

# Technical Resources at Your Fingertips: Building America Solution Center and Standard Work Specifications for Existing Homes

## Panelists

Chrissi Antonopoulos, Pacific Northwest National Laboratory

David LoVullo, National Renewable Energy Laboratory

## Moderator

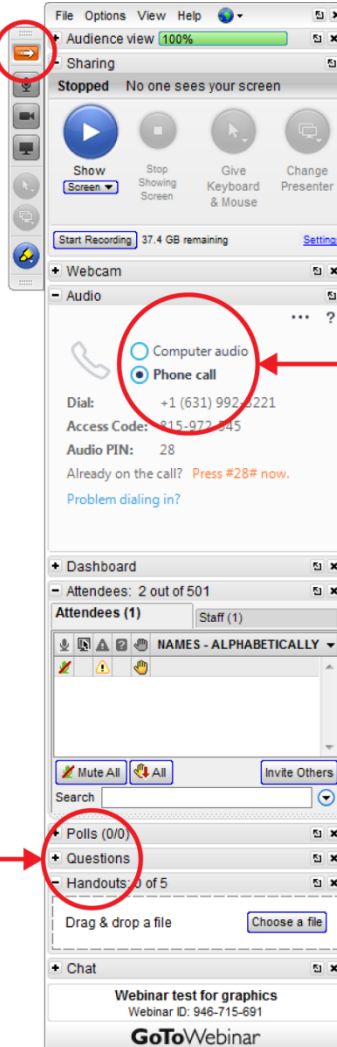
Linh Truong – National Renewable Energy Laboratory

June 26, 2018



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# Agenda

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- ✓ **Welcome and Introductory Remarks**
- ✓ **Overview of Building America ([buildingamerica.gov](http://buildingamerica.gov))**
  - Linh Truong – National Renewable Energy Laboratory
- ✓ **Speaker**
  - Chrissi Antonopoulos, Pacific Northwest National Laboratory
  - David LoVullo, National Renewable Energy Laboratory
- ✓ **Questions and Answers**
- ✓ **Closing Remarks**



## Technical Resources at Your Fingertips: Building America Solution Center and Standard Work Specifications for Existing Homes

**Chrissi Antonopoulos**

Senior Energy Analyst,  
Pacific Northwest National Laboratory

- Building America Solution Center (BASC) Intro:
  - Overview of stakeholders and users
  - Tour of core BASC content and user interface related to existing homes
  - Linkages between BASC and SWS
- Standard Work Specifications (SWS) Intro:
  - Overview of SWS tool and application
  - Linkages between SWS and BASC

# World-Class Expert Guidance...

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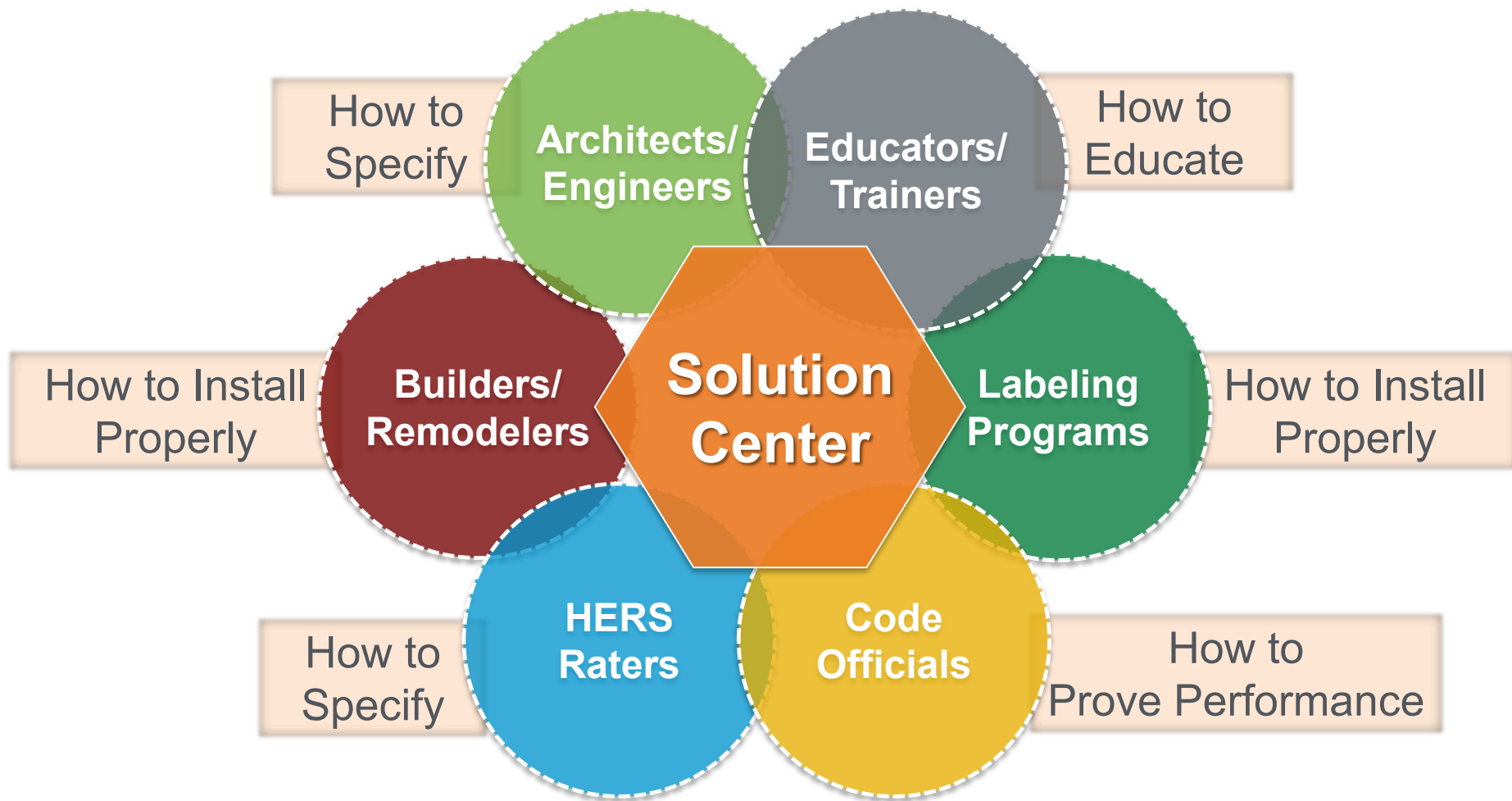


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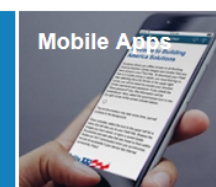
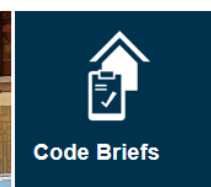
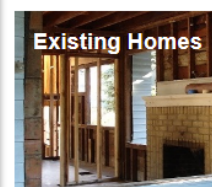
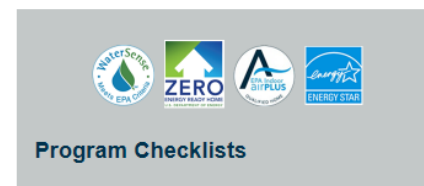
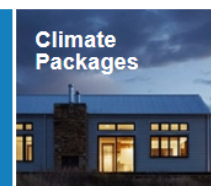
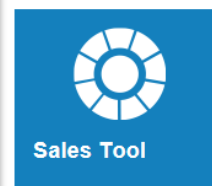
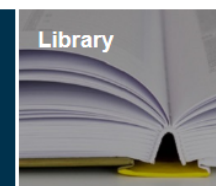
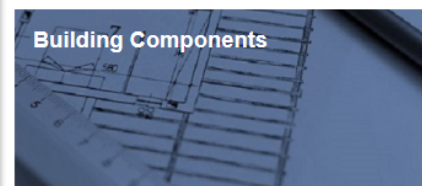
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## Drainage Plane Behind Exterior Wall Cladding

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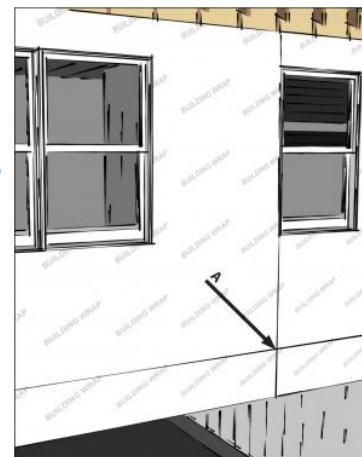
### Sales

### Scope

Install a fully sealed continuous drainage plane behind the exterior cladding on the walls of the home to keep water out of the wall cavities.

- Make sure that this layer laps over flashing installed around doors, windows, and wall penetrations and any flashing installed at the top or base of walls.
- Provide an additional bond-break drainage plane layer behind all stucco and non-structural masonry wall cladding assemblies.
- Possible monolithic weather-resistant barrier materials include house wrap that is sealed or taped at all joints; rigid foam insulation or other sheathing materials with a weather-resistant coating if all joints are fully taped; building paper or building felt installed with shingle-style laps; liquid-applied coatings; or other water-resistant barrier materials recognized by the ICC-ES or another accredited agency.

See the [Compliance Tab](#) for related codes and standards requirements, and criteria to meet national programs such as DOE's Zero Energy Ready Home program, ENERGY STAR Certified Homes, and Indoor airPLUS.



House wrap is sealed at all seams and overlaps flashing to serve as a continuous drainage plane over the exterior walls.

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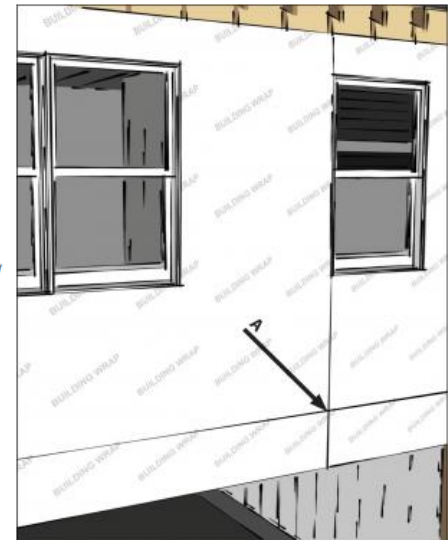
### Scope

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See the [Compliance Tab](#) for related codes and standards requirements, and criteria to meet national programs such as DOE's Zero Energy Ready Home program, ENERGY STAR Certified Homes, and Indoor airPLUS.



House wrap is sealed at all seams and overlaps flashing to serve as a continuous drainage plane over the exterior walls.

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### Description

Most exterior wall cladding systems leak. Wind pressure and capillary action can drive rainwater through the many cracks, joints and small gaps in a building's exterior, and with typical residential siding systems, it is nearly impossible to seal all those holes. Even if a builder succeeds in sealing a majority of the holes, the caulks and sealants used to seal them will not last as long as the exterior cladding materials, and the sealants will need to be reapplied periodically. A wall that tries to block entry of water using caulks and sealants is sometimes called a "barrier wall," but it is not a very practical system for residential buildings ([BSC 2007](#)).

A more practical way to protect building exteriors from rainwater relies on a "drainage approach," achieved by installing a drainage plane beneath the exterior cladding. With this approach, any water that leaks through the cladding will run into a water-resistant surface, and safely drain down the wall. For a detailed Building America sponsored research report about taped insulating sheathing drainage planes, see [Guidance on Taped Insulating Sheathing Drainage Planes](#).

