



Building Science Require A Better Workforce

SAM RASHKIN
Chief Architect
Building Technologies Office

Supply System:

Workforce
Competent
in Building
Science

Product on Shelf:

Better
Buildings

- > Comfort
- > Health
- > Safety
- > Durability

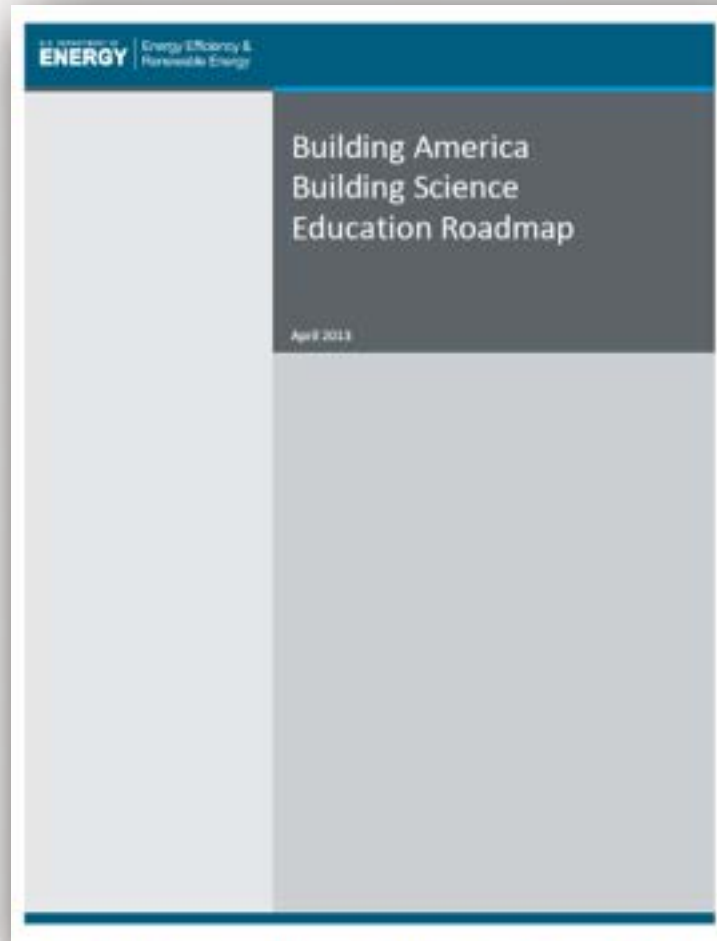
Market Demand:

Consumers
and
Transaction
Process
That Value
Better
Buildings

Building Science Big Prize:

- **\$100's B** Savings
- **Millions** MMTcE
- **100,000's** of Jobs
- **National Security**

Building America Building Science Education Summit



Framework for
Consistent Competency

DOE Guidelines for
Building Science
Education

Full Integration with
Degree Programs

DOE '**Race to Zero**'
Student Design
Competition

Value Understood
in the Market

Building Science
Translator

Workforce Classifications

1 High-School Ed.	2 Builder/ Remodel Pros	3 Program/ Project Manager	4 Transact. Process Pros	5 Design/ Construc. Pros	6 Building Science Pros	7 Home Energy Pros	8 Building Dept.
Physics	Builder	Utility	Realtor	A/E Degree	Forensics	Auditors	Code Offic.
	GC/Forem.	Energy Eff.	Appraiser	Lic. Arch.	QA Envel.	Perf Assess	
	Remodeler	Maint. Pro	Home Insp	Mech. Eng.	QA M&E		
	Insulator	Facil. Man.	Insurers	Civil/Struc.			
	HVAC		Lenders	Mat. Sci.			
	Plumber			Designers			
	Home Perf.			Landscape			
				Const. Man			

