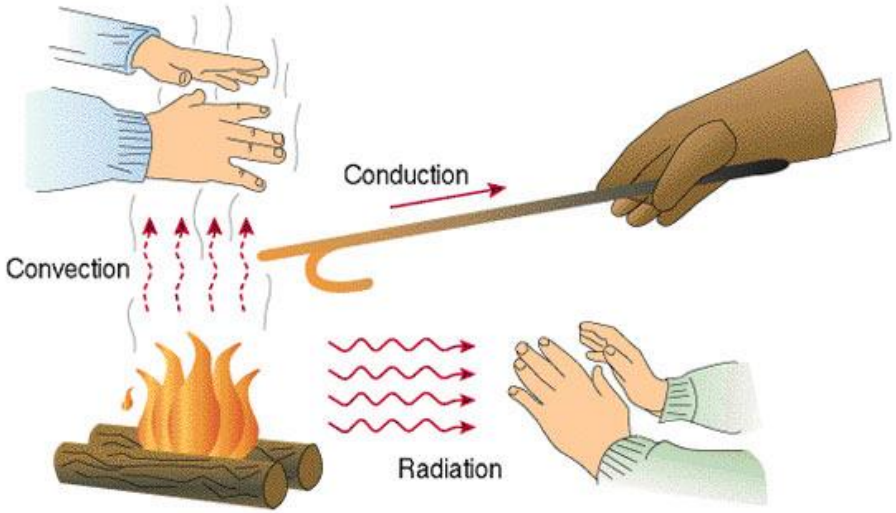
Vapor

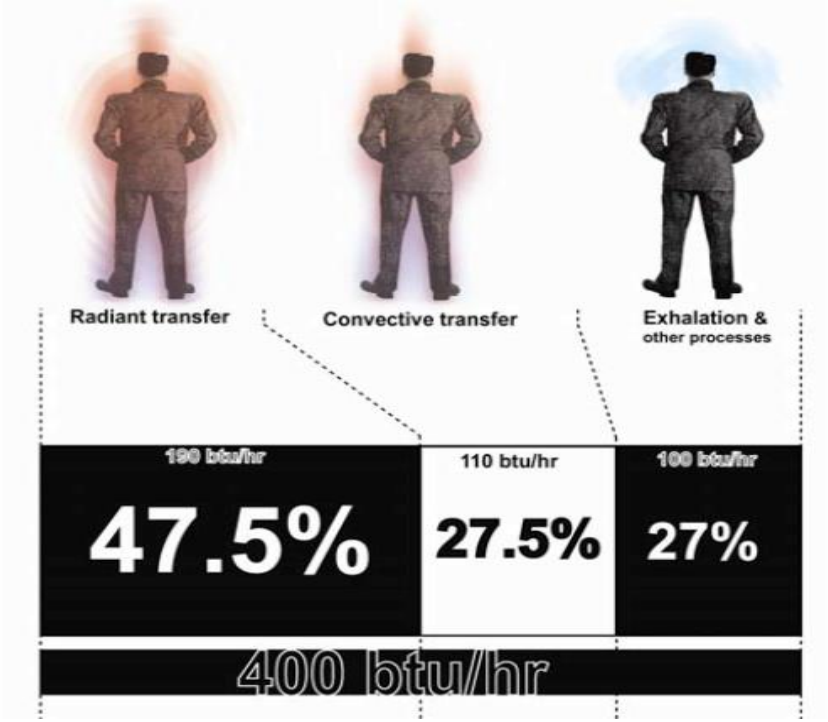
Insulation

Thermal Flows (Heat Transfer)

Three Modes of Heat Transfer:

- Conduction
- Convection
- Radiation





Top 10 Best Practices for Today's Homebuilder

1. Design
2. Superior Air Sealing
3. High-R Walls
4. High-R Ceilings
5. Windows
6. Ducts and Distribution
7. Fresh Air Ventilation
8. Appliances and Lighting
9. Mechanical Systems
10. Solar Energy

Good, Better, Best options will be provided for each approach

1. Design for Efficiency

1. Design for Efficiency

- **Good:** Continuous thermal boundary
- **Better:** Add right sizing design & systems
- **Best:** Add optimization with energy modeling

Best: Optimize with Energy Modeling

Computerized analysis of:

- Heat loss
- Heat gain
- Air leakage
- Mechanical efficiency
- Assumes “typical” occupant behavior

Analyze measures:

- Select optimum package
- Customer needs
- Price point

CONTACT YOUR RATER

Best: Optimize with Energy Modeling

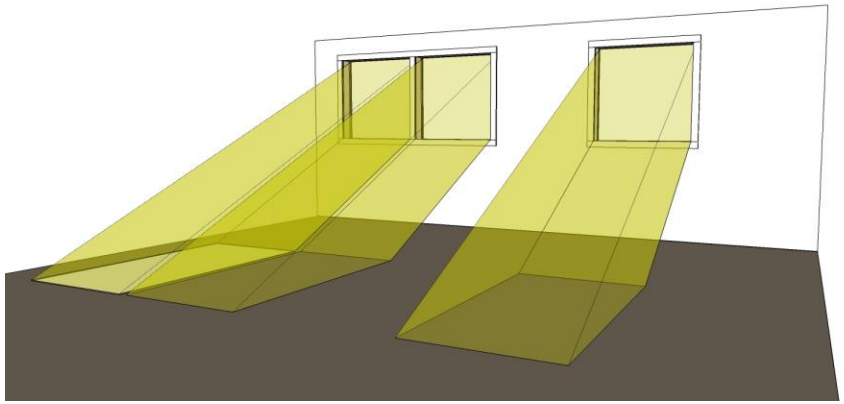
Shell measures

- Insulation
- Air sealing
- Windows

Equipment measures

- Heating/cooling efficiency
- Water heating efficiency
- Solar

Minimum shell measures create a consistent interior temperature and durable building. They also create a minimum level of occupant comfort and reduce equipment size and cost.