To work effectively, the drainage plane must be designed and installed to channel water away from the building. This will involve the following ([Smegal and Lstiburek 2012](#)):

- Lapping drainage plane materials over all exterior wall flashings so water flowing down the walls is directed away from the building. Common wall flashings include flashing at the base of walls, sidewall flashing where roofs intersect walls, and flashings around window and door openings.
- Carefully sealing around all penetrations through the wall. Examples of common wall penetrations include those for water spigots, exhaust vent outlets, HVAC line sets, and wiring for outdoor light fixtures and receptacles.

While the primary function of a weather-resistant barrier is rainwater control, the drainage plane may also serve as an air barrier if the seams in the drainage plane are taped or otherwise sealed. An effective air barrier is critical to long-term durability of the building, particularly in hot and cold climates where moisture-laden air moving into the enclosure may cause condensation problems ([Lstiburek 2006](#)).

### Drainage Plane Materials

Materials that may be used to create an effective drainage plane include:

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### Ensuring Success

Visually inspect the exterior walls before siding is installed to ensure that the weather-resistive barrier or rigid foam sheathing is correctly installed and correctly integrated with wall flashings to direct water out and down, away from the wall cavities. Seams in house wrap and rigid foam insulation should be taped, and the tape must adhere uniformly to the substrate without peeling or open "fish mouths" (i.e., folds in the tape that create an opening that does not adhere to the house wrap or rigid foam sheathing).



Figure 1 - The tape shown here was not firmly bonded to the house wrap.

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### Climate

The chief climate factor is exposure to rainfall. Buildings in regions with more rainfall are subject to increased incidence of water damage.

Drainable wall assemblies are recommended in all exposure regions. Rain-screen wall systems are considered best-practice upgrades in all exposure regions to ensure the long-term durability of building assemblies, but are especially recommended in High and Extreme exposure regions, as shown on the map below ([BSC 2004](#)).





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### Training

#### Right and Wrong Images



#### Presentations

[Flashing at the Bottom of Brick-Veneer Walls](#)  (2 MB)

**Author(s):** Steve Easley & Associates

**Organization(s):** Steve Easley & Associates

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[Flashing at the Bottom of Stucco Walls](#)  (7 MB)

**Author(s):** Steve Easley & Associates

**Organization(s):** Steve Easley & Associates

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[Water-Managed Adhered Concrete Masonry](#)  (3 MB)

**Author(s):** Steve Easley & Associates

**Organization(s):** Steve Easley & Associates

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#### Videos



[Building Enclosure: Exterior Wall Overview](#) (68 MB)

**Courtesy Of:** [NAHB Research Center](#)

**Author(s):** NAHB Research Center

**Organization(s):** NAHB Research Center

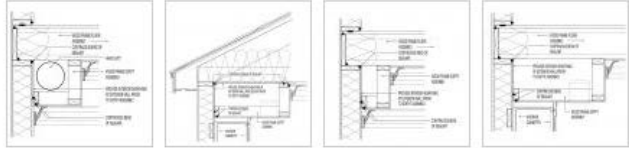
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### CAD Images



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### Compliance

The Compliance tab contains both program and code information. Code language is excerpted and summarized below. For exact code language, refer to the applicable code, which may require purchase from the publisher. While we continually update our database, links may have changed since posting. Please contact our [webmaster](#)  if you find broken links.

#### [ENERGY STAR Certified Homes](#)

ENERGY STAR Version 3/3.1 (Rev. 08) National Program Requirements. Exhibit 1. Design the ENERGY STAR reference design home to meet the following infiltration limits:

IECC Climate Zones 1 and 2 - 6 air changes per hour at 50 Pascals (ACH50)

CZ 3 and 4 - 5 ACH50

CZ 5, 6, and 7 - 4 ACH50

CZ 8 - 3 ACH50

Rater Field Checklist, Thermal Enclosure System:

2. Fully-Aligned Air Barriers.<sup>5</sup> 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)<sup>6</sup>

2.1 Dropped ceilings/soffits below unconditioned attics, and all other ceilings.

Footnotes:

(5) For purposes of this Checklist, an air barrier is defined as any durable solid material that blocks air flow between conditioned space and unconditioned space, including necessary sealing to block excessive air flow at edges and seams and adequate support to resist positive and negative pressures without displacement or damage. EPA recommends, but does not require, rigid air barriers. Open-cell or closed-cell foam shall have a finished thickness  $\geq 5.5$  in. or 1.5 in., respectively, to qualify as an air barrier unless the manufacturer indicates otherwise. If flexible air barriers such as house wrap are used, they shall be fully sealed at all seams and edges and supported using fasteners with caps or heads  $\geq 1$  in. diameter unless

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This Retrofit tab provides information that helps installers apply this "new home" guide to improvement projects for existing homes. This tab is organized with headings that mirror the new home tabs, such as "Scope," "Description," "Success," etc. If there is no retrofit-specific information for a section, that heading is not included.

### SCOPE

Retrofit an existing house with a new water control membrane drainage plane behind the existing cladding.

- Remove all existing cladding (siding).
- Remove any existing building paper or house wrap.
- Assess the condition of the exterior sheathing and replace it if necessary.
- If windows and doors are not properly flashed, remove and reinstall them to properly integrate them with the new water control membrane and drainage plane.
- Follow the steps in the [Scope](#) and [Description](#) tab for new construction to install a drainage plane layer.

For more information on conditions that may be encountered when working with walls in existing homes, see the assessment guide on walls, windows, and doors.

See the U.S. Department of Energy's [Standard Work Specifications](#) for more on sealing walls to keep out moisture, air, and pests. Follow safe work practices as described in the [Standard Work Specifications](#).

### DESCRIPTION

Retrofitting an existing house with a new drainage plane and water control membrane is an invasive and costly project that involves removing the exterior cladding in its entirety. It is undertaken in extreme circumstances such as when a new cladding is desired for aesthetic reasons or because the current siding is in bad condition, and the existing siding cannot be "over-clad" (for structural reasons or setback requirements, for example). In these cases, the weather-resistant barrier is often replaced as part of the cladding replacement. It may also be done if the exterior of the wall has experienced extensive water damage and repair is not possible without increasing drainage and replacing the water control membrane. In the latter case, replacement of the exterior sheathing is also frequently required. Stucco or adhered-stone houses with inadequate drainage have required this type of retrofit.

As described in the [Description](#) tab, the weather-resistant barrier can consist of many types of material, sealed at all seams and edges and supported using fasteners.


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### Case Studies

[Technology Solutions Case Study: Guidance on Taped Insulating Sheathing Drainage Planes](#) 

(612 KB)

 [Belongs to 0 Field Kits](#)

**Author(s):** Building Science Corporation

**Organization(s):** Building Science Corporation

**Publication Date:** November, 2014

Case study by Building Science Corporation on best practices for using rigid foam sheathing as a drainage plane in new and retrofit wall construction.

[Edit](#)

### References and Resources\*

[Brick, Stucco, Housewrap and Building Paper: Research Report 0105](#)

**Author(s):** Lstiburek

**Organization(s):** BSC

**Publication Date:** June, 2008

Research study discussing how housewraps restrict or permit the passage of water molecules based on size, but cannot control the direction in which the water vapor molecules move.

[Building America Best Practices Series Volume 11: 40% Whole-House Energy Savings in the Marine Climate](#) 

**Author(s):** Baechler, Gilbride, Hefty, Cole, Williamson, Love

**Organization(s):** PNNL, ORNL

**Publication Date:** September, 2010

Report providing builders in marine climates with guidance for building homes that have whole-house energy savings of 40% over the Building America benchmark with no added overall costs for consumers.



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**BUILDING SCIENCE-TO-SALES TRANSLATOR**

**Continuous/Sealed Weather Resistant Barrier = Wall Water Barrier**




**TECHNICAL DESCRIPTION:**

A water barrier and drainage plane directs water that leaks through the part of a wall exposed to the weather, to safely drain down and away from the wall. The water-resistant surface could be house wrap, rigid foam insulation that is taped or sealed at all seams, or a painted-on coating. House wrap should be lapped shingle style over any exterior wall flashings installed around openings, penetrations, or where the walls intersect roofs, foundations, or other transitions. Any holes through the wall, such as for windows, water spigots, exhaust vent outlets, HVAC condensate lines, or light fixtures and receptacles, should be carefully sealed and flashed.

**Alternate Terms**

- Dry-by-Design Wall Construction
- Wall Water Barrier Technology
- Professionally Installed Wall Water Barrier

**Wall Water Barrier Sales Message** 

Wall water barriers help drain water away from above-grade walls. What this means to you is peace-of-mind knowing your home has a comprehensive set of measures that minimize the risk of water damage in your home. Wouldn't you agree every home should have full water protection?



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- Launched in October, 2017
- 90% populated
- Navigation based on the “Steps” to home performance:

## Step 1 Ensure Safe and Durable

Check adequate outside combustion air or direct power-vent equipment

### Rationale:

Ensure exhaust of combustion gases before making home more airtight. Ensure home can accommodate improvement

## Step 2 Ensure Fresh Air

Provide whole-house ventilation and pressure balancing

### Rationale:

Ensure dilution or exhaust of contaminants before making home more airtight

## Step 3 Ensure Moisture Protection

Provide details draining water from roof, walls, windows, and foundation

### Rationale:

Ensure dry assemblies before reducing drying potential

## Step 4 Ensure Draft-Free

Provide air sealing and air barriers and verify with test

### Rationale:

Capture critical air sealing opportunities that will be lost after insulation in place

## Step 5 Ensure Thermal Comfort

Add insulation in attics, walls, floors, and foundation to 2009 IECC or greater

### Rationale:

Now it's time to insulate at least to the latest code.

## At Replacement Upgrade Components

Replace heating and cooling equipment, water heaters, windows, appliances, lighting, fans and electronics when they fail or become out-of-date with ENERGY STAR qualified products or better, and improve systems to operate more efficiently.

# BASC Existing Homes

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As a community driven tool, we welcome your [comments](#) on how to continuously improve the Solution Center. If you are interested in submitting content, please become a [registered user](#) and see the [criteria for submissions](#).

### Existing Homes Tool

Welcome to the Existing Homes tool. Here you will find installation guidance for making existing homes more energy efficient, comfortable, and less expensive to operate. The tool is designed around common upgrades. Steps are numbered to indicate priorities from a health and safety standpoint. If you are doing a comprehensive renovation you may be interested in all the listed steps. If you are doing a more limited project, such as insulating an attic, reroofing, or replacing a water heater, you may focus on just a few steps.

It is worth visiting the first section no matter what project you have in mind. Nine assessment guides are listed to help gauge whether a home is safe and sound for upgrades plus a guide to help consumers plan a series of upgrades over time. These guides may help ensure that projects (and bids and contracts) cover related upgrades and are completed in the correct sequence.

If you want to learn more about how the guides work, or about other features in the Solution Center that will help with existing homes, [click here](#).