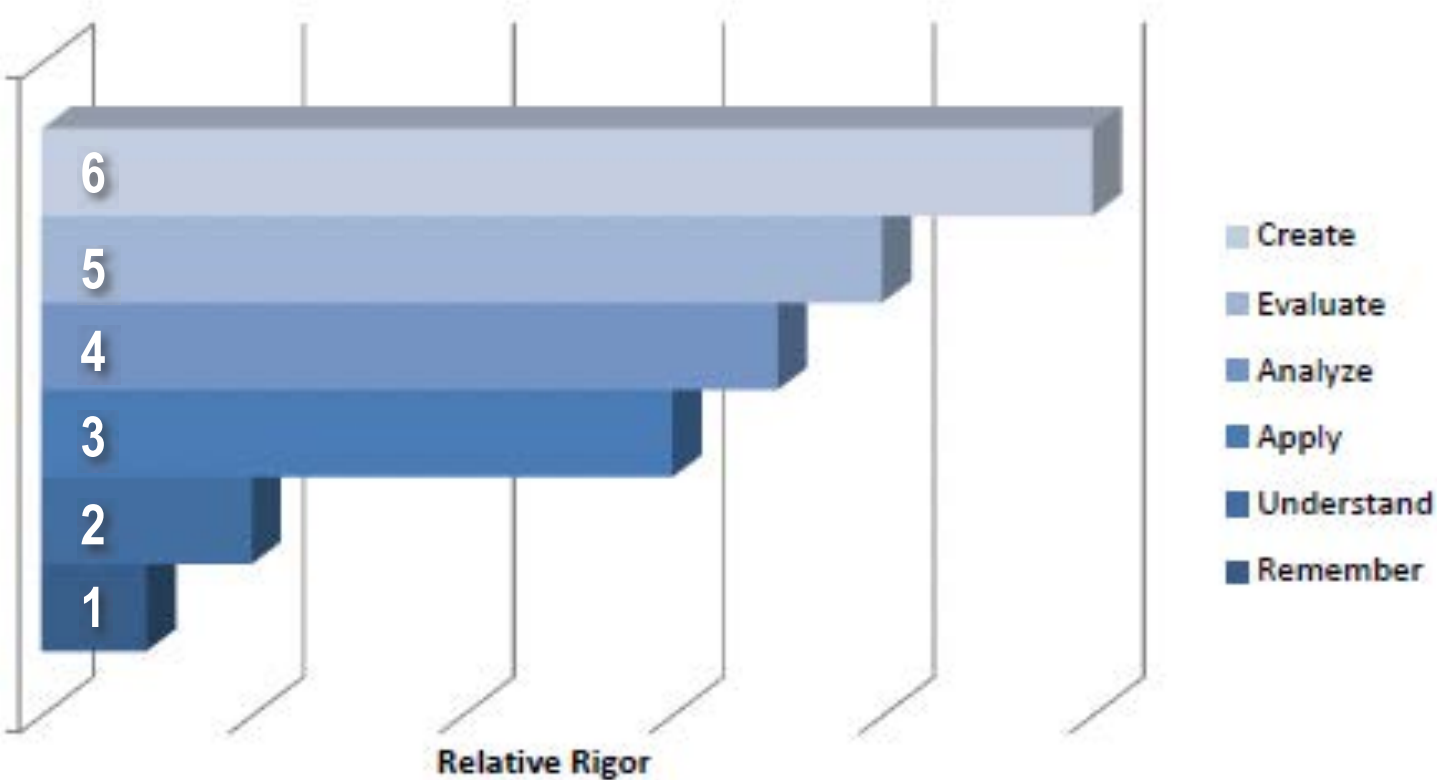
Building Science Skills

1 Integration of Whole-Bldg. Sys.	2 Building Science Principles	3 Operations & Maintenance	4 Building Testing
1.1 Performance	2.1 Heat Transfer	3.1 User Interface/Cont.	4.1 Commissioning
1.2 Life-Cycle Cost Eff.	2.2 Material Selection	3.2 Preventative Maint.	4.2 Diag. & Forensics
1.3 Disaster Resistance	2.3 Moisture Transport	3.3 Replacement/Renov.	4.3 Perf. Mon./Assess.
1.4 Int. Design & Const.	2.4 Control Layers		4.4 Ntl. Codes & Stds
1.5 Quality Management	2.5 Convective Transprt.		4.5 Cert. Programs
1.6 Bldg/Energy Model'g	2.6 Hygrothermal Anal.		
1.7 Cost Trade-Off Anal.	2.7 HVAC Systems		
	2.8 HVAC Inter. w/Struc.		
	2.9 Fenestration		
	2.10 Plumbing Systems		
	2.11 Electrical Systems		
	2.12 Lgting & Appliances		
	2.13 Indoor Air Quality		
	2.14 Control/Automation		

**Building
Science
Proficiency
Based on
Blooms
Taxonomy**

6	Create (Design)
5	Evaluate (Synthesis)
4	Analyze (Analysis)
3	Apply (Application)
2	Understand (Comprehension)
1	Remember (Knowledge)

Consistent Framework – Proficiency Level Relative Rigor



Consistent Framework - Building Science Education Matrix

Mechanical Engineer Guideline

Work in Progress

Building Science Education Matrix v10
 WORKFORCE CLASSIFICATION

Workforce Classifications

Skills

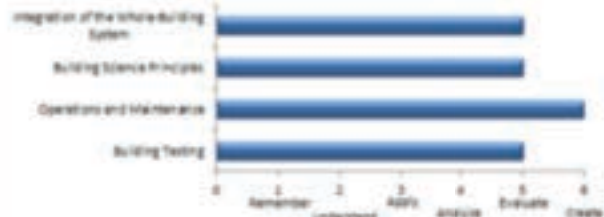
Proficiency Levels:	WORKFORCE CLASSIFICATION																														
	1. High School	2. Bachelor's	3. Master's	4. Professional	5. Post-Professional	6. Post-Professional	7. Post-Professional	8. Post-Professional	9. Post-Professional	10. Post-Professional																					
1. Integration of the Whole-Building System																															
a. Performance: Energy, Water, Comfort, IAQ	1	2	5	2	5	5	4	4	3	5	3	3	3	5	2	3	6	6	5	6	6	4	6	6	5	4	4	5	3		
b. Life Cycle Cost	2	5	5	2	4	4	4	4	2	5	3	5	1	4	3	3	4	6	6	5	6	6	4	6	6	1	1	1	5	2	
c. Occupant Health	2	2	4	2	4	2	3	4	3	4	3	3	2	3	4	4	3	6	6	5	6	6	4	5	6	3	3	5	4	3	
d. Occupant Productivity	2	2	5	2	3	4	3	4	2	4	2	3	2	2	3	2	1	5	5	4	3	3	3	5	5	4	4	2	5	3	
e. Ventilation	2	2	6	2	6	6	5	4	3	2	4	2	2	2	4	2	2	5	4	3	5	4	6	5	4	4	2	5	3		
f. Building Envelope	2	2	3	2	3	4	2	4	3	6	1	3	2	2	3	2	2	6	5	4	3	3	3	4	5	4	4	3	5	2	
g. Cost Estimation	2	2	5	2	4	4	4	5	3	3	2	5	3	4	3	2	2	5	4	4	5	3	5	5	4	4	2	5	2		
2. Building Science																															
a. Moisture Control (Construction)	1	2	3	2	5	4	2	4	3	4	3	2	2	2	4	2	1	5	4	6	3	6	4	2	3	6	4	4	3	5	3
b. Moisture Control (Operations)	1	2	4	2	4	4	2	4	3	4	3	2	2	2	4	2	1	5	5	4	6	5	3	4	6	4	4	3	5	3	
c. Construction Materials (Construction)	1	2	4	2	4	4	3	4	3	5	3	2	2	2	4	2	1	5	5	3	6	5	2	4	6	4	4	3	5	3	
d. Material Selection (Construction)	1	2	3	2	4	2	2	4	3	5	2	2	3	3	4	2	2	5	5	4	3	6	5	1	4	5	4	4	3	5	3
e. Control Systems (Construction, Air, Water, Energy)	1	2	5	2	5	4	2	4	3	5	3	2	2	2	4	2	1	6	4	3	4	6	1	5	6	5	5	1	5	3	
f. HVAC System (Construction)	1	2	3	2	4	2	2	4	1	4	1	1	1	1	2	2	1	6	5	3	3	6	5	1	3	6	4	4	3	5	3
g. HVAC System (Operations)	2	2	3	2	3	6	3	4	4	4	3	2	3	3	4	2	2	6	4	6	3	3	3	3	3	3	3	3	3	4	3
h. HVAC System (Maintenance)	2	2	3	2	3	5	3	4	3	4	3	2	2	2	4	1	1	5	4	2	5	4	1	3	6	3	4	3	5	3	
i. Plumbing System (Construction)	2	2	3	2	3	4	2	4	3	5	3	2	2	3	4	3	2	6	5	5	4	4	5	2	4	6	4	4	3	5	3
j. Plumbing System (Operations)	2	2	3	2	2	3	6	4	3	4	3	2	2	2	4	2	2	6	5	5	3	4	3	2	3	5	4	4	3	4	3
k. Electrical System (Construction)	2	2	2	2	3	2	3	3	3	2	3	2	2	2	4	2	2	5	3	3	4	3	2	3	4	4	3	4	3	4	3
l. Lighting/Controls (Construction, Health, Safety)	2	2	3	2	2	3	3	4	4	4	3	4	3	2	3	2	2	4	5	4	1	2	5	3	2	5	3	3	3	4	3
m. Indoor Environmental Quality (Construction, Health, Safety)	2	2	4	2	4	5	3	4	4	5	3	2	3	2	4	3	2	5	4	6	2	4	4	1	4	5	4	4	3	4	3
n. Construction Management	2	2	3	2	2	5	2	4	3	3	3	4	2	2	2	2	2	5	4	5	1	1	4	1	3	5	3	3	3	4	3
3. Operations and Maintenance																															
a. Moisture Control	3	2	4	2	2	5	2	4	2	3	3	2	3	2	4	3	1	3	4	6	1	1	4	2	5	4	4	4	3	4	2
b. Energy	3	2	3	2	2	4	3	4	2	2	3	2	3	2	3	2	1	4	4	5	2	1	4	3	4	4	4	4	3	4	2
c. HVAC	2	2	4	2	3	5	4	5	3	3	3	4	3	3	4	2	2	5	5	6	4	1	5	3	4	5	4	4	3	4	2
4. Building Technology																															
a. Construction	1	2	4	2	4	5	3	5	3	4	2	2	2	2	3	2	2	6	4	6	3	1	4	1	5	5	5	5	4	5	3
b. Diagnostic & Performance	1	2	3	2	4	5	4	5	3	4	3	2	2	2	4	3	1	5	3	3	1	3	2	4	5	5	5	4	5	2	
c. Performance Measurement	2	2	3	2	4	5	2	5	3	4	3	3	2	3	4	2	1	6	4	3	1	4	1	4	5	5	5	4	5	2	