2. Superior Air Sealing

2. Superior Air Sealing

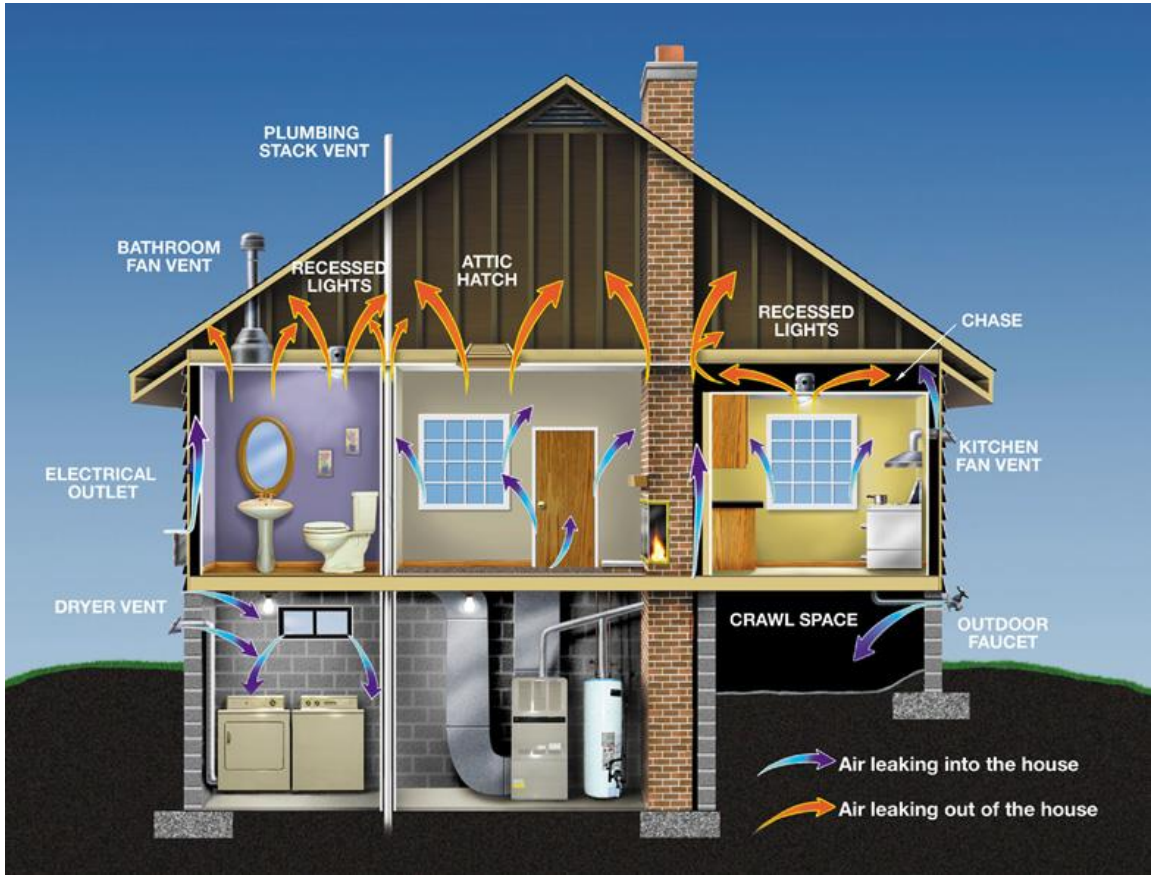
Good: Code level caulking and sealing

Better: Fully continuous air barrier

Best: Exterior sheathing sealed

Air Leakage

- 30% of heat loss in “typical” home
- Transport moisture
- Reduce comfort
- Increase indoor pollution
- Largest cause of ice dams



Better

Continuous Air Barrier With Alignment

Photos Courtesy: Bruce Sullivan

Best

Exterior Air Barrier System

Exterior sheathing tape or glue sheathing to framing with construction adhesive.

Photos Courtesy: Bruce Sullivan

Best

Self-Adhered Water Resistive Air Barrier

Best

Liquid Applied Weather Resistive Barriers - Exterior

Prosoco

StoGuard

Tremco Enviro-Dri

Best

Advanced Air Sealing

Tapes

Budax Top

Contega

Pro Clima

SIGA

Tescon

Unitape Rapidcell

3M 8067

Membranes

Pro Clima

SIGA

Best

Aerobarrier

No more caulking needed to weatherize a space pre-drywall.
AeroBarrier requires no manual labor to apply and removes any sealing guesswork.

Source: Aerobarrier

3. High Performance Wall Systems

3. High Performance Wall Systems

Good: Intermediate or advanced framing with blown insulation

Better: Single plate with staggered studs + blown insulation (≤ R-27) or 2x6 with exterior continuous insulation.

Best: Insulated sheathing or double-stud + blown insulation (> R-27)

Better

Wall Insulation up to R-27

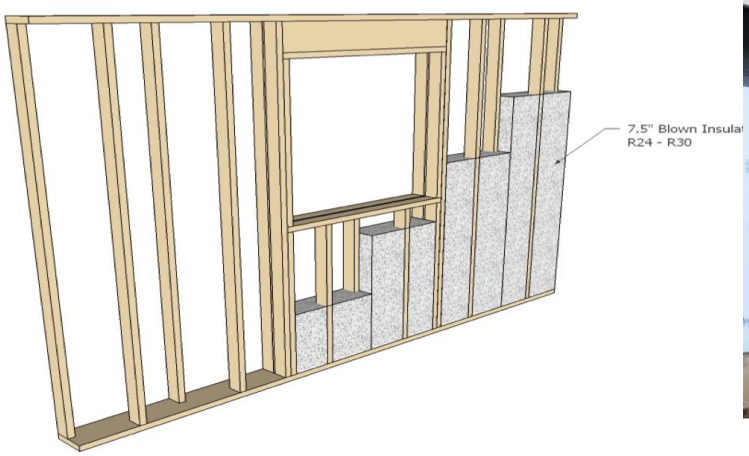


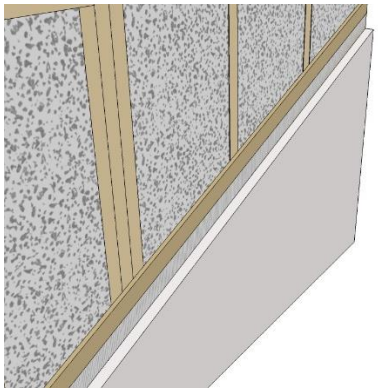
Photo Courtesy: Bruce Sullivan

Staggered Stud Wall With 8” Plates

2x6 Stud Wall With Exterior Rigid Insulation

Exterior Insulations

XPS – Extruded Polystyrene



EPS – Expanded Polystyrene

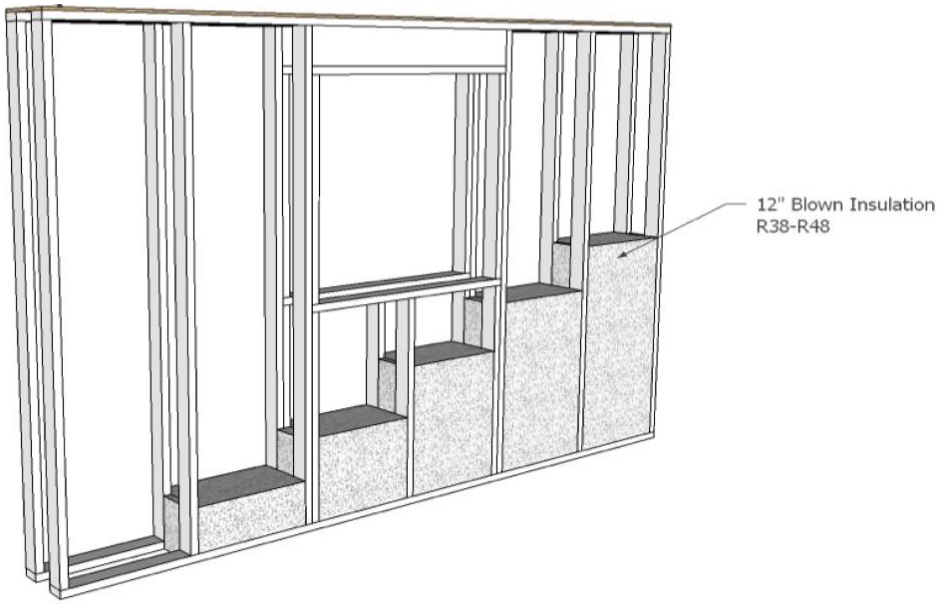
Rockwool Panels

Thermal Break Shearwall (TBS)