**Step 1: Ensure Safe and Durable**



**Step 2: Ensure Fresh Air**



**Step 3: Ensure Moisture Protection**



**Step 4: Ensure Draft Free**



**Step 5: Ensure Thermal Comfort**



**Anytime: Equipment Upgrades**



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## Pre-Retrofit Assessment of Hazardous Materials

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Remove or remediate hazardous materials that will be affected by the retrofit work or that may impact indoor air quality. The U.S. Environmental Protection Agency (EPA) document, [Healthy Indoor Environment Protocols for Home Energy Upgrades](#), provides guidance on a number of hazardous materials including asbestos, lead, polychlorinated biphenals, and radon (along with other soil gases). It also talks about the role that tobacco smoke and home furnishings play as potential sources of indoor pollutants. The protocols provide additional information on all of the materials described here. Other references are included with each topic.

### Asbestos



Vermiculite insulation between attic joists (image courtesy of [EPA](#)).

Asbestos is a naturally occurring silicate mineral that has historically been used in building materials. Cutting, tearing or abrasion of asbestos materials can release asbestos fibers into the air. If inhaled, the asbestos particles can cause lung cancer and other forms of lung disease. Examples of materials that might contain asbestos include vermiculite insulation in attics and walls, tape used to seal old ducts, insulation on steam pipes and ducts, door gaskets in furnaces, plaster in old houses, vinyl flooring, and wall cladding. To find out more about asbestos, see the [EPA's asbestos website](#).

### Volatile Organic Compounds



Volatile organic compounds (VOCs) include formaldehyde and a variety of other chemicals, some of which may have short- or long-term adverse health effects. VOCs can be found in insulation, cabinetry, carpets, paints, and stains. The U.S. Environmental Protection Agency's [Indoor airPLUS Program](#) recommends choosing no- and low-VOC versions of these types of products for installation in the home. The Building America Solution Center includes guides to help contractors meet the requirements of the EPA's Indoor airPLUS [checklist](#). VOC-containing products such as solvents, cleansers, coatings, and fuels are often stored in the garage. Attached garages should be well sealed from living spaces and possibly ventilated with an exhaust fan as described in these [guides](#). Furnace and air conditioner ducts and air handlers should not be located in garages, which could enable the spread of pollutants throughout the house as described in the guide [No ducts or equipment in garages](#). Flammable solvents and fuels should not be stored in any part of a residential structure. To find out more about VOCs, visit the EPA's [website on indoor air quality and volatile organic compounds](#).


### Soil Gases including Radon

Air sealing to reduce heat loss may also reduce natural air changes in the home that dilute soil gases or indoor air pollutants, leading to increased concentrations of soil gases in the home. Air sealing steps should include air sealing of any cracks in and around the



### CURRENT PROJECT:

-  Home Improvement Guides
-  Step 1: Ensure Safe and Durable
-  **Pre-Retrofit Assessment of Hazardous Materials**

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## Existing Homes Tool

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 Step 1: Ensure Safe and Durable >

 Step 2: Ensure Fresh Air >

 Step 3: Ensure Moisture Protection >

 Step 4: Ensure Draft Free >

 Step 5: Ensure Thermal Comfort >

 Anytime: Equipment Upgrades >

Click

## Step 5: Ensure Thermal Comfort

The following categories provide information about adding insulation in attics, walls, floors, and foundation to 2009 IECC or greater levels. Consult Step 1, Step 2, Step 3 and Step 4 before completing items here.

Click on the links below for detailed information about each topic in this step:



[Insulate Existing Attic or Roof](#)



[Insulate Existing Exterior Walls](#)



[Insulate Existing Foundations](#)



[Insulate Existing Floors over Unconditioned Space](#)



[Upgrade Windows](#)



[Place HVAC Equipment and Ducts in Conditioned Space](#)



[Dehumidification in Hot-Humid Climates](#)



### CURRENT PROJECT:



Home Improvement  
Guides



Step 5: Ensure Thermal  
Comfort

## Step 5: Ensure Thermal Comfort

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[Insulate Existing Exterior Walls](#)



[Insulate Existing Foundations](#)



[Insulate Existing Floors over Unconditioned Space](#)



[Upgrade Windows](#)



[Place HVAC Equipment and Ducts in Conditioned Space](#)



- ☐ Air Sealed, Insulated Basements
- ☐ Ducts in Dropped Ceilings
- ☐ Ducts in Interstitial Floor Framing
- ☐ Ducts in Raised Ceiling Sections
- ☐ No Ducts or Air Handlers Located in Garage
- ☐ Unvented, Insulated Crawlspaces



[Dehumidification in Hot-Humid Climates](#)



### CURRENT PROJECT:



Home Improvement  
Guides



Step 5: Ensure Thermal  
Comfort



## Ducts in Dropped Ceilings

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[Scope](#) [Description](#) [Success](#) [Climate](#) [Training](#) [CAD](#) [Compliance](#) **[Retrofit](#)** [More](#) [Sales](#)

This Retrofit tab provides information that helps installers apply this “new home” guide to improvement projects for existing homes. This tab is organized with headings that mirror the new home tabs, such as “Scope,” “Description,” “Success,” etc. If there is no retrofit-specific information for a section, that heading is not included.

### Additional Scope Language for Retrofit Applications

Bring air distribution system including air handling equipment and duct work into the conditioned space of the house.

- Following the design considerations outlined in the Main Body’s Description Tab, layout a duct system that can be enclosed by constructing or retrofitting soffits to form ducts chases. If needed, relocate air handling equipment into home’s interior or create a sealed closet around any air handling equipment installed in the garage, crawlspace or attic and connect it to the home’s conditioned space.
- Lay out the duct system incorporating the chase work in dropped ceilings, soffits, and architectural features where possible.
- Pre-cut and seal any wall or ceiling penetrations necessary for constructing the chase; seal around any penetrations in the path of the chase. Repair any pre-existing damage in chase path.
- Install sealed and insulated ducts by suspending from the ceiling.
- Enclose the duct work with soffit framing.
- Install drywall, mud, and tape or otherwise finish the soffit exterior.
- For more on [duct sealing and insulating](#), see the U.S. Department of Energy’s Standard Work Specifications. The Specifications also discuss [safe work practices](#).

### Additional Description Language for Retrofit Applications

Attempting to retrofit ducts in a dropped ceiling is a challenging installation involving replacing or moving existing ducts and HVAC equipment out of an unconditioned attic or crawlspace and into the interior of the house. In all but the simplest floorplans this will be a difficult and most often not cost-effective retrofit. Installing a dropped ceiling or fur-down duct system in a retrofit situation is more challenging and less likely to be successful than implementing the system in new construction. The home’s layout is presumably fixed, and the chase system must be made to work with the existing

## CURRENT PROJECT:

-  Home Improvement Guides
-  Step 5: Ensure Thermal Comfort
-  Place HVAC Equipment and Ducts in Conditioned Space
-  **Ducts in Dropped Ceilings**

- Project map tracks existing homes tool clicks.
- User lands either on the scope tab or retrofit tab.

- Links to SWS available on all BASC retrofit guides, embedded in scoping statements
- Take user directly to the associated SWS content
- BASC image gallery integrates photos from SWS Flickr account
- SWS links user to BASC

## Whole House Ventilation Strategies for Existing Homes

[Feedback](#)

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### Scope

### Description

### Success

### Climate

### Training

### CAD

### Compliance

### More

### Scope

To assess and upgrade the ventilation system in an existing home, do the following:

- Preliminary Planning
  - Determine project goals with respect to ventilation.
  - Determine what code or program requirements must be met.
  - Assess existing ventilation systems (including local ventilation for kitchen and bathrooms).
  - Assess existing heating and cooling systems – especially if new ventilation may be integrated with existing HVAC systems.
- Determine the most appropriate type of ventilation.
- Install and commission ventilation system.




This HRV, installed in a con provides balanced ventilati home

For an overview of whole-building ventilation systems, see the Building America Solution Center guide [Whole-Building Delivered Ventilation](#). For information on assessing the performance of existing ventilation systems, see the [Pre-Retrofit Assessment of Ventilation Systems](#).

The U.S. Department of Energy's Standard Work Specifications have additional information on [ventilation systems](#).

Last Updated: 03/06/2018



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Standard Work Specifications Tool

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### Keyword

### Housing Type

- ☐ [Single-Family Homes \(34\)](#)
- ☐ [Manufactured Housing \(28\)](#)
- ☐ [Multifamily Homes \(55\)](#)

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- 2 ☐ [Health & Safety \(12\)](#)
- 3 ☐ [Air Sealing \(8\)](#)
- 4 ☐ [Insulation \(18\)](#)
- 5 ☐ [Heating & Cooling \(17\)](#)
- 6 ☐ [Ventilation \(39\)](#)
- 7 ☐ [Baseload \(5\)](#)

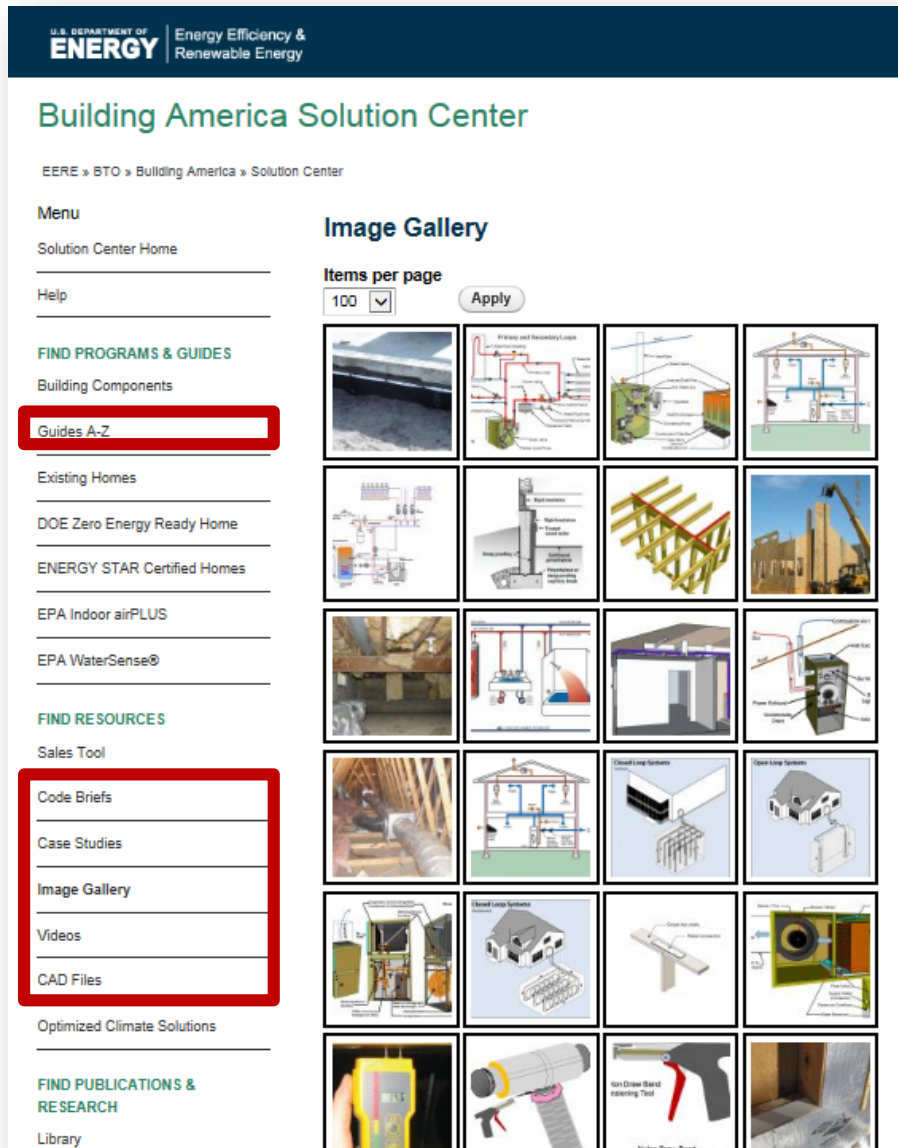
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6.6204.1 [Commissioning Ventilation Systems](#)  
**Topic:** Whole Building Ventilation  
**Subtopic:** System Evaluation  
**Desired Outcome:** Verify proper operation of existing system, installed system air flow meets required standard and provides continuous ventilation for background pollutant sources  
**Available In:** [Single-Family Homes](#), [Manufactured Housing](#)