Consistent Framework – Sample Guideline

Building Science Education Guidelines for Mechanical Engineers

A summary of the proficiency levels¹ for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.

Average Mechanical Engineer Proficiency Levels



As the entity responsible for managing home energy certifiers, a mechanical engineer should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole building system (Average = 5)		
Simultaneous consideration of energy, durability, comfort and IAQ	6	<input type="checkbox"/>
Annualized cash flow	6	<input type="checkbox"/>
Building techniques related to natural and man-made disasters	5	<input type="checkbox"/>
Integrated design and construction		
Quality management	5	<input type="checkbox"/>
Building energy modeling	5	<input type="checkbox"/>
Cost trade-off analysis (optimized first costs)	4	<input type="checkbox"/>

¹ The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

Topic

Proficiency Level

Checkbox

Building science principles related to the enclosure (Average = 5)		
Heat transfer (convection, conduction and radiation)	6	<input type="checkbox"/>
Moisture transport of liquid	5	<input type="checkbox"/>
Convective air transport due to pressure differences	6	<input type="checkbox"/>
Material selection (IAQ, thermal mass, moisture)	4	<input type="checkbox"/>
Controls layers (heat, vapor, water, air and solar gain)	4	<input type="checkbox"/>
Hygrothermal analysis	3	<input type="checkbox"/>
HVAC systems (heating, cooling and ventilation)	6	<input type="checkbox"/>
HVAC interactions with the enclosure	6	<input type="checkbox"/>
Filtration considerations	5	<input type="checkbox"/>
Plumbing systems (heating, distribution, conservation)	5	<input type="checkbox"/>
Electrical systems	3	<input type="checkbox"/>
Lighting appliances and miscellaneous loads	4	<input type="checkbox"/>
Indoor environmental quality (temperature uniformity and indoor pollutants)	6	<input type="checkbox"/>
Control automation systems	5	<input type="checkbox"/>

Operations and maintenance

Average = 6

User controls (ex: thermostat)	6	<input type="checkbox"/>
Preventative maintenance (ex: cleaning air filters)	5	<input type="checkbox"/>
Determination of appropriate replacement choices	6	<input type="checkbox"/>

Building testing and certification

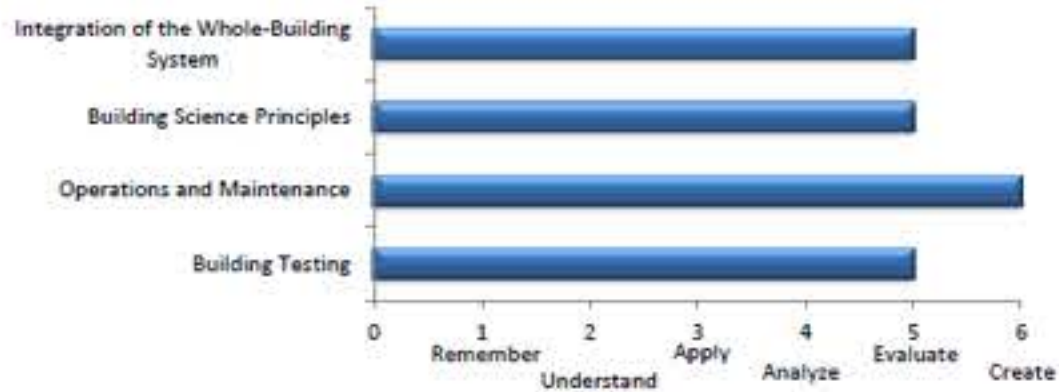
Average = 5

Commissioning	6	<input type="checkbox"/>
Diagnostics and forensics	5	<input type="checkbox"/>
Monitoring	6	<input type="checkbox"/>
National codes and standards	3	<input type="checkbox"/>
Certification programs	3	<input type="checkbox"/>