Polyisocyanurate – Foil Faced

Best

Wall Insulation above R-27

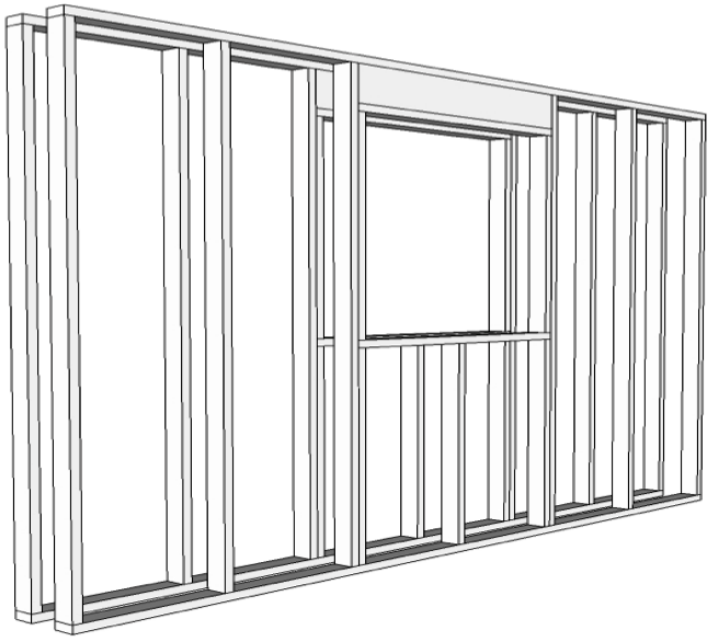


Double Stud Wall

2x6 Stud Wall With
Exterior Rigid Insulation

Best

Double Stud Wall



Framing Thickness	R-Value
8”	28
10”	42
12”	50

4. High R-Value Ceilings

4. High R-Value Ceilings

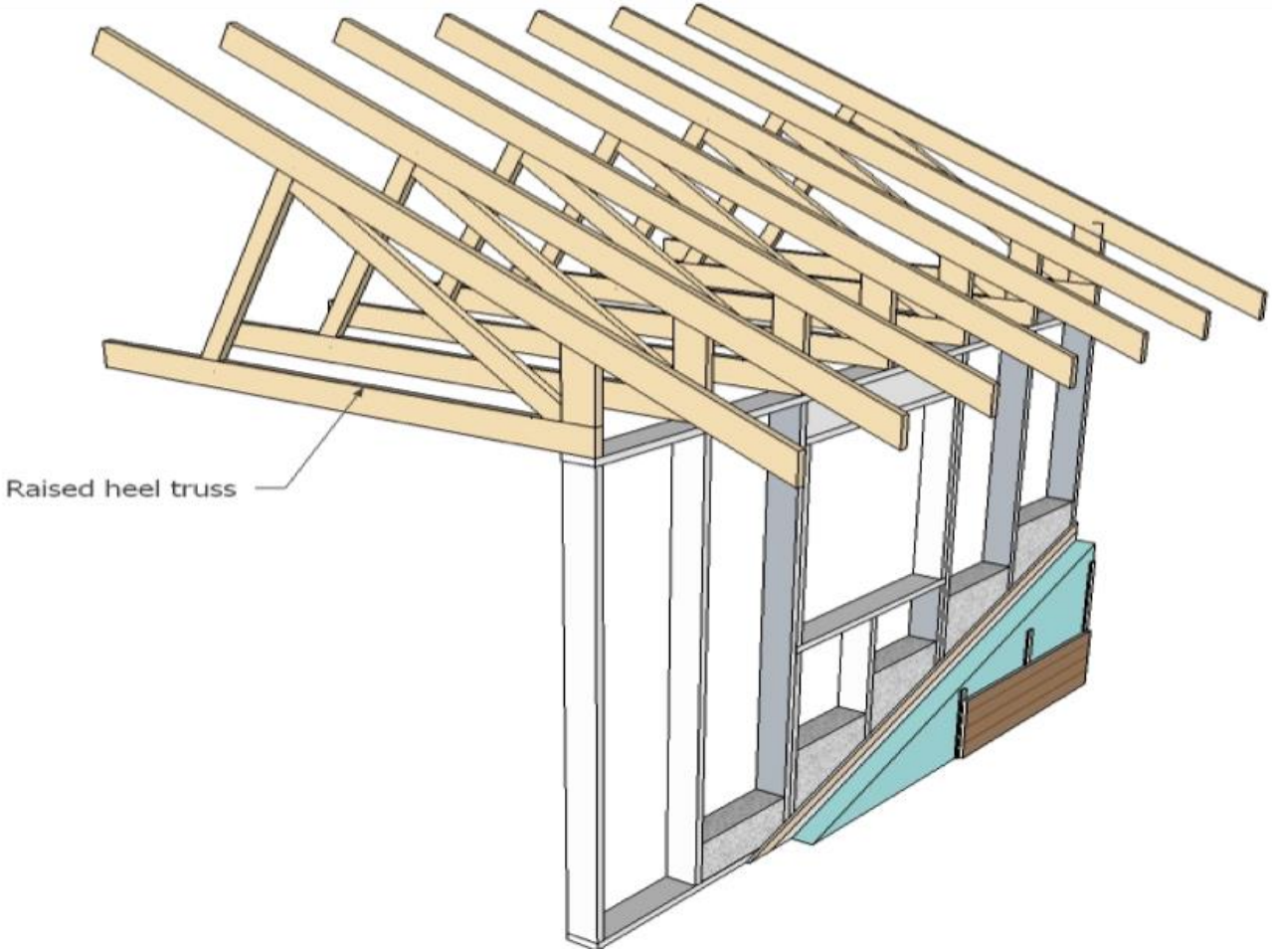
Good: Standard truss with R-21 high density fiberglass batts or rigid insulation inserts + 1" vent channel at eaves