6.6102.1 [Outside Air Ventilation Supply Ducts](#)  
**Topic:** Supply  
**Subtopic:** Components  
**Desired Outcome:** Ventilation supply ducts effectively move the required amount of air and prevent condensation  
**Available In:** [Single-Family Homes](#)

3.1602.15 [Ventilation Existing Duct Sealing \(All Building Types\)](#)  
**Topic:** Ducts  
**Subtopic:** Duct Sealing  
**Desired Outcome:** Improved effectiveness and efficiency of ventilation distribution



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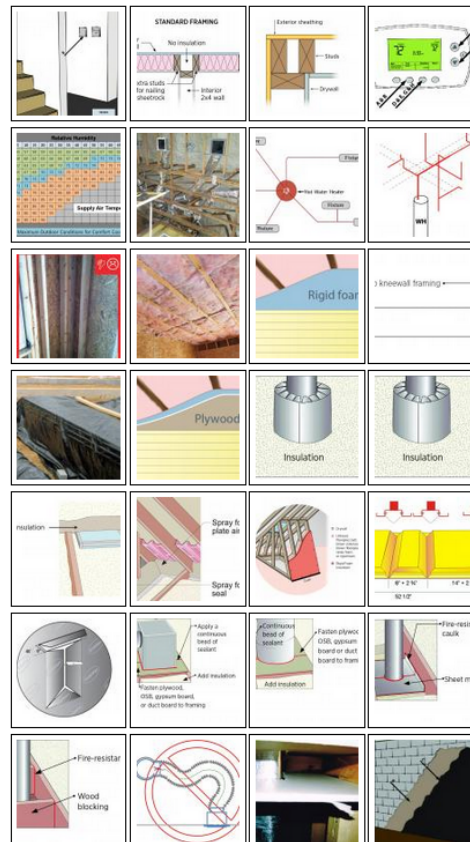
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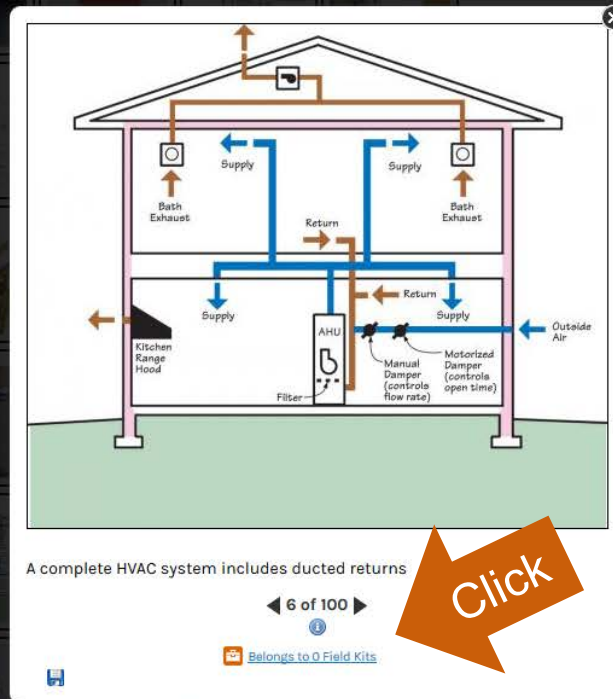
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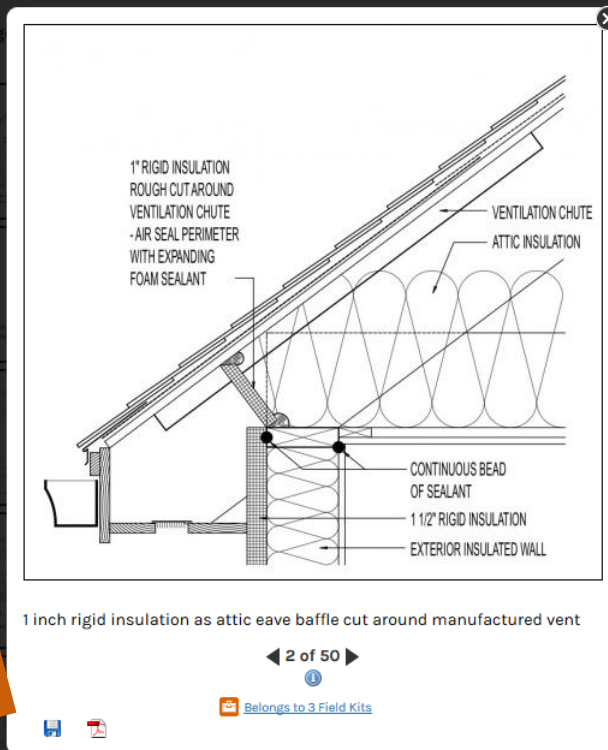
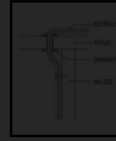
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1 inch rigid insulation as attic eave baffle cut around manufactured vent

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Belongs to 3 Field Kits



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### Program Checklists

The Building America Solution Center supports a suite of U.S. Department of Energy (DOE) and U.S. Environmental Protection Agency (EPA) labeling programs designed to aid construction of comfortable, healthy, durable, and energy efficient homes. Click on the program logos below to find detailed guides to help you install and specify the measures in each program's checklists.

Add guides to your Field Kits, for easy access on the job site! Use the [Mobile Apps](#) to synchronize your field kits to your mobile devices and use them whenever and wherever you need them. Visit our [Help](#) page for detailed information.



Only a select group of the top builders in the country meet the high performance requirements of the DOE's [Zero Energy Ready Home program](#). The Zero Energy Ready label shows that builders have achieved an extraordinary level of excellence. These homes are so efficient that with the installation of a renewable energy system, they offset all or most of their annual energy consumption. [Learn More](#) about the program.



[ENERGY STAR Certified Homes](#) are designed and built to standards well above most other homes on the market today, delivering energy efficiency savings of up to 30 percent when compared to typical new homes. A new home that has earned the ENERGY STAR label has undergone a process of inspections, testing, and verification to meet strict requirements set by the EPA, delivering better quality, better comfort, and better durability. [Learn More](#) about the program.



[Indoor airPLUS](#) helps builders meet the growing consumer preference for homes with improved indoor air quality. Indoor airPLUS builds on the foundation of EPA's ENERGY STAR requirements for new homes and provides additional construction specifications to provide comprehensive indoor air quality protections. [Learn More](#) about the program.



The U.S. Environmental Protection Agency (EPA) [WaterSense® checklist](#) provides links to technical guides that align with measures included in the EPA WaterSense New Home Specification. The numbers and titles of this checklist follow the same order and numbering of those in the EPA WaterSense Labeled New Home Inspection Checklist. [Learn More](#) about the program.

Welcome to our new homepage! The Building America Solution Center provides access to expert information on hundreds of high-performance construction topics, including air sealing and insulation, HVAC components, windows, indoor air quality, and much more. Click on the links below to explore the Solution Center.

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[Spray foam on concrete foundation wall with framed interior wall](#)  
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### Sales Tool

The goal of this Building Science-to-Sales Translator is to provide a new glossary of sales themes that can be used across the industry to consistently reinforce the value of high-performance homes. This includes applying this new language consistently to all consumer-facing materials used by government programs and industry alike. Use the tool below to explore sales themes that relate to each primary area of a high performance home.

Use the tool below to navigate through sales themes. When logged into your BASC account, you can create customized Sales Worksheets. You will see the MY SALES WORKSHEETS block on the upper right of your screen. Click Create Sales Worksheet to make a new customized sales list, or View All Sales Worksheets to see all saved Sales Tools. For in-depth instructions for creating sales worksheets, see [this presentation](#).



[Termite shield with exterior rigid foam above and below](#)  
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BUILDING SCIENCE-TO-SALES TRANSLATOR

High-MERV Filter = High Capture Filter

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MERV 16

TECHNICAL DESCRIPTION:

Furnace filters can clean indoor air by trapping dust, pollen, mold spores, pet dander and other indoor air contaminants. Air filter efficiency is defined in MERVs, or "Minimum Efficiency Reporting Value." A typical 1-inch-thick spun fiberglass furnace filter has a rating of 1 to 4 on the MERV scale and can trap particles like sawdust, carpet fibers, dust mites, and pollen. ENERGY STAR Certified Homes requires filters to be at least MERV 6; these filters can clean the air of most cement dust, mold spores, animal dander, and hair spray. DOE's Zero Energy Ready Home program requires that filters be at least MERV 8; these filters can capture even smaller particles. Even higher MERV levels are available. HEPA filters with MERV ratings from 17 to 20 can filter out particles smaller than 0.3 microns, including viruses. Higher MERV filters restrict airflow and furnace systems need to be designed to handle their physical size and still meet air flow requirements.

Alternate Terms

High-Capture Filter Technology

Alt T

High Capture Filter Sales Message

High-capture filters can remove dangerous particles from the comfort system air stream. What this means to you is your family can breathe better every day knowing your home is equipped to help manage a critical respiratory contaminant. Wouldn't you agree protecting health is too important to ignore in new homes?

This Sales guidance available on both the guide "Sales" tab and in the Sales Tool



- Create Field Kits
- Create Point-of-Sale Fact Sheets and Training Materials
- Access saved and created content from your mobile device

## User account

Create new account

Log in

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### User information

Username \*

Spaces are allowed; punctuation is not allowed except for periods, hyphens, apostrophes, and underscores.

E-mail Address \*

A valid e-mail address. All e-mails from the system will be sent to this address. The e-mail address is not made public.

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- Select a value -



Construction Type \*

New and Existing Homes  
New Homes  
Existing Homes



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All Climate Zones  
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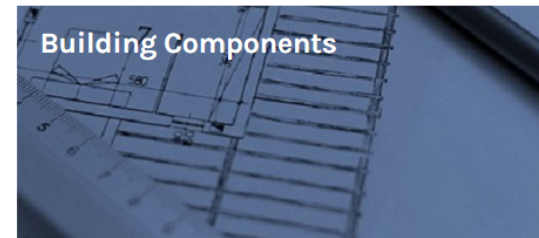
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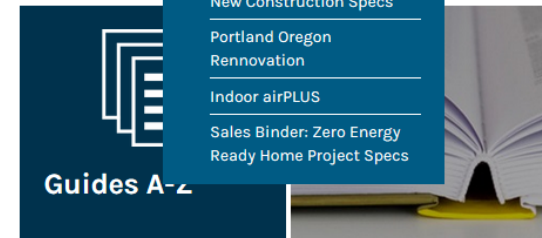
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Welcome to our new homepage! The Building America Solution Center provides access to expert construction topics, including air sealing and insulation, HVAC components, windows, indoor air quality, and more. Explore the links below to explore the Solution Center.