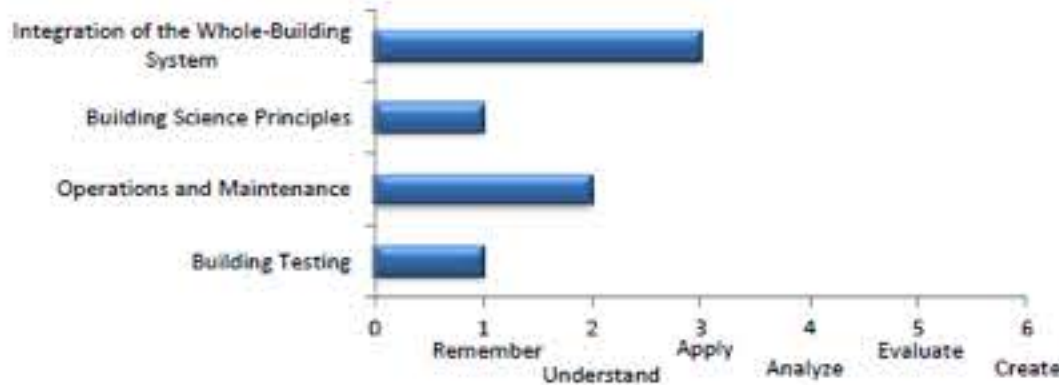
The _____ mechanical engineer certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Average Mechanical Engineer Proficiency Levels



Average Appraiser Proficiency Levels



Skills		Proficiency					
		1	2	3	4	5	6
1 Integration of Whole-Building System	1.1: Performance: Energy, Durability, Comfort, IAQ						
	1.2: Life-Cycle Cost-Effectiveness Analysis						
	1.3: Disaster Resistance/Resiliency						
	1.4: Integrated Design and Construction						
	1.5: Quality Management						
	1.6: Building and Energy Modeling						
	1.7: Cost Trade-Off Analysis						
Content							
	2.1: Heat Transfer (Conduction, Radiation, Convection)						
	2.2: Moisture Transport (Liquid, Vapor, Psychrometry)						
	2.3: Convective Mass (air) Transport (Pressure/Flow)						
	2.4: Thermal Selection (IAQ, Thermal Mass, Insulation)						

Level 1: Identify and state the units for: heat flux, heat rate, thermal conductivity, temperature gradient, emissivity, heat transfer coefficient

Level 2: Define key terms including conduction, convection, radiation, energy, steady state.

Level 3: Calculate heat transport, conductivity, area or temperature difference through a solid using Fourier's law.

Level 4: Draw a heat transfer diagram that shows each mode of heat transfer in context with the geometry

Level 5: Determine the mode of heat transfer most important or likely to occur in a system if given information about the substances/processes involved.

Level 6: Design an integrated hybrid thermal envelope

2. Building Science Principles - 2.1 Heat Transfer

Skills		Proficiency					
		1	2	3	4	5	6
1 Integration of Whole-Building System	1.1: Performance: Energy, Durability, Comfort, IAQ	<div style="text-align: center; border: 2px solid gray; padding: 10px;"> <p>Workforce-Specific Content</p> <p>Per Guideline:</p> <p>Mechanical Engineer</p> </div>					
	1.2: Life-Cycle Cost-Effectiveness Analysis						
	1.3: Disaster Resistance/Resiliency						
	1.4: Integrated Design and Construction						
	1.5: Quality Management						
	1.6: Building and Energy Modeling						
	1.7: Cost Trade-Off Analysis						
2 Building Science Principles	2.1: Heat Transfer (Conduction, Radiation, Convection)						
	2.2: Moisture Transport (Liquid, Vapor, Psychrometrics)						
	2.3: Convective Mass (air) Transport (Pressure/Flow)						
	2.4: Material Selection (IAQ, Thermal Mass, Moisture)						
	2.5: Control Layers (Thermal, Vapor, Water, Air, Solar Gain)						
	2.6: Hydrothermal Analysis						
	2.7: HVAC Systems (Heating, Cooling, and Ventilation)						
	2.8: HVAC Interactions with Enclosure						
	2.9: Fenestration						
	2.10: Plumbing Systems (Heating, Distribution, Conservation)						
2.11: Electrical Systems							
2.12: Lighting/Appliances and Miscellaneous Loads							
2.13: Indoor Envir. Quality (Thermal Comfort, Health, Safety)							
2.14: Control/Automation Systems							
3 Operation & Maint.	3.1: User Interface and Controls						
	3.2: Preventive Maintenance						
	3.3: Replacement and Renovation						
4 Building Testing	4.1: Commissioning						
	4.2: Diagnostics and Forensics						
	4.3: Performance Monitoring/Assessment						

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Job Classification

Click on the image above to find content organized by job classification. Examples include mechanical engineer, appraiser, home performance contractor, code official and many more!