Better: Raised heel truss, parallel chord cantilevered truss

Best: True vaulted ceiling (I-joist) or insulated roof above attic

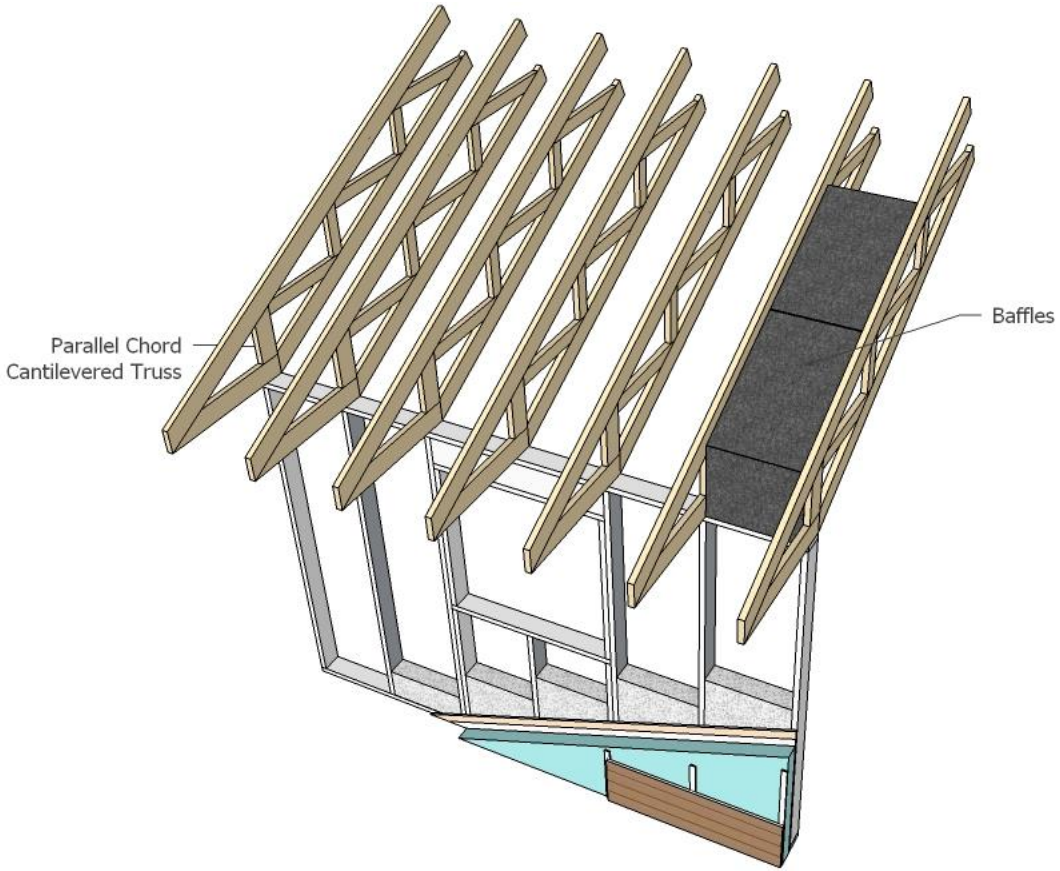
Better

Raised Heel Truss



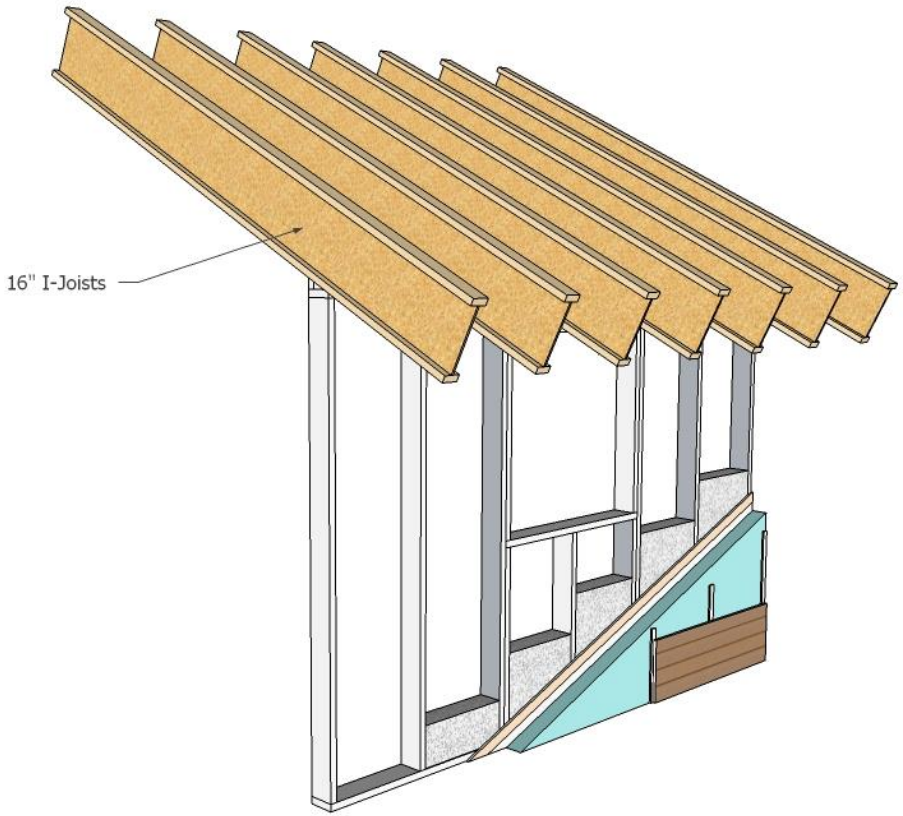
Best

Parallel Chord or Scissors Truss



Best

I-Joists Vaulted



5. Windows

5. Windows

Good: Proper U-value and Solar Heat Gain Coefficient (SHGC) for applications

Better: Window design (avoid too much glazing)

Best: Daylighting + high performance low U-value

Best

Super-Low U-value & Daylighting

- U-0.09 to U-0.20
- Triple glazed
- Low-e
- Gas fill
- Double air seal

Best

Super-Low U-value & Daylighting

Most Windows on South Facing Walls

Design for light penetration

Limit Windows on North

Use light-colored interior finishes

Share light between spaces

6. Ducts and Distribution

6. Ducts and Distribution

Good: Seal ducts with mastic

Better: Seal ducts with mastic and test

Best: Ducts inside or ductless system

The Problems With Ducts

- Inadequate insulation
- Too much duct air leakage
- Pressure difference induced building leakage
- Ducts can be responsible for 20% of building heat loss.

Photo Courtesy: Bruce Sullivan

Duct Seal and Test

- Test after top out is best for finding and sealing leaks
- HVAC installers that are experienced and confident can successfully test at finish

Photo Courtesy: Bruce Sullivan

Best

Ducts Inside

Why?

- Temperature
- Condensation
- Leakage

How?

- Design
- Dropped ceilings
- Soffits
- Interior walls
- Unvented crawls
- Conditioned attics

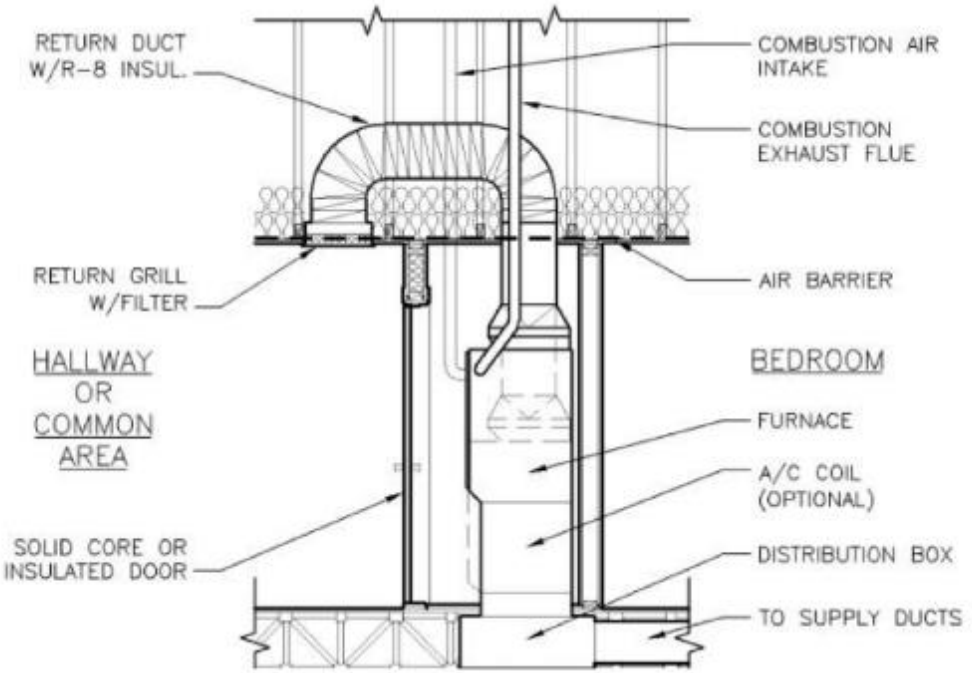
Best

How do you Bring Ducts Inside?