### Building Components



### Guides A-Z

New Field Kit

View All Field Kits

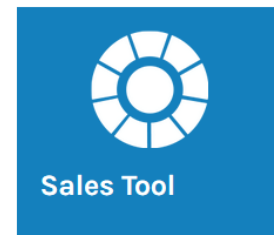
Zero Energy Ready Home  
Project #1

New Construction Specs

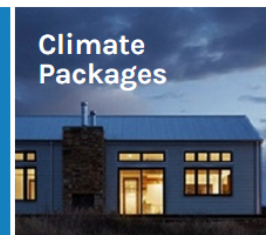
Portland Oregon  
Renovation

Indoor airPLUS

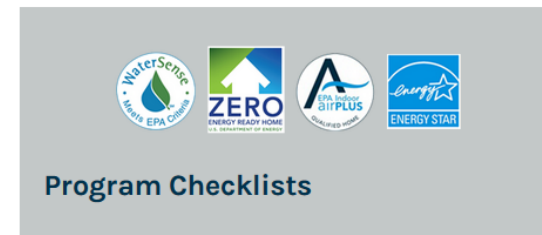
Sales Binder: Zero Energy  
Ready Home Project Specs



### Sales Tool



### Climate Packages



### Program Checklists



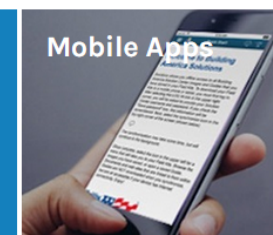
### Existing Homes



### Code Briefs



### Website Widget



### Mobile Apps

[Advanced Framing vs Traditional Framing](#)  
Video Posted: March, 2018

[Condensing HVAC has Corrosion-Resistant Condensate Drain Pan](#)  
Guide Posted: March, 2018



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## Ducted Returns

[Feedback](#)

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[Belongs to O Field Kits](#)

Click

**Scope** Description Success Climate Training CAD Compliance Retrofit More Sales

### Scope

Provide for pressure balancing between bedrooms and the rest of the house.

- Install ducted returns or a combination of ducted returns, transfer grilles, jump ducts, and/or door undercuts in bedrooms to allow pressure balancing between bedrooms and the rest of the house in homes with ducted heating and cooling systems by providing a path for room air to return to the central air handler, thereby increasing the volume of conditioned air circulating in the room.
- Do not use building cavities alone for return air pathways. Return pathways should be ducted from the return grille to the return plenum of the central air handler. The return ducts should be sealed with mastic or metal tape at all seams and joints.
- ENERGY STAR Certified Homes requires that the dedicated return ducts, transfer grilles, jump ducts, and/or door undercuts together achieve a rater-measured pressure differential of  $\leq 3$  Pascals (0.012 inch water column) with respect to the main body of the house when bedroom doors are closed and the air handler is operating on the highest design fan speed. A rater-measured pressure differential of  $\leq 5$  Pascals (0.020 inch water column) is acceptable for rooms with a design airflow  $\geq 150$  cfm.
- Refer to the balancing report provided by the HVAC contractor for the bedroom air flows to size the return ducts. If a balancing report was not provided, the flow of the supply register when the air handler is on high speed may need to be measured using a flow hood, anemometer, or other flow measurement tool.
- Test the pressure differential with the bedroom doors closed.



A ducted central return brings air from central return registers back to the air handler through insulated, air-sealed ducts

See the Compliance Tab for related codes and standards requirements, and criteria to meet national programs such as DOE's Zero Energy Ready Home program, ENERGY STAR Certified Homes, and Indoor airPLUS.

**Last Updated:** 03/13/2018

## San Francisco Zero Energy Ready Home Project #1

### Guides



#### [Cantilevered Floor](#)

Guide describing how to air seal and insulate a cantilevered floor.



#### [Step and Kick-Out Flashing at Roof-Wall Intersections](#)

Guide describing how to install step and kick-out flashing on roofs.



#### [Double Walls](#)

This guide describes air barrier and insulation installation, along with air sealing for double walls - ha design as an architectural feature that provides a more dimensional appearance.



#### [Roof Deck Valleys and Penetrations Sealed](#)

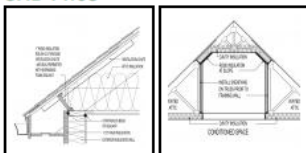
Guide describing how to apply heavy membranes at valley/roof deck penetrations in wet climates to roofing.



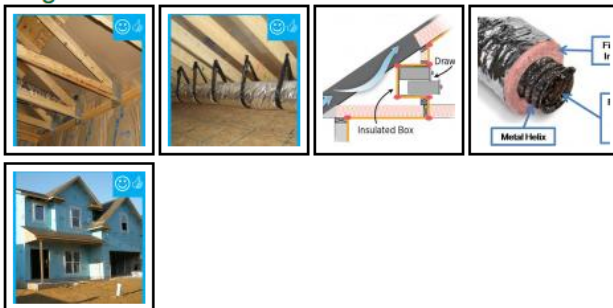
#### [Bathroom Fan Ratings](#)

Guide describing the bathroom exhaust fan ENERGY STAR rating requirements.

### CAD Files



### Images



Create Field Kits to train installation crews. Add any type of BASC content:

- CAD files
- Images
- Guides
- Information Guides
- Videos
- Case Studies
- Sales Messages

# Share Field Kits



demo



## Building

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Message Options

Send Paste

Arial 10 A- A+ [Text Formatting Icons]

Attach File Table Pictures [Insert Icons]

To: [ ]

Cc: [ ]

Bcc: [ ]

Subject: Solution Center Field Kit

I want to share a Building America Solution Center field kit with you. You may view it at: <https://basc.pnnl.gov/fieldkit/2>

Enter your keywords

[Share this Field Kit](#)







Welcome to our new homepage! The Building America Solution Center provides access to expert information on hundreds of high-performance construction topics, including air sealing and insulation, HVAC components, windows, indoor air quality, and much more. Click on the links below to explore the Solution Center.

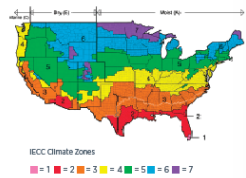
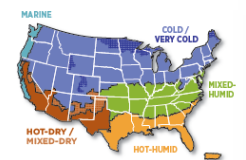
[Help](#)



# BASC Climate Packages

U.S. DEPARTMENT OF  
**ENERGY**

Energy Efficiency &  
Renewable Energy



## Climate Zone Maps

Map of Building America climate regions (top) for program reporting and IECC climate zones (bottom) as a reference for compliance information



BUILDING TECHNOLOGIES OFFICE

## Building America's Optimized Solutions for New Homes

### Cold Climate

2

#### BUILDING AMERICA'S OPTIMIZED SOLUTIONS FOR NEW HOMES: COLD CLIMATE

### DOE's Building America Solution Center

Decades of research in energy efficient design have led to the Building America Solution Center. Builders and contractors are encouraged to use this resource to improve the durability and performance of energy efficiency options listed in Table 1.



The Building America Solution Center provides access to expert information on hundreds of high-performance construction topics, including air sealing and insulation, HVAC components, windows, indoor air quality, and much more.

Users can navigate the Solution Center in one of four ways:

- Building components
- Labeling program checklists
- Alphabetically
- By publications

Registered users can also save customized content in their own field-kits!

Find what you are looking for on the Building America Solution Center website: [basc.energy.gov](http://basc.energy.gov)

Table 1. Optimized Solution: Cold Climate

Measure	Performance	Options
<b>THERMAL ENCLOSURE</b>		
High-R Ceiling	R-49	<ul style="list-style-type: none"> <li>Unvented Attics</li> <li>Spray Foam Underside Roof</li> <li>Spray Foam + Permeable Insulation</li> <li>Exterior Rigid Insulation Over Sheathing</li> <li>SIP Roof</li> <li>Vented Attics</li> <li>Blown-in or Batt Insulation</li> </ul>
High-R Walls	R-20 Cavity and R-10 Continuous	<ul style="list-style-type: none"> <li>Single-Wall Cavity Insulation with Advanced Framing</li> <li>Spray Foam</li> <li>Spray Foam + Permeable Insulation</li> <li>Exterior Rigid Insulation</li> <li>Double-Wall Cavity Insulation</li> <li>SIP Walls</li> <li>Insulated Concrete Walls</li> </ul>
Basement Foundation	R-15 Continuous or R-19 Cavity	<ul style="list-style-type: none"> <li>Exterior Rigid Foundation Insulation</li> <li>Interior Foundation Insulation</li> <li>Rigid Insulation plus Batt</li> <li>Cavity with Batt or Blown-in</li> <li>Shallow Frost-Protected Foundation</li> </ul>
High-R Window	U≤0.27 (R≥3.7) SHGC≤0.46	<ul style="list-style-type: none"> <li>ENERGY STAR® Certified Window</li> <li>Ideally R-5 Window</li> </ul>
Air Tightness	ACH50≤2	<ul style="list-style-type: none"> <li>Air Sealing</li> <li>Air Barriers</li> </ul>
<b>HVAC SYSTEM</b>		
Heating Equipment	94% AFUE (Gas), or 10 HSPF (Electric)	<ul style="list-style-type: none"> <li>Direct Vent Gas Furnace</li> <li>Air-Source Heat Pump</li> <li>Geothermal Heat Pump</li> <li>Ductless Mini-Split Heat Pump</li> </ul>
Cooling Equipment	13 SEER	<ul style="list-style-type: none"> <li>Air-Source Heat Pump/Air Conditioner</li> <li>Geothermal Heat Pump</li> <li>Ductless Mini-Split Heat Pump</li> </ul>
Duct Location	Conditioned Space	<ul style="list-style-type: none"> <li>Raised Ceiling</li> <li>Dropped Ceiling</li> <li>Buried and Encapsulated Ducts</li> </ul>
Whole-House Ventilation	ASHRAE 62.2 5 cfm/W and 70% Heat Recovery	<ul style="list-style-type: none"> <li>Exhaust-Only Ventilation</li> <li>Supply-Only Ventilation</li> <li>Balanced Ventilation</li> </ul>
<b>ENERGY EFFICIENT COMPONENTS</b>		
Water Heating	EF 0.8	<ul style="list-style-type: none"> <li>Gas Tankless</li> <li>Heat Pump Water Heater</li> <li>Solar</li> </ul>
Lighting	ENERGY STAR	<ul style="list-style-type: none"> <li>Compact Fluorescent Light (CFL)</li> <li>Light-Emitting Diode (LED)</li> </ul>
Appliances	ENERGY STAR	
Exhaust Fans	ENERGY STAR	<ul style="list-style-type: none"> <li>Individual Room</li> <li>Central Exhaust</li> </ul>
Ceiling Fans	ENERGY STAR	

Abbreviations: Solar Heat Gain Coefficient (SHGC), Annual Fuel Utilization Efficiency (AFUE), Heating Seasonal Performance Factor (HSPF), Air Changes Per Hour (ACH), Seasonal Energy Efficiency Ratio (SEER), and Energy Factor (EF).

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## Building America Solution Center

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Welcome to our new homepage! The Building America Solution Center provides access to expert information on hundreds of high-performance construction topics, including air sealing and insulation, HVAC components, windows, indoor air quality, and much more. Click on the links below to explore the Solution Center.