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- Find Your Topic By:
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- Find Partners By:
 - Interactive Map
 - Job Classification
- Resources:
 - Video Directory
 - Case Studies
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- Architect
- Mechanical Engineer
- Civil Engineer
- Landscape Architect
- Material Science Engineer



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Mechanical Engineer Checklist

▶ [Building Science Principles](#)

▶ [Integration of the Whole-Building System](#)

▶ [Operations and Maintenance](#)

▶ [Building Testing and Certification](#)

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Home

About

Help

Find Your Topic By:

Job Classification

Building Science Topic

Find Partners By:

Interactive Map

Job Classification

Resources:

Video Directory

Case Studies

Free Reading Material

Mechanical Engineer Checklist

▶ Building Science Principles

▶ Integration of the Whole-Building System

- Heat Transfer
- Moisture Transport
- Convection Mass (air) Transport
- Material Selection
- Control Layers
- Hygrothermal Analysis
- HVAC Systems
- HVAC Interactions with the Enclosure
- Fenestration**
- Plumbing Systems
- Electrical Systems
- Lighting, Appliance, and Miscellaneous Loads
- Indoor Environmental Quality
- Control/Automation systems

▶ Operations and Maintenance

▶ Building Testing and Certification

BUILDING SCIENCE EDUCATION SOLUTION CENTER

Automatic or manual proficiency level filter

Fenestration

Learning Objectives

Lecture Notes

Teaching Materials

Problem Sets

Proficiency Level 1: Remember

Define key terms including u-factor, NFRC label, SHGC, VT, air leakage, and LSG.

Describe different window operation methods and be prepared to comment on air leakage implications.

Proficiency Level 2: Understand

Describe types of window frames and glazing including low-e, tinting, and reflective coatings

Describe ways that sunlight transmittance is measured and rated.

Explain distinguishing features of each of the primary glazing types including tints, low-e, etc.

Proficiency Level 3: Apply

Sketch the primary components of a window and describe the role that each plays (frame, panes, sill, etc.).

Proficiency Level 4: Analyze

Classify window performance for specific regions using information from the NFRC label.

Explain the importance of u-factors in predicting window performance.

Proficiency Level 5: Evaluate

Select the best window system for specific orientations and geography.

Fenestration (i.e. windows and skylights) provide our homes with light, warmth, and ventilation. When properly designed, selected and installed, energy-efficient windows can help minimize heating, cooling, and lighting costs, while improving comfort for building occupants.



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Fenestration

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Resources:

[Video Directory](#)[Case Studies](#)[Free Reading Material](#)[Learning Objectives](#)[Lecture Notes](#)[Teaching Materials](#)[Problem Sets](#)**Proficiency Level 1: Remember**[Fenestration – Key Terms - Remember](#)[Fenestration – Primary Window Components - Remember](#)**Proficiency Level 2: Understand**[Fenestration – Window Types - Understand](#)[Fenestration – Physical Measurements and Rating Labels - Understand](#)[Fenestration – Distinguishing Features - Understand](#)**Proficiency Level 3: Apply**[Fenestration – Correct Window Installation Methods -- Apply](#)**Proficiency Level 4: Analyze**[Fenestration – Window Performance - Analyze](#)[Fenestration – Importance of U-Factors - Analyze](#)**Proficiency Level 5: Evaluate**[Fenestration – Primary Window Components - Evaluate](#)

Fenestration (i.e. windows and skylights) provide our homes with light, warmth, and ventilation. When properly designed, selected and installed, energy-efficient windows can help minimize heating, cooling, and lighting costs, while improving comfort for building occupants.

Level 1: Remember

Level 2: Understand

Level 3: Apply

Level 4: Analyze

Level 5: Evaluate

Level 6: Design

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Fenestration

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Resources:

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[Learning Objectives](#)
[Lecture Notes](#)
[Teaching Materials](#)
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Videos That Explain High Performance Glass

This series of videos explains everything from basic types of windows, to the physics associated with cold air window performance.

Glazing Type Handout

This handout can be altered to provide the basis for a homework problem.

Videos

Daylighting

This video describes how to encourage daylighting design in buildings to save on energy costs associated with lighting.

Window U-Value Calculation

This video describes how window U-value is calculated.

Thermal Conductivity and Thermal Resistance

This video describes how to calculate thermal conductivity and thermal resistance of building components.

Fenestration (i.e. windows and skylights) provide our homes with light, warmth, and ventilation. When properly designed, selected and installed, energy-efficient windows can help minimize heating, cooling, and lighting costs, while improving comfort for building occupants.

Level 1: Remember

Level 2: Understand

Level 3: Apply

Level 4: Analyze

Level 5: Evaluate

Level 6: Design

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Fenestration

[Home](#)[About](#)[Help](#)[Find Your Topic By:](#)[Job Classification](#)[Building Science Topic](#)[Find Partners By:](#)[Interactive Map](#)[Job Classification](#)[Resources:](#)[Video Directory](#)[Case Studies](#)[Free Reading Material](#)[Learning Objectives](#)[Lecture Notes](#)[Teaching Materials](#)[Problem Sets](#)

Appropriate Use of Low-E Coatings

Should Low-E coatings be used in a hot climate area?

Improving Window Performance

Which of the following options would NOT improve the performance of a window?

- (a) Increase airtightness of a window
- (b) Increase the number of glass panes.
- (c) Increase the thermal performance of the window frame.
- (d) Increase the thickness of glass.

NFRC Label Information

List 3 window performance measures that appear on an NFRC label?

Advantage of Inert Gas in Windows



Type of Problem: Homework

One of the advantages of a window assembly that uses an inert gas in the air gap is:

- (a) Inert gases are not explosive.
- (b) The inert gas acts as an insulator and reduces the heat transfer through the window.
- (c) These windows can use single pane glazing.
- (d) Windows with inert gases are low cost.