Move the ducts and air handler to conditioned space

and/or

Turn unconditioned space to conditioned space



Best

Two Story Home

Best

Make the Transition to Ducts Inside

- Research options
- Consult verifier
- Bring designer and HVAC in early
- Adapt stock plans over time
- Persist

7. Fresh Air Ventilation

7. Fresh Air Ventilation

Good: Exhaust only

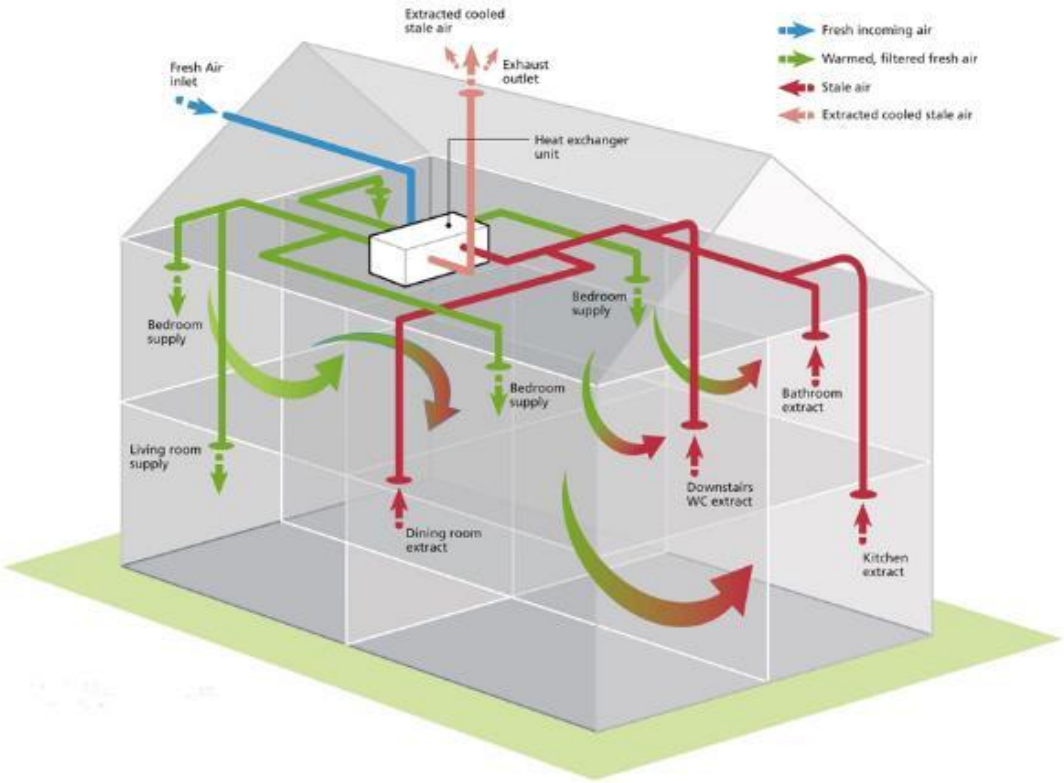
Better: Supply + exhaust (w/ ECM blower motor)

Best: Heat Recovery Ventilator (HRV) or Energy Recovery Ventilator (ERV)

Ventilation Strategies

Heat Recovery Ventilator (HRV)
= sensible heat

Energy Recovery Ventilator (ERV)
= sensible heat + moisture



Best

Through the Wall ERV

Lunos

Best

Equipment selection

Efficiency

Energy use (ECM)

Air flow rating

Freeze protection

Noise

Variable speed

Unit dimensions

Maintenance requirement

Options: filtration, controls, self-balancing

Zehnder

8. Lighting and Appliances

8. Lighting and Appliances

Good: Energy Star appliances

Better: Add heat pump dryer

Best: Add induction cooktop

Better

Appliances

- Heat pump clothes dryers
- No vent needed

Best

Appliances

- Induction Cooktop

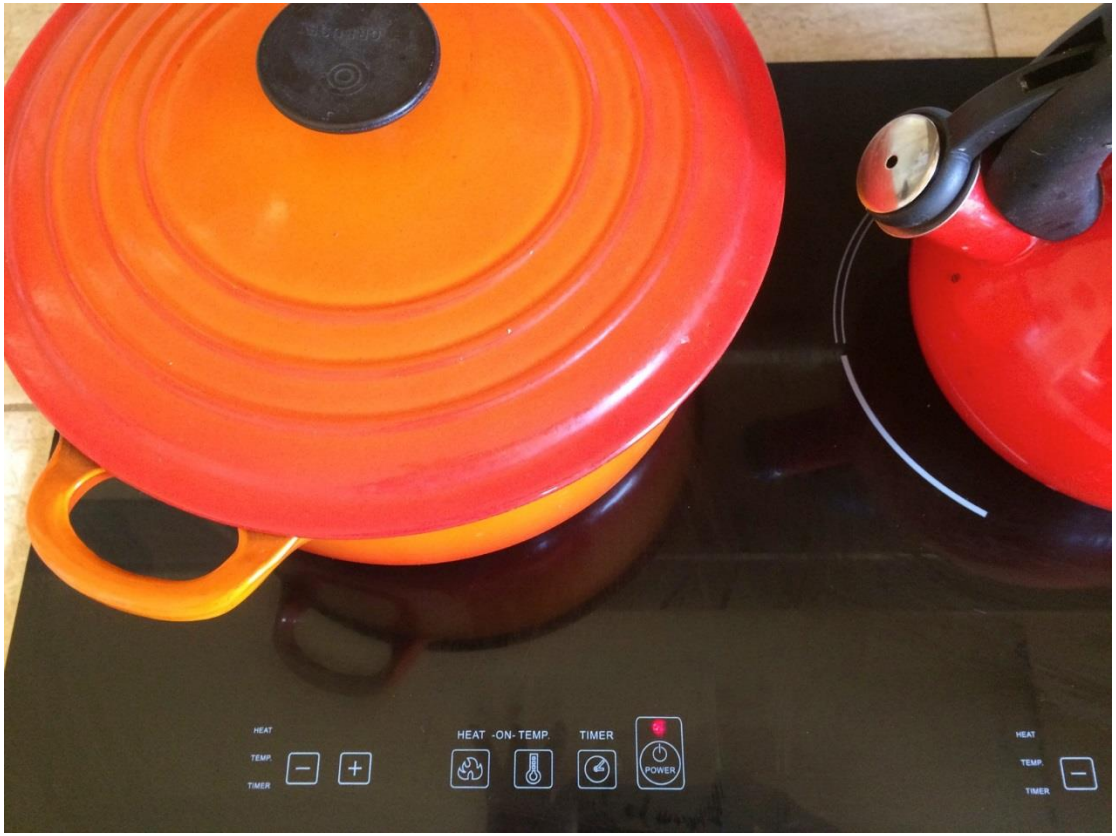


Photo Courtesy: Bruce Sullivan

9. Mechanical Systems

9. Mechanical Systems

Good: High-efficiency ducted heat pump or condensing gas furnace

Better: Ductless heat pump or Highest efficiency condensing gas furnace.