## Building Components

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## Library



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## Climate Packages



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[Website Widget](#)

## Mobile Apps

Help decision makers understand technical requirements and energy savings to meet ZERH certification

[Foundation wall interior rigid insulation with furring strips](#)  
CAD File Posted: November, 2017

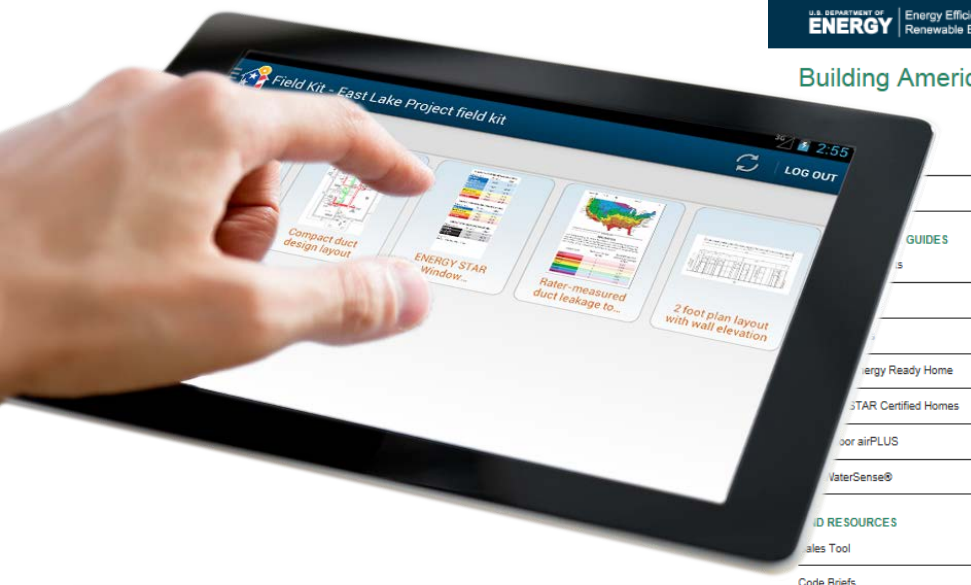


As a community driven tool, we welcome your [comments](#) on how to continuously improve the Solution Center. If you are interested in submitting content, please become a [registered user](#) and see the [criteria for submissions](#).

# BASC Mobile App

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Welcome to our new homepage! The Building America Solution Center provides access to expert information on hundreds of high-performance construction topics, including air sealing and insulation, HVAC components, windows, indoor air quality, and much more. Click on the links below to explore the Solution Center.

### Building Components

Guides A-Z

### Library



Sales Tool

### Climate Packages



Program Checklists

### Existing Homes



Code Briefs



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### Mobile Apps



[Termite shield with exterior rigid foam above and below](#)  
CAD File Posted: November, 2017

### Recently Added Content

[Spray foam on concrete foundation wall with framed interior wall](#)  
CAD File Posted: November, 2017

[Foundation wall interior rigid insulation with furring strips](#)  
CAD File Posted: November, 2017



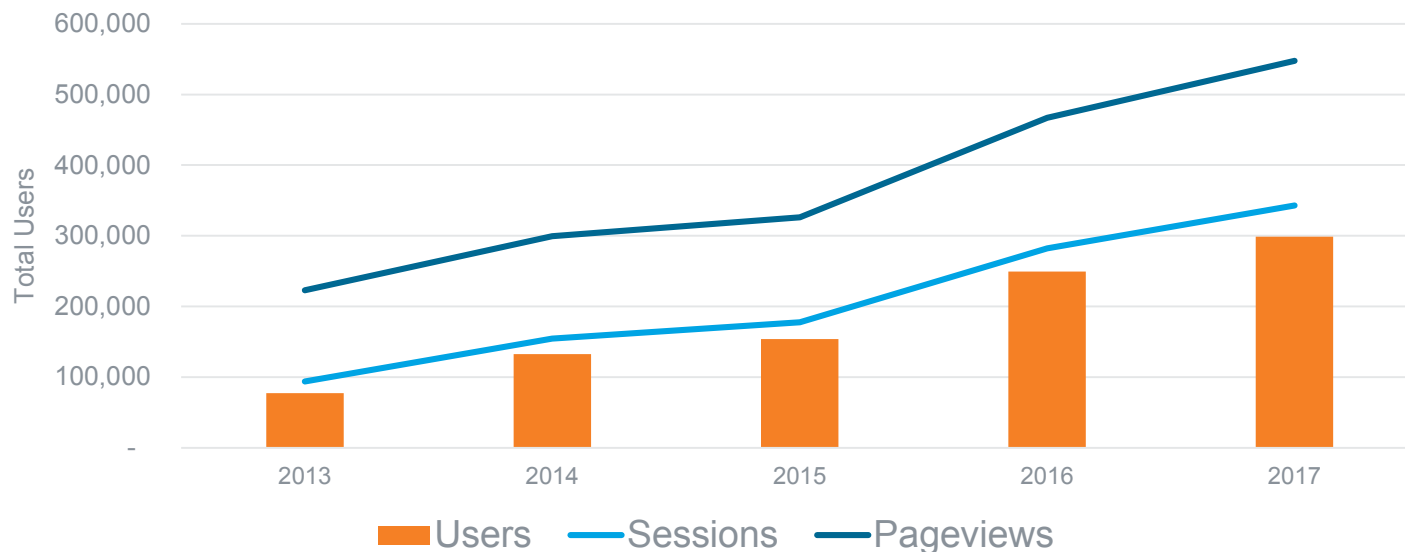
“Solutions” mobile app  
for iOS through the  
Apple store and Android  
via:

<https://basc.energy.gov/solutions>  
Field kits can also be accessed from  
computers



As a community driven tool, we welcome your [comments](#) on how to continuously improve the Solution Center. If you are interested in submitting content, please become a [registered user](#) and see the [criteria for submissions](#).

## Total BASC Users By Calendar Year (2013-2017)



*“The Building America Solution Center is full of best practices. Every guide in there is based on the right way to do things.”*

**C.R. Herro**

V-P of Environmental Affairs, Meritage Homes

*“We built our business on the shoulders of giants, including the Building America Solution Center.”*

**Gene Myers**

CEO, Thrive Home Builders  
(Professional Builder Magazine Builder of the Year)

# Thank you!

Chrissi Antonopoulos

[Chrissi.Antonopoulos@pnnl.gov](mailto:Chrissi.Antonopoulos@pnnl.gov)



# Guidelines for Home Energy Professionals: *Standard Work Specifications*

---

David LoVullo, Engineer

June 25, 2018



# Contents:

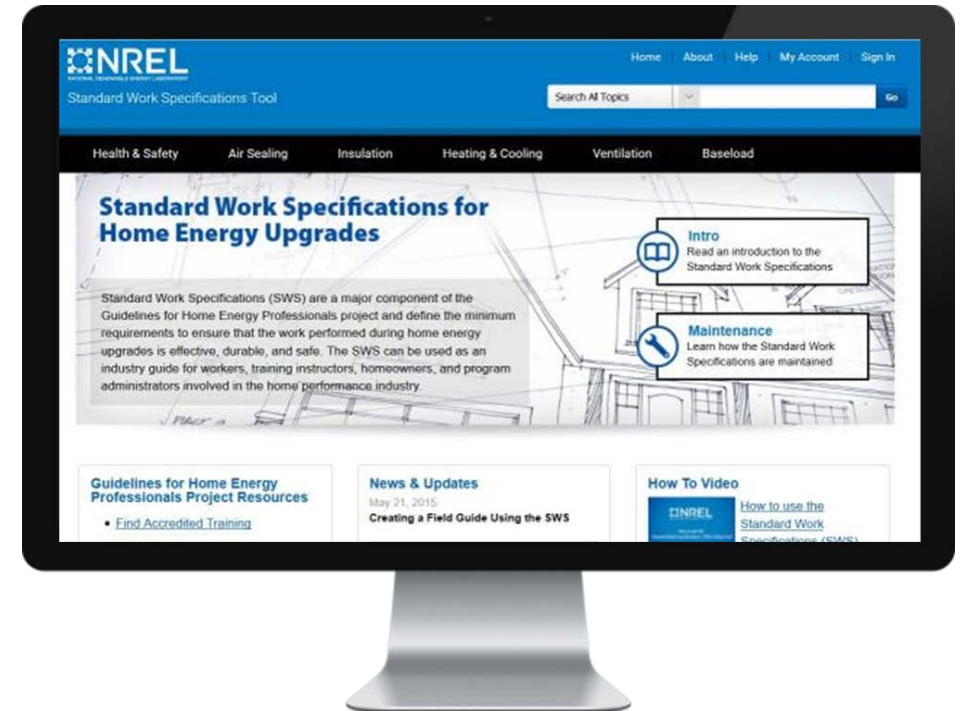
**1 Guidelines for Home Energy Professionals**

**2 Standard Work Specifications**

**3 Building America as a Resource**

**4 Field Guide Template**

**5 How the SWS are used in the field**



A man in a blue shirt is using a yellow and black thermal imaging camera. He is wearing a watch and a ring. In the background, another man is looking on. The setting appears to be a workshop or garage with various tools and equipment visible.

# Guidelines for Home Energy Professionals Project



# Home Performance Industry Collaboration

Guidelines for Home Energy Professional (GHEP) Project was developed in 2011 for whole-house Retrofits.

It has three basic pillars:

1. Standard Work Specifications (SWS)
  - Define quality work
  - Used for training, developing certifications and educating homeowners
2. Home Energy Professionals Certification
  - Competency based certifications that ensure skilled workers
  - Job Task Analysis (JTA) for four distinct occupations
3. Accredited Training
  - Interstate Renewable Energy Council (IREC) selected as an independent third-party to ensure proper training to competencies identified in the JTAs

## Goal:

Collaborate with industry to develop tools needed for a high-quality residential energy upgrade industry, supported by accredited training programs, and a skilled and credentialed workforce.