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Level 1: Remember

Level 2: Understand

Level 3: Apply

Level 4: Analyze

Level 5: Evaluate

Level 6: Design

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- Home
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- Help
- Find Your Topic By:
 - Job Classification
 - Building Science Topic
- Find Partners By:
 - Interactive Map
 - Job Classification
- Resources:
 - Video Directory
 - Case Studies
 - Free Reading Material



- Architect
- Mechanical Engineer
- Civil Engineer
- Landscpe Architect
- Material Science Engineer



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Landscape Architect Checklist

- Home
- About
- Help
- Find Your Topic By:
 - Job Classification
 - Building Science Topic
- Find Partners By:
 - Interactive Map
 - Job Classification
- Resources:
 - Video Directory
 - Case Studies
 - Free Reading Material

- ▶ Building Science Principles
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 - Heat Transfer
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 - Indoor Environmental Quality
 - Control/Automation systems
- ▶ Operations and Maintenance
- ▶ Building Testing and Certification

BUILDING SCIENCE EDUCATION SOLUTION CENTER

Automatic or manual proficiency level filter

Fenestration

- Learning Objectives
- Lecture Notes
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- Problem Sets

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- Level 1: Remember
- Level 2: Understand
- Level 3: Apply
- Level 4: Analyze
- Level 5: Evaluate
- Level 6: Design

- Home
- About
- Help
- Find Your Topic By:
 - Job Classification
 - Building Science Topic
- Find Partners By:
 - Interactive Map
 - Job Classification
- Resources:
 - Video Directory
 - Case Studies
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BUILDING SCIENCE EDUCATION SOLUTION CENTER

Partners A-Z

[Home](#)[About](#)[Help](#)[Find Your Topic By:](#)[Job Classification](#)[Building Science Topic](#)[Find Partners By:](#)[Alphabetical List](#)[Job Classification](#)[Resources:](#)[Video Directory](#)[Case Studies](#)[Free Reading Material](#)[Cold Climate Housing Program - University of Minnesota](#)

The Cold Climate Housing Program (CCH) is an information and education program that promotes the idea of the "house as a system."

[Dr. Heather Dillon](#)

Heather Dillon is a professor at the University of Portland, in Portland, OR. She teaches building science to undergraduate mechanical engineering students.

[Guardian Industries Corporation](#)[Shiley School of Engineering - University of Portland](#)

The University of Portland is a thriving community of over 5,000 students, faculty and staff located on a bluff overlooking the booming metropolitan city of Portland, Oregon.

[The Appraisal Foundation](#)

The Appraisal Foundation (Foundation) is the nation's foremost authority on the valuation profession.

[The Energy and Environmental Building Alliance](#)

The Energy & Environmental Building Alliance (EEBA) provides an invaluable platform for insight, collaboration and education.

BUILDING TYPE

[Residential \(6\)](#)[Both \(4\)](#)[Commercial \(4\)](#)

JOB CLASSIFICATION

[Material Science Engineers \(2\)](#)[Mechanical Engineers \(2\)](#)[Appraisers \(1\)](#)[Builders/Remodelers \(1\)](#)[Civil and Structural Engineers \(1\)](#)

PARTNERSHIP LEVEL

[Silver \(4\)](#)

MOU's Signed

- The Appraisal Foundation
- University of Portland
- University of Minnesota
- EEBA

MOU's in Progress

- Virginia Tech
- RESNET
- AIA



- Become Partner and Align with Guidelines
- Recruit Partners
- Provide Solution Center Content
- Engage Stakeholders

Framework for
Consistent Competency

DOE Guidelines for
Building Science
Education

Professional Degree
Program Integration

DOE '**Race to Zero**'
Student Design
Competition

Value Understood
in the Market

Building Science
Translator

Race to Zero (RTZ) Vision

Inspire and develop the next generation of building science professionals

Advance and enhance building science curriculum at universities



- Annual Competition (Starting 2014)
- Collaborative Teams
- Market Ready Solutions (Design + Cost)
- Building Science Training
- Comprehensive Integrated Design
- Expert Juror Presentations
- Easily Integrated in Existing Course
- NREL Two-Day Event
- Career Connections

- 301 Students
- 25 Universities
- 31 Teams





Urban Single-
Family
Contest

**Prairie View
A&M
University**

RTZ 2016 Grand Winner Design

Affordable zero ready home for a historically significant, low income neighborhood.