Best: Add heat pump water heater or condensing tankless gas water heater

Good

System Types – High Efficiency

Refrigerant Cycle Systems

Air Source Heat Pumps – Use the ambient air as the source or sink for heat

Hybrid Heat Pumps – system above with high efficiency gas furnace for backup heat

Seasonal Energy Efficiency Ratio (SEER)

- Btus ÷ Watts
- Standard conditions (outdoor: 95°F, 50% RH, indoor: 80°F, 50% RH)

Heating Season Performance Factor (HSPF)

- Btus ÷ KWh
- Range of conditions, including cycling

HSPF 9 – 13.5

Good

System Types – High Efficiency

Condensing Gas Furnace

AFUE: 90-93%

Better

System Types – High Efficiency

Condensing Gas Furnace

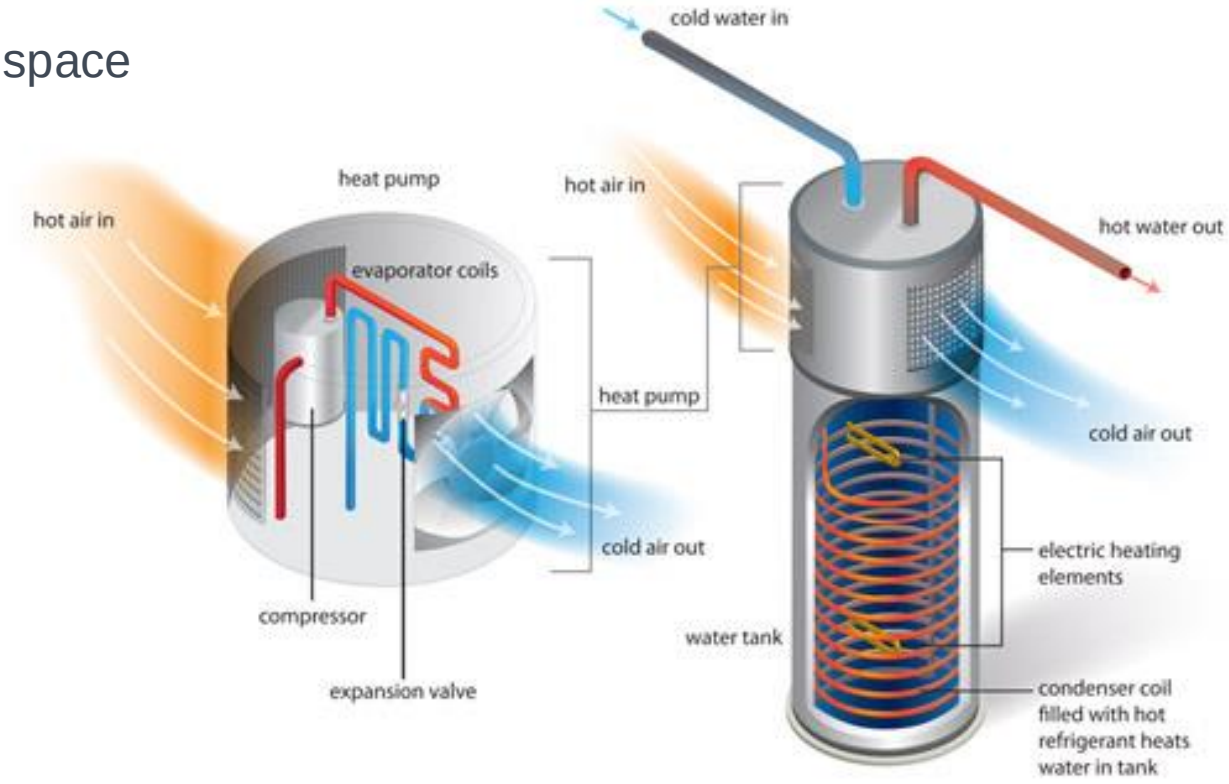
AFUE: 94-99%

System Types – Ductless Heat Pump

Best

Heat Pump Water Heater

- High efficiency
- Locate in buffered space
- Troubled history



Best

Condensing On-Demand Water Heater

- High efficiency
- Natural Gas or LPG

Best

CO2 Heat Pump Water Heater

- Energy factor: 3.35 (at 67.5° F ambient)
- Northern climate energy factor: 3.2
- First-hour rating: 97.8 gallons
- Number of consecutive 16-gallon efficient showers: 7.5
- Sound level of outside unit: 48 dBA

10. Solar Electric

10. Solar Electric

Good: Solar PV and Electric Vehicle (EV) ready

Better: Zero Energy (ZE Ready)

Best: Positive Energy with EV

Good

Solar PV Ready

Solar Roof Area must utilize 80% or more of solar resource available (TSRF) OR Prescriptive Path

Good

Solar PV Ready

Good

Electric Vehicle Ready

Space in the breaker panel to accommodate a dedicated 240v circuit

Zero Energy (ZE Ready)

Evolution in Zero Energy

Early Adopters
Custom luxury homes

→

2nd Wave
Affordable & Multifamily

→

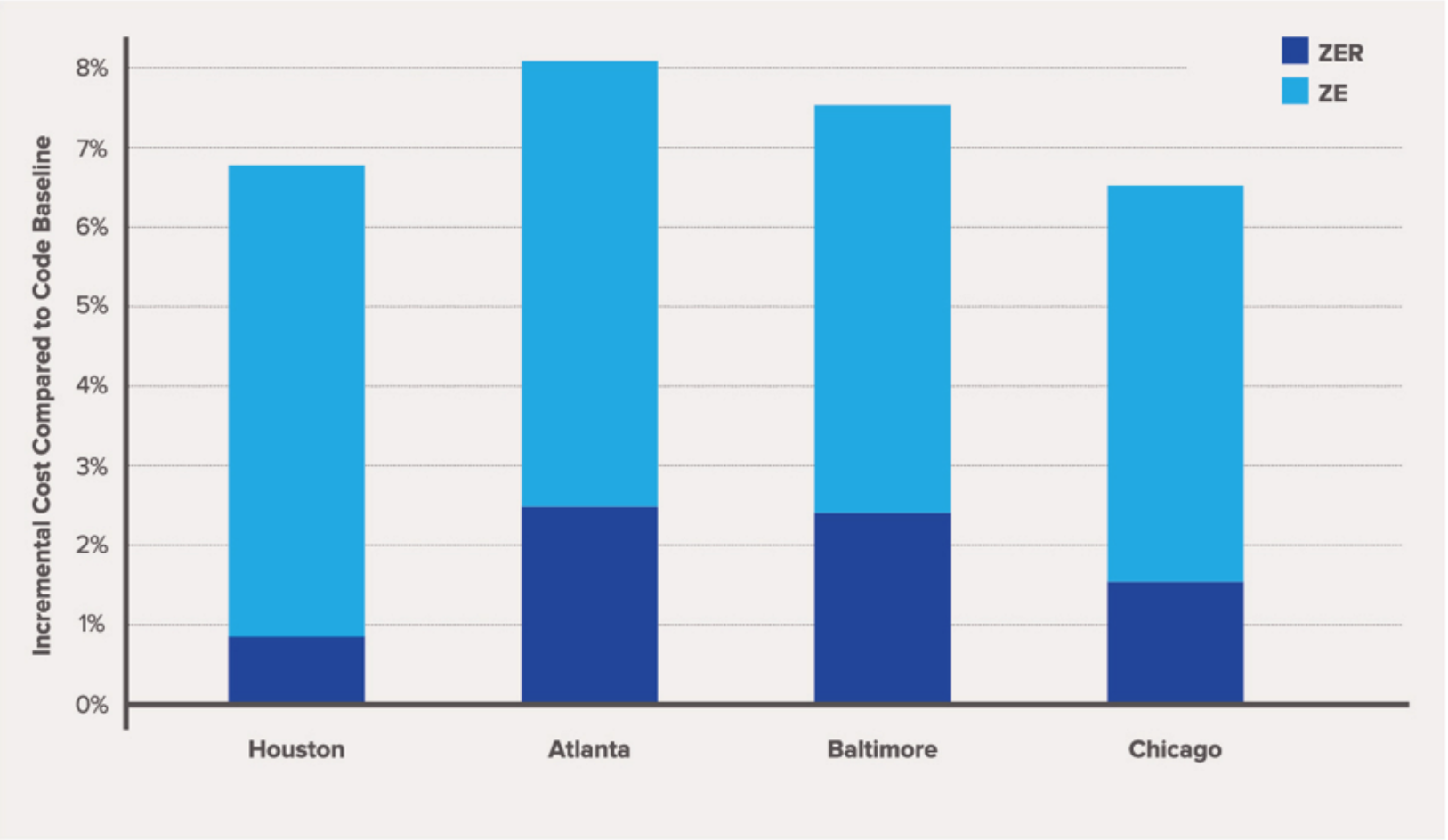
3rd Wave (Present)
Spec & Productions builders