# Quality Work Plan

In 2015, the Weatherization Assistance Program (WAP) implemented the Quality Work Plan:

1. Standard Work Specifications (SWS)
  - Each grantee must have a field guide based on the SWS
2. Home Energy Professionals Certifications
  - Quality Control Inspector
    - Starting in 2015, every home weatherized must be inspected by a certified Quality Control Inspector
3. Accredited Training
  - All WAP workers must receive training aligned with the JTA from IREC-accredited training center



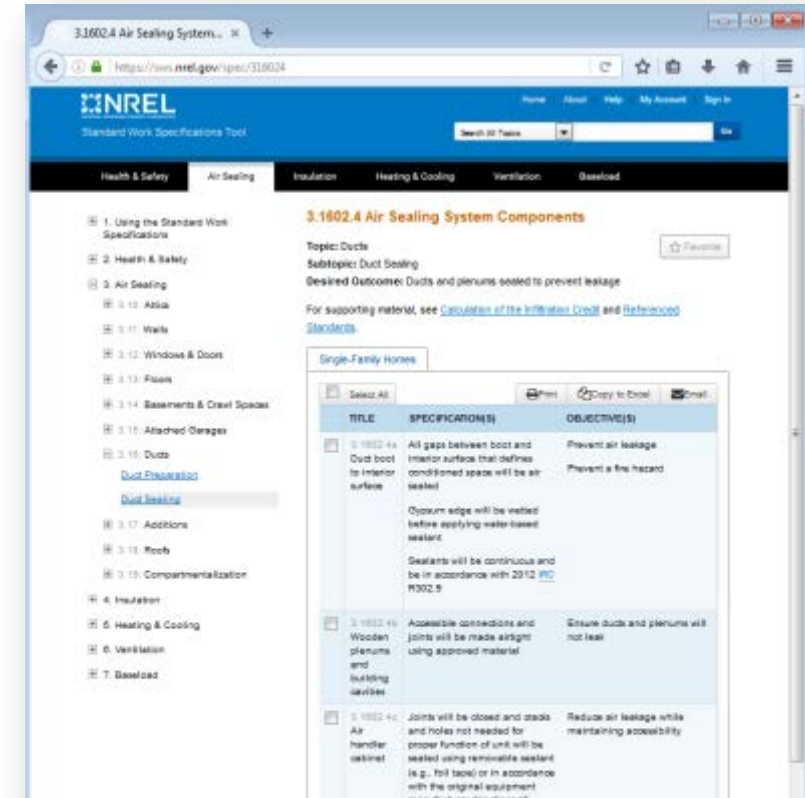
# Standard Work Specifications



# What are the Standard Work Specifications?

- The SWS is a **FREE** online tool that defines minimum outcomes:
  - ✓ Hundreds of home performance tasks
  - ✓ Simple written descriptions
  - ✓ Clearly defined outcomes
  - ✓ Organized from general-to-specific
- This document uses a whole-house approach to define weatherization tasks in *single-family*, *multifamily*, and *manufactured* housing.
  - ✓ Reduces variation
  - ✓ Increases consistency
  - ✓ Ensures quality work in all areas

Visit: [sws.nrel.gov](https://sws.nrel.gov)

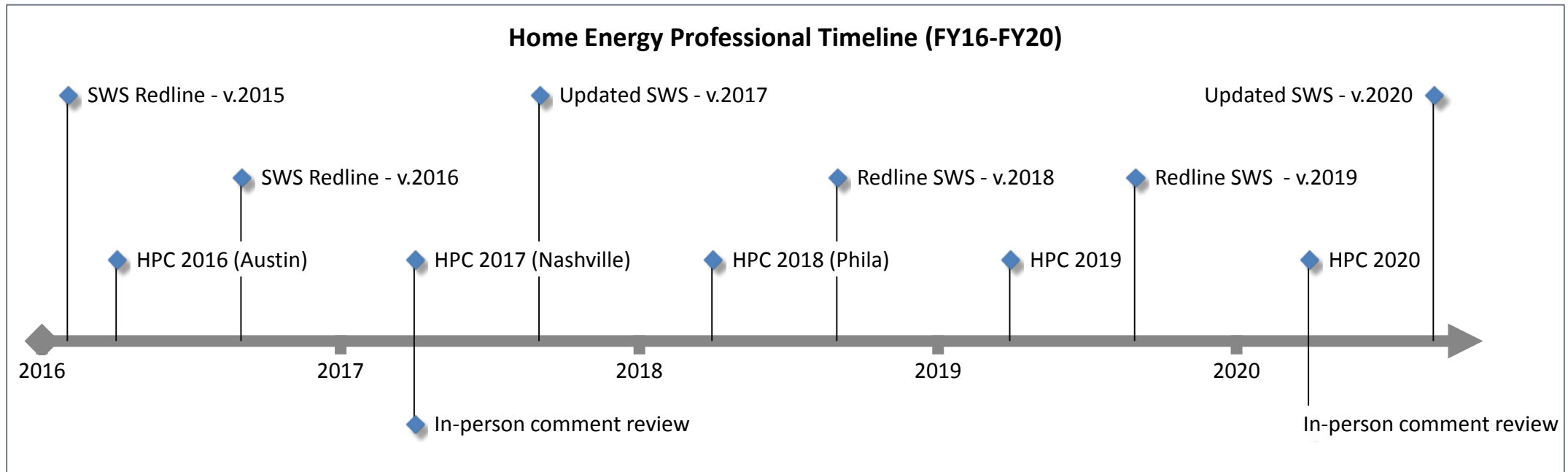


*This is pretty sweet. It's like a social media platform for home energy professionals...I'm excited to use it!*

— Michael Levinson, Group14 engineering

# Development and Maintenance

- Robust consensus process
  - Developed by over 160 Subject Matter Experts (SMEs)
  - Received 2,000 comments from over 300 stakeholders
  - Over 40 SMEs currently active on JTA and SWS technical committees



# The resulting SWS Online Tool

## *Features:*

- ✓ Advanced search
- ✓ Integrated glossary
- ✓ Print details
- ✓ Email details
- ✓ Create lists of Favorites
- ✓ Create QC Checklists
- ✓ Submit comments
- ✓ Links to external resources, such as **BASC**
- ✓ Application programming interface (API)
- ✓ Create and share **Field Guides**



## *Possible Users:*

### **Training Program Instructor**

- Needs to find specific details to copy and paste into a lesson



### **Energy Auditor**

- Needs to create a list of retrievable specifications that she can reference on the job



### **Quality Control/Building Inspector**

- Needs to cite and link to SWS details when writing a home inspection



### **WAP Program Manager**

- Needs to quickly refer to the SWS to confirm how the work should be done and send specifications via email



# Benefits to Programs

- The Standard Work Specifications immediate benefits includes:
  - ✓ Consistency
  - ✓ Existing free resource
  - ✓ Covers wide array of measures
  - ✓ Use only what you need
  - ✓ Improves quality
  - ✓ Great training aid
  - ✓ Reduces liability

*“We do 4,000 jobs a year in Arizona and the work we are seeing now is **nearly flawless**. The only issues we ever see are contractors who have been doing this work for years and who assume they are doing it correctly...until they start failing inspections. **Then we put these tools in their hands, and they don't fail inspections anymore**”*

— Chris Baker, Arizona Public Service  
On implementing the SWS in Arizona's Home Performance with Energy Star Program



# Collaboration with Building America



# Supporting Material

- SWS provides link to external resources where applicable
- Recent links to the Building America Solution Center (BASC) were identified throughout the SWS and added
- More that +100 identified connections were added that link directly to relevant pages and guides on the BASC website
- Additional BASC links are still being added to the SWS to strengthen both resources





# Building America as a Resource

## 4.1005.1 Accessible Floors—Batt Installation

**Topic:** Attics

**Subtopic:** Attic Floors

For supporting material, see [Building America Solution Center](#).

**Desired Outcome:** Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow

### Single-Family Homes

<input type="checkbox"/> Select All <input type="button" value="Print"/> <input type="button" value="Copy to Excel"/> <input type="button" value="Email"/>			
	TITLE	SPECIFICATION(S)	OBJECTIVE(S)
<input type="checkbox"/>	4.1005.1a Preparation	Subfloor or drywall will be removed to access cavities as necessary, including inaccessible knee-wall attic floor spaces  All electrical junctions will be flagged to be seen above the level of the insulation  Open electrical junction boxes will have covers installed	Access the workspace  Provide location of electrical junctions for future servicing  Prevent an electrical hazard
<input type="checkbox"/>	4.1005.1b Installation	Batt insulation will be installed in accordance with manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions  Insulation will be installed to the	Insulate to prescribed R-value

## Building America Solution Center

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### Batt Insulation for Existing Vented Attics

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[Scope](#) [Description](#) [Success](#) [Climate](#) [Training](#) [CAD](#)  
[Compliance](#) [More](#) [Sales](#)

#### Scope

Insulate a vented attic in an existing home by installing batt insulation on the ceiling plane of the attic, as follows:

- Before any retrofit work is done, inspect the roof and attic; repair any leaks, remove active knob and tube wiring, and remediate any hazardous materials.
- If existing bath fans vent into the attic, they must be vented to the outside.
- Remove any existing insulation, debris and dust, and prepare the attic floor for air sealing and fibrous batt insulation.
- Seal all attic floor penetrations with sealant, one-part spray foam, or rigid blocking material as needed.
- Verify that proper ventilation of the attic is provided with

**MOBILE FIELD KIT**

The Building America Field Kit allows you to save items to your profile for review or use on-site.

[Sign Up](#) or [Log In](#)

The diagram illustrates the installation of batt insulation in a vented attic. The top part shows a cross-section of the roof with labels: Existing roof shingles, Existing roof underlayment, Existing roof sheathing, Existing roof framing, and Continuous air gap extending from soffit vent to ridge vent or other means of providing ventilation. The bottom part shows a cross-section of the attic floor with labels: Batt insulation, Top of existing ceiling framing, and Existing ceiling. A legend indicates that gray tone indicates existing components. A vertical dimension line on the right indicates the 'Minimum total installed R-value per climate zone'.

A person wearing a white full-body protective suit, a respirator mask, and a headlamp is working in a confined space. They are holding a large, flexible, corrugated hose. The environment is dimly lit, with wooden structural beams visible. A cloud of dust or debris is being stirred up near the person's feet. The text "SWS Field Guides" is overlaid on the left side of the image.

# SWS Field Guides

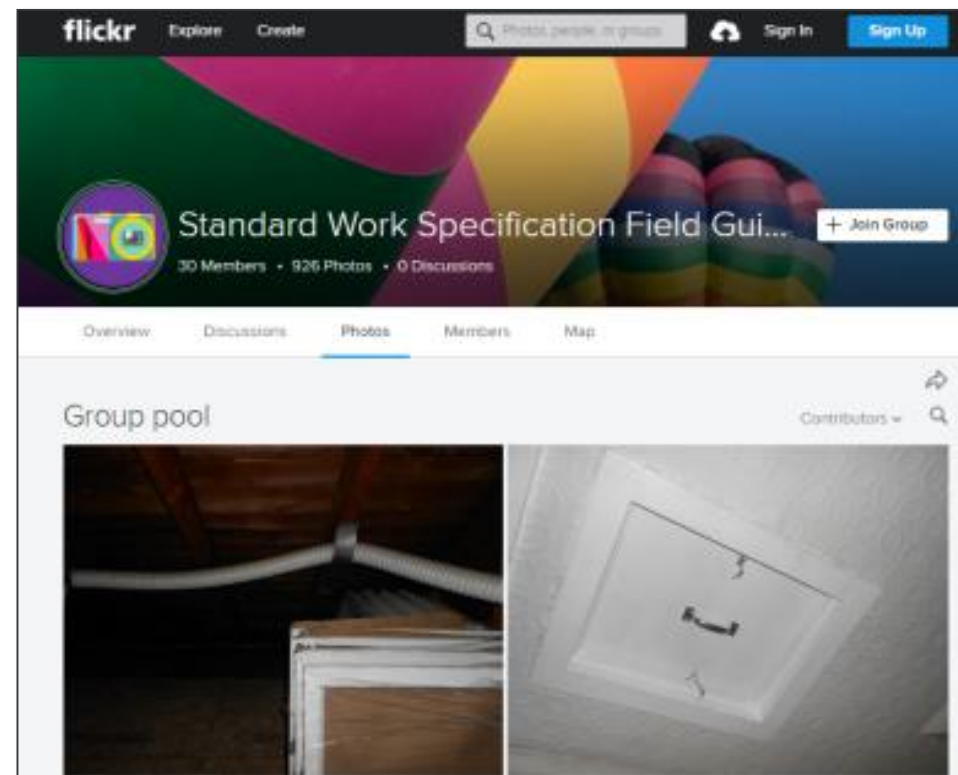
# State Field Guides and the SWS

- The SWS tool has the ability to quickly and simply allow users to create **field guides** from existing specifications