Building Science: Control Layers



Figure 37. Thermal Barrier

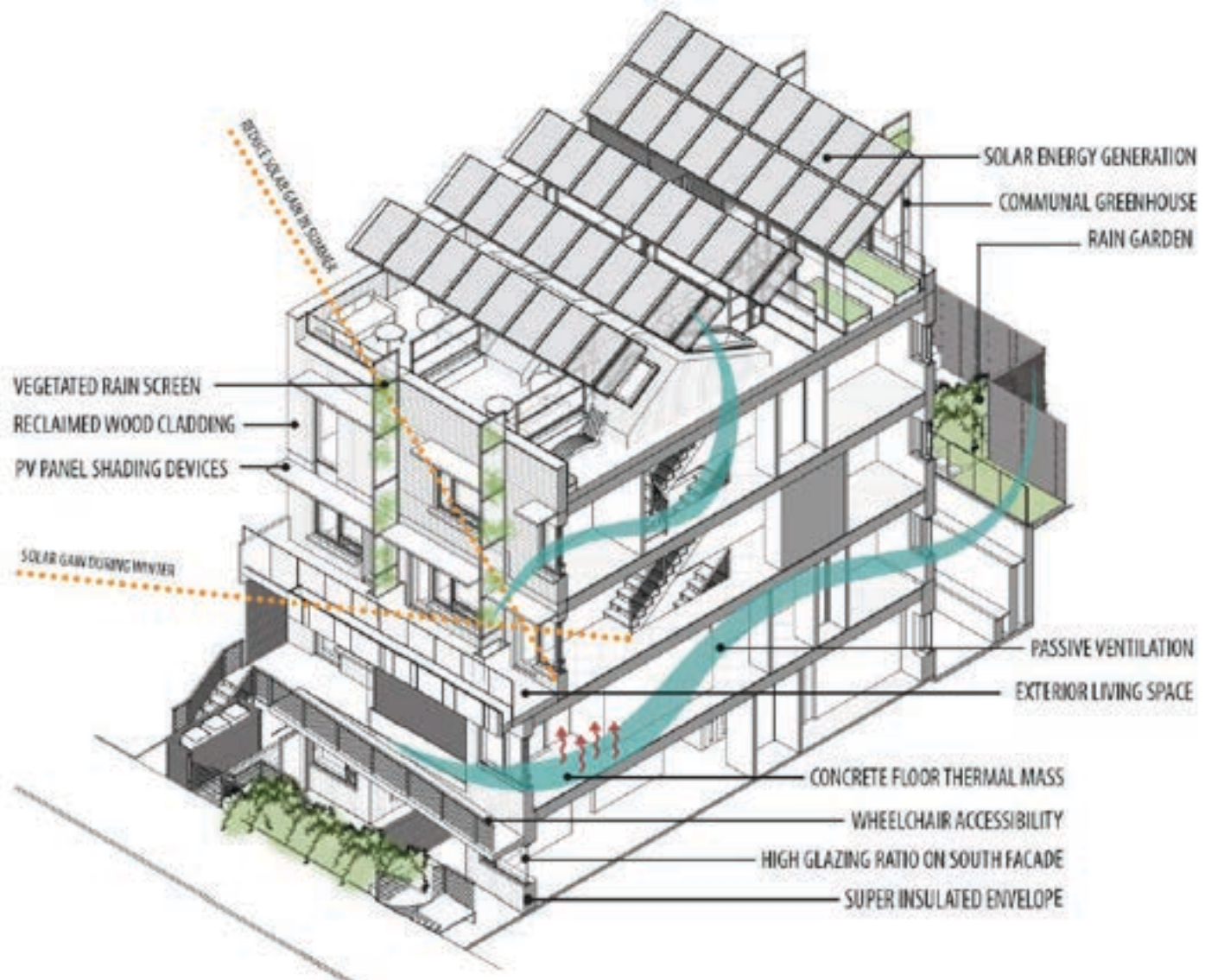


Figure 38. Vapor Barrier



Figure 39. Water Barrier





“This required me to work with industry professionals and to design with a different mindset than usual school projects.”

2016 Race to Zero Participant



“I had almost zero knowledge in everything I had to do for this project. Learning the material in class then getting to apply it in a real world application was amazingly helpful...”

2016 Race to Zero Participant



“I am going to be looking for a job in building science/high-performance building.

I found out that this is exactly what I want to do because of the Race to Zero.”

2016 Race to Zero Participant



Race to Zero Experience

“This competition is a great opportunity to go beyond regular materials and resources that are introduced in the typical classroom.”

2016 Race to Zero Participant



- Recruit University Teams
- Serve as Juror
- Participate in Career Connections
- Promote Event
- Become a Sponsor

Framework for
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Building Science
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Value Understood
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Building Science
Translator

It's really difficult to sell an...

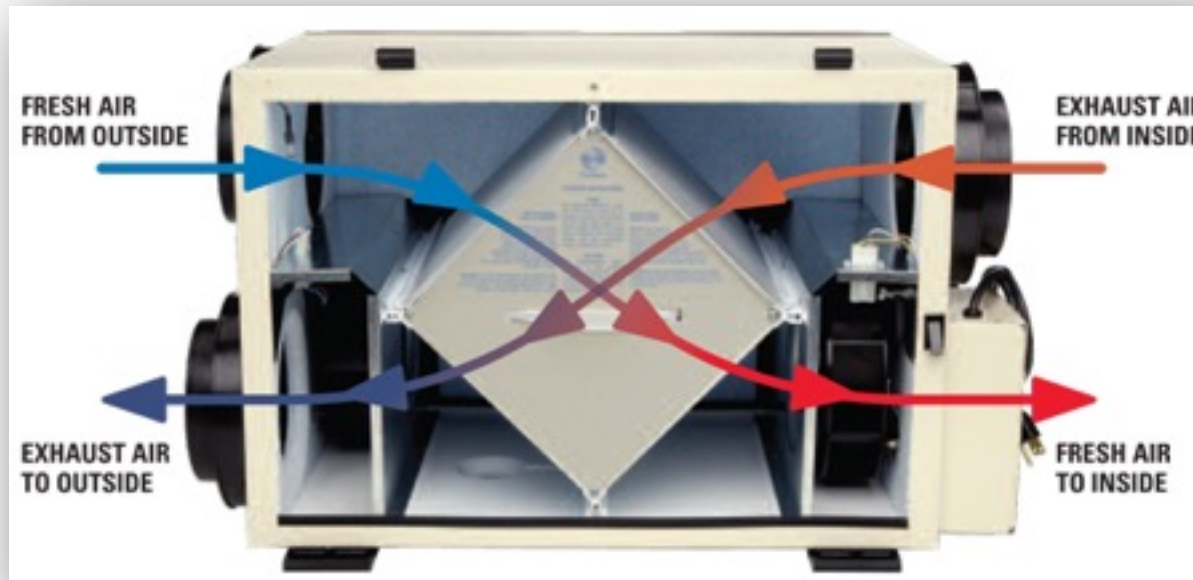
Energy **Audit**

It's much easier to sell an...

Energy **Check-up**

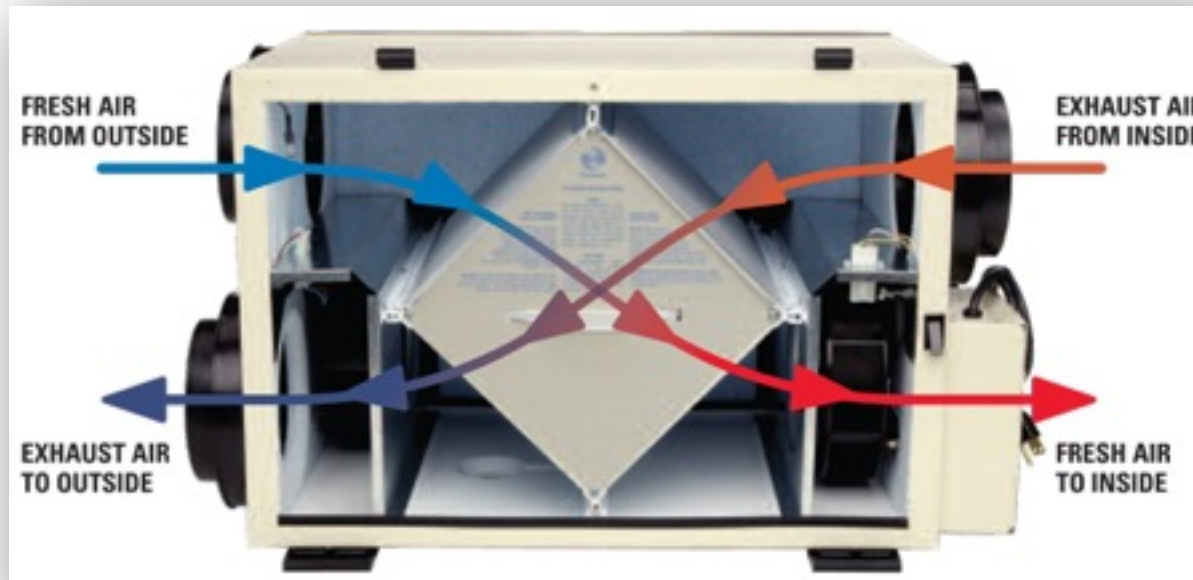
It's really difficult to sell a...