Buying Power of Zero Energy Construction

- $10 / month in energy savings buys $2000 more house or at least $2000 more mortgage
- Owners can easily save $100 per month on energy costs which would allow $20,000 higher mortgage with no impact to the owner's month budget
- Size reduction can free up additional funds. If construction costs are 200/sf, then reducing size from 2400 to 2000 sf yields $80,000.

For further reading - https://zeroenergyproject.org/buy/cost-less-to-own/

Cost Above Code for Zero Energy



https://www.rmi.org/zero-energy-homes-are-ready-for-mainstream-markets/

ZE Ideal VS ZE Production Reality

5	Renewable systems
4	High efficiency appliances & lighting
3	Right-sized mechanicals
2	High performance shell
1	Efficient use of space

5	High efficiency appliances & lighting
4	High performance shell
3	Efficient use of space
2	Hyper efficient mechanicals
1	Renewable systems

Kite vs Rocket

Best

Positive Energy + EV

Energy Trifecta

1. Rooftop Solar Electric Panels
2. Electric Vehicle
3. On-site batteries

… and grid-conneted.

Local Incentives and Programs


Process Improvement

Quality Assurance

When does it happen?

Who does it?

Prevention is better than detection.

Implementation

Quality Management Planning:

- Plan, plan, plan
- Identify responsible parties
- Verify proper installation
- Documentation

- Insulation
- Air Sealing Details
- Durability Details

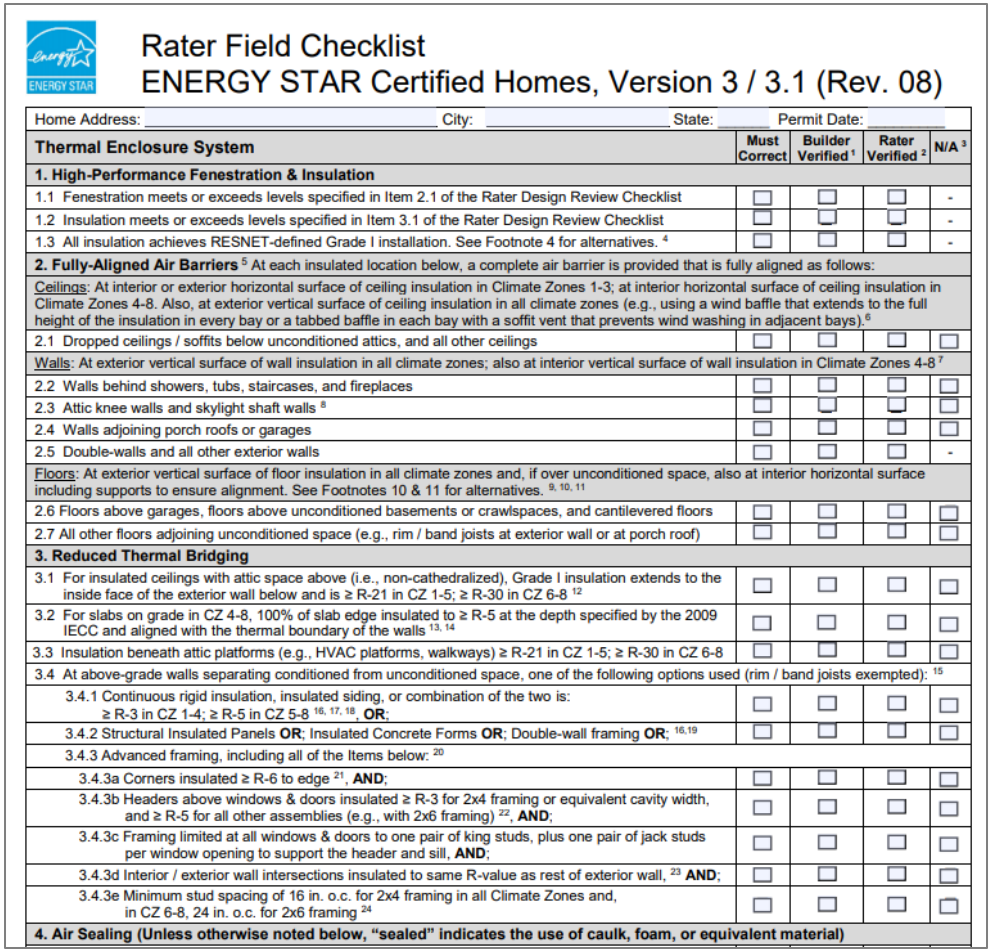
Quality Checklist

Air Sealing

Ductwork

Framing

Insulation



Rater Field Checklist
ENERGY STAR Certified Homes, Version 3 / 3.1 (Rev. 08)