1. Select relevant **specifications**
2. Add necessary details such as **tools**, **materials**, **notes**, and **step-by-step** instruction
3. Select relevant **photos** from over 900+ public photos on the SWS Field Guide Flickr account
4. **Publish!**

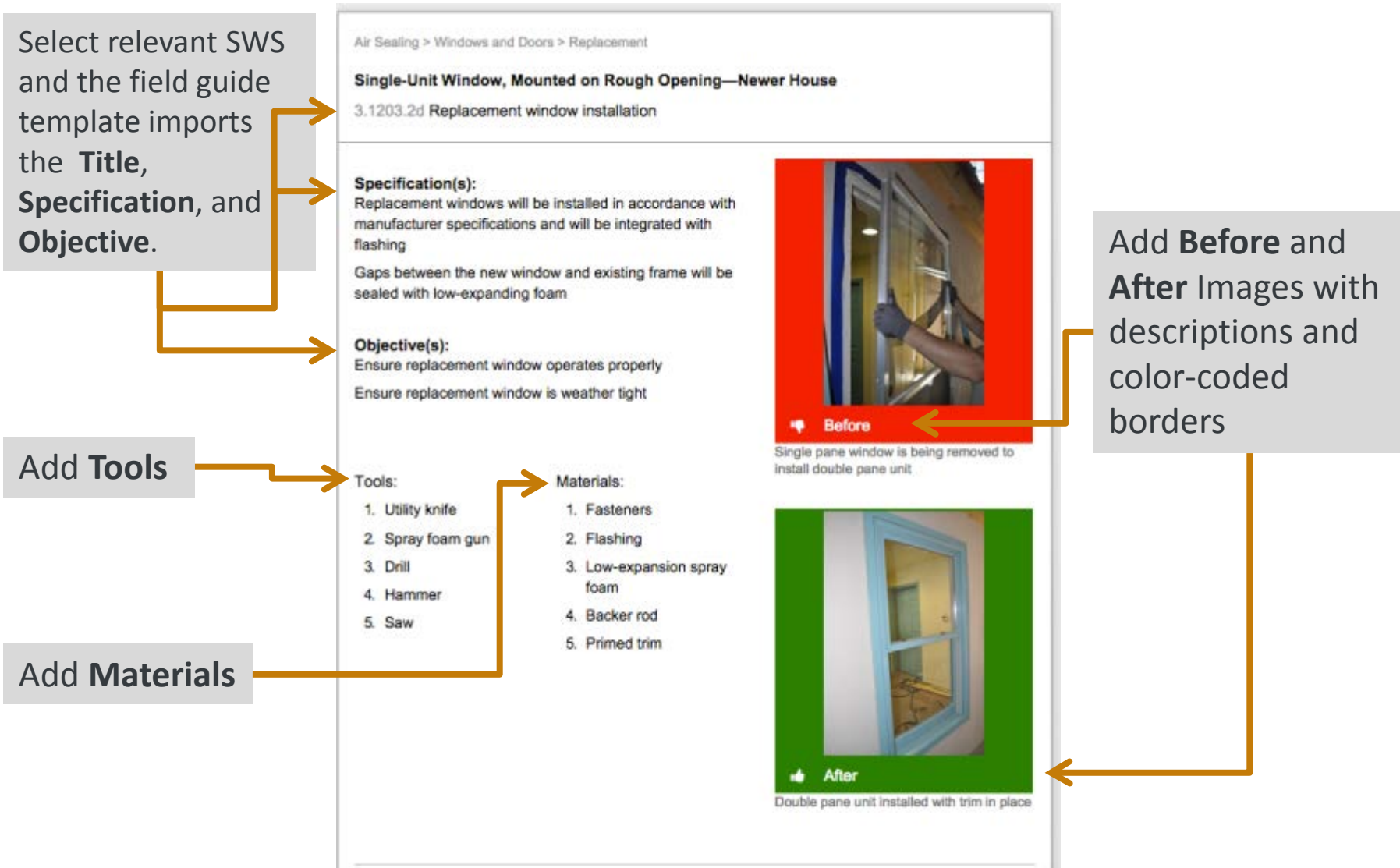
A **Field Guide** is a jobsite manual that provides instructions to the crew with step-by-step, illustrated guidance on proper installation of common measures



[https://www.flickr.com/groups/sws\\_field\\_guide/](https://www.flickr.com/groups/sws_field_guide/)



# Built-in Field Guide Template



# Add Photos from SWS Flickr Account

### How To Add a Photo

Photos are sourced from [Flickr.com](#) using the photo ID number in the photo's URL.

For example, to add the Flickr photo at <http://www.flickr.com/photos/standardworkspecs/11953292144>, copy the number **11953292144** into the form field.

The [Standard Work Specifications Flickr Group](#) is a good place to start searching.

You may upload your steps in any order then drag them into the proper place using the handles that appear to the left of each uploaded image.


**STEPS**

**Add a Step**

[http://www.flickr.com/photos/\[username\]/](http://www.flickr.com/photos/[username]/)

**Upload**

Photos must be publicly searchable and the owner must have granted permission for them to be downloaded.  
Files must be less than **2 MB**.



1. Find photo


2. Upload

3. Add caption

4. Add to guide

**STEPS**

**FILE INFORMATION**



**14293731472\_717d332cd27\_o.jpg (5.32 MB)**

**Alternate text**

This text will be used by screen readers, search engines, or when the image cannot be loaded.

**Caption**

Remaining: 111


Provide a caption up to 120 characters.


**Remove**


Air Sealing > Windows and Doors > Replacement


**Single-Unit Window, Mounted on Rough Opening—Newer House**


3.1203.2d Replacement window installation


  
Install flashing to manufacturer specs and industry standards


  
Flanges have been folded out to allow for easy installation


  
Fasten window flange securely around exterior of entire window

  
With window secured in place, check for proper function

  
Check that sash locks align properly, indicating window is plumb

  
Fill interior gap with compressible foam or appropriate sealant

  
Prime and replace interior trim and, if needed, sill

  
Replace exterior trim and patch exterior siding or finish as needed

NREL | 17



How is the SWS Being Used



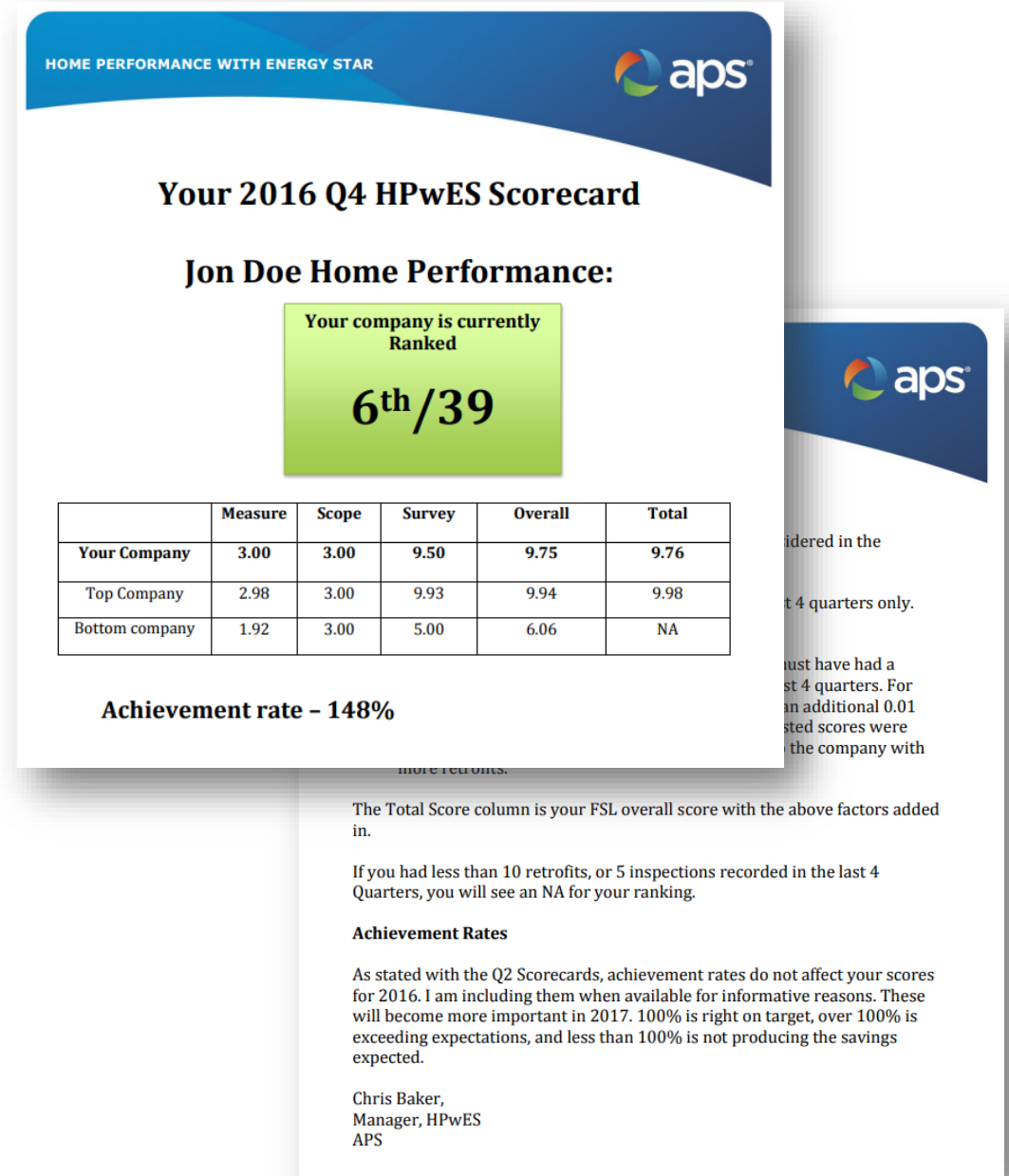
# Quality Assurance

- Communicate quality expectations from installers to Quality Control Inspectors
  - Pictures are less subject to interpretation and removes subjectivity
  - Completed work either passes or fails
- Set standards across states, counties, cities



# Performance Assessment For Contractors

- Contractor scorecards based on the SWS measure and rank contractors
  - 0 to 10 scores
  - Measured work against SWS
  - Contractors receive scorecards and feedback
  - Contractors know their rank
- Utilities residential programs can use to incentivize performance
  - E.g., smart thermostat program offered to top-10 ranking contractors





# Training

- Train *new* workers to the home performance industry
- Train *existing* workers for different job tasks
- Develop training materials and curriculum
  - IREC
  - WAPTAC
  - Arizona Public Service



# Thanks

---

**[www.sws.nrel.gov](http://www.sws.nrel.gov)**

**[David.lovullo@nrel.gov](mailto:David.lovullo@nrel.gov)**

**[Workforce.guidelines@nrel.gov](mailto:Workforce.guidelines@nrel.gov)**

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.



## Question?

Select the 'questions' pane on your screen  
and type in your question.



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<http://energy.gov/eere/buildings/subscribe-building-america-updates>



# Thank You!

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