Ventilation System



It's much easier to sell a...

Fresh-Air System



Building Science Translator

'Race to Zero'

Guidelines

Translator

Building America Building Science Translator – Page 1a

Building Science Measure	New Building Science Terminology	Alternate Terms					
		Lives Better		Works Better		Lasts Better	
		Engineered Comfort	Healthful Environment	Ultra-Efficient	Advanced Technology	Quality Built	Enhanced Durability
High-Performance Thermal Enclosure	High-Performance Thermal Enclosure	Enhanced Comfort Enclosure	Moisture Managed Enclosure	High-Efficiency Enclosure	Advanced Enclosure Technology	Professionally-Installed Thermal Enclosure	Low-Maintenance Enclosure
High-Performance Window System	High-Performance Window System	Enhanced Comfort Window System	Quiet Window System	High-Efficiency or Ultra-Efficient Window System	Advanced Window System Technology	Professionally-Installed Window System	Enhanced Durability Window System
High-R Window	High-Efficiency Window	Enhanced Comfort Window	Quiet Window	High-Efficiency or Ultra-Efficient Window	Advanced Window Technology		Sun Protection Window
Weather-Resistant Window	Professionally-Installed Window	Draft-Free Window Installation	Moisture-Managed Window Installation	Energy-Saving Window Installation	Advanced Window Installation	Professionally-Installed Window	Weather-Protected Window Installation
High-Performance Insulation System	High-Performance Insulation System	Enhanced Comfort Insulation System	Enhanced Quiet Insulation System	High-Efficiency or Ultra-Efficient Insulation System	Advanced Insulation System	Professionally-Installed Insulation System	Next-Gen Insulation System
High-R Insulation	High-Efficiency or Ultra-Efficient Insulation	Enhanced Comfort Insulation	Enhanced Quiet Insulation	High-Efficiency or Ultra-Efficient Insulation	Advanced Insulation Technology		
High-R Wall Insulation	High-Efficiency or Ultra-Efficient Wall Insulation	Enhanced Comfort Wall Insulation	Enhanced Quiet Wall Insulation	High-Efficiency or Ultra-Efficient Wall Insulation	Advanced Wall Insulation		
High-R Floor Insulation	High-Efficiency or Ultra-Efficient Floor Insulation	Enhanced Comfort Floor Insulation	Enhanced Quiet Floor Insulation	High-Efficiency or Ultra-Efficient Floor Insulation	Advanced Floor Insulation		
High-R Attic Insulation	High-Efficiency or Ultra-Efficient Attic Insulation	Enhanced Comfort Attic Insulation	Enhanced Quiet Ceiling Insulation	High-Efficiency or Ultra-Efficient Attic Insulation	Advanced Attic Insulation		
High-R Foundation Insulation	High-Efficiency or Ultra-Efficient Foundation Insulation	Enhanced Comfort Foundation Insulation	Enhanced Quiet Foundation Insulation	High-Efficiency or Ultra-Efficient Foundation Insulation	Advanced Foundation Insulation		
Insulation Quality Installation	Premium-Installed Insulation	Enhanced Comfort Insulation Installation	Enhanced Quiet Insulation Installation	Energy Saving Insulation Installation	Advanced Insulation Installation Practices	Professionally-Installed Insulation	Moisture Control Insulation Installation
Fully Aligned Air Barriers	Whole-House Draft Barrier	Whole-House Draft Barrier	Air Contaminant Barrier	Energy Saving Air Barrier	Advanced Air Barrier Technology	Professionally-Installed Draft Barrier	Moisture Control Air Barrier



The image shows a brochure for Vivid Living, titled "VIVID LIVING HEALTHFUL ENVIRONMENT". The brochure features a logo at the top with a house icon and the tagline "INNOVATIVE HOME BUILDERS". Below the title is a row of five images: wood planks, a window frame, a blue mesh filter, paint cans, and a fan. To the right of these images is a "ZERO ENERGY READY HOME" logo. The brochure lists several key features and services:

- Fresh Air**
 - Supply Fresh Air System
 - Odor and Moisture Control Fans
 - High-Capture Filtration Technology
- Quiet**
 - Quiet Window Technology
 - Quiet Wall Technology
- Moisture Control**
 - Dry-by-Design Construction
 - Moisture Control System - Whole House
 - Moisture Controlled Comfort System
 - Moisture Controlled Windows
 - Moisture Controlled Lower Level
- Pest Control**
 - Bug Control Barrier
 - Pest Screened Home
- Outdoor Contaminant Control**
 - Contaminant Sealed Construction
 - Contaminant Sealed Comfort Delivery
 - Dust and Pollen Barrier
 - Radon Controlled Home
- Chemical Control**
 - Formaldehyde Controlled Home
 - VOC Controlled Home
- Fume Control**
 - Carbon Monoxide Controlled Equipment
 - Carbon Monoxide Controlled Fireplace
 - Fume Controlled Garage

At the bottom of the brochure, contact information is provided: Vivid Living • 40 Sample Street, Suite 500, Andover, MA 02800 • 978.877.1902 • www.vividliving.com

World-Class Expert Guidance...

Building America Solution Center
BASC