Home Address: _____ City: _____ State: _____ Permit Date: _____

Thermal Enclosure System	Must Correct	Builder Verified [1]	Rater Verified [2]	N/A [3]
1. High-Performance Fenestration & Insulation				
1.1 Fenestration meets or exceeds levels specified in Item 2.1 of the Rater Design Review Checklist	☐	☐	☐	-
1.2 Insulation meets or exceeds levels specified in Item 3.1 of the Rater Design Review Checklist	☐	☐	☐	-
1.3 All insulation achieves RESNET-defined Grade I installation. See Footnote 4 for alternatives. [4]	☐	☐	☐	-
2. Fully-Aligned Air Barriers [5] At each insulated location below, a complete air barrier is provided that is fully aligned as follows:				
Ceilings: At interior or exterior horizontal surface of ceiling insulation in Climate Zones 1-3; at interior horizontal surface of ceiling insulation in Climate Zones 4-8. Also, at exterior vertical surface of ceiling insulation in all climate zones (e.g., using a wind baffle that extends to the full height of the insulation in every bay or a tabbed baffle in each bay with a soffit vent that prevents wind washing in adjacent bays).[6]				
2.1 Dropped ceilings / soffits below unconditioned attics, and all other ceilings	☐	☐	☐	☐
Walls: At exterior vertical surface of wall insulation in all climate zones; also at interior vertical surface of wall insulation in Climate Zones 4-8 [7]				
2.2 Walls behind showers, tubs, staircases, and fireplaces	☐	☐	☐	☐
2.3 Attic knee walls and skylight shaft walls [8]	☐	☐	☐	☐
2.4 Walls adjoining porch roofs or garages	☐	☐	☐	☐
2.5 Double-walls and all other exterior walls	☐	☐	☐	-
Floors: At exterior vertical surface of floor insulation in all climate zones and, if over unconditioned space, also at interior horizontal surface including supports to ensure alignment. See Footnotes 10 & 11 for alternatives. [9, 10, 11]				
2.6 Floors above garages, floors above unconditioned basements or crawlspaces, and cantilevered floors	☐	☐	☐	☐
2.7 All other floors adjoining unconditioned space (e.g., rim / band joists at exterior wall or at porch roof)	☐	☐	☐	☐
3. Reduced Thermal Bridging				
3.1 For insulated ceilings with attic space above (i.e., non-cathedralized), Grade I insulation extends to the inside face of the exterior wall below and is ≥ R-21 in CZ 1-5; ≥ R-30 in CZ 6-8 [12]	☐	☐	☐	☐
3.2 For slabs on grade in CZ 4-8, 100% of slab edge insulated to ≥ R-5 at the depth specified by the 2009 IECC and aligned with the thermal boundary of the walls [13, 14]	☐	☐	☐	☐
3.3 Insulation beneath attic platforms (e.g., HVAC platforms, walkways) ≥ R-21 in CZ 1-5; ≥ R-30 in CZ 6-8	☐	☐	☐	☐
3.4 At above-grade walls separating conditioned from unconditioned space, one of the following options used (rim / band joists exempted): [15]				
3.4.1 Continuous rigid insulation, insulated siding, or combination of the two is: ≥ R-3 in CZ 1-4; ≥ R-5 in CZ 5-8 [16, 17, 18], **OR**;	☐	☐	☐	☐
3.4.2 Structural Insulated Panels **OR**; Insulated Concrete Forms **OR**; Double-wall framing **OR**; [16,19]	☐	☐	☐	☐
3.4.3 Advanced framing, including all of the Items below: [20]				
3.4.3a Corners insulated ≥ R-6 to edge [21], **AND**;	☐	☐	☐	☐
3.4.3b Headers above windows & doors insulated ≥ R-3 for 2x4 framing or equivalent cavity width, and ≥ R-5 for all other assemblies (e.g., with 2x6 framing) [22], **AND**;	☐	☐	☐	☐
3.4.3c Framing limited at all windows & doors to one pair of king studs, plus one pair of jack studs per window opening to support the header and sill, **AND**;	☐	☐	☐	☐
3.4.3d Interior / exterior wall intersections insulated to same R-value as rest of exterior wall, [23] **AND**;	☐	☐	☐	☐
3.4.3e Minimum stud spacing of 16 in. o.c. for 2x4 framing in all Climate Zones and, in CZ 6-8, 24 in. o.c. for 2x6 framing [24]	☐	☐	☐	☐
4. Air Sealing (Unless otherwise noted below, "sealed" indicates the use of caulk, foam, or equivalent material)				

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Quality Construction Chain

1. Each person must check upstream work before beginning
2. Each person must know how to do their work
3. Each person must know that all critical details are done defect free
4. Each person must check their own critical work details

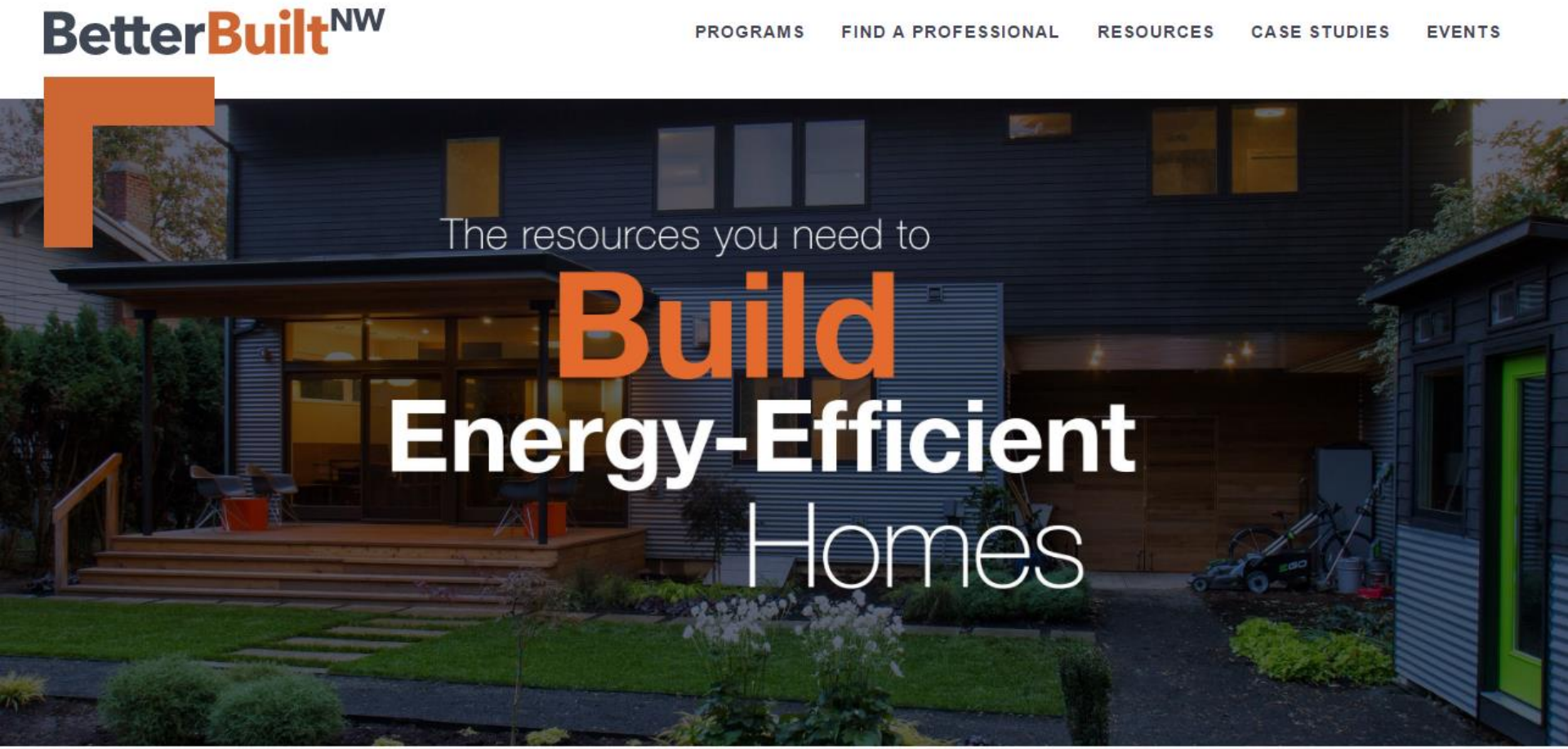
Source: Advanced Energy

Quality Assurance

What does the rater verify?

- Performance testing
  - Duct air leakage
  - Building air leakage
  - Ventilation performance
- Insulation level and placement
- Air sealing details
- Durability details
- Ventilation operation
- HVAC system sizing

Where To Go for Support



www.betterbuiltnw.com

Thank You!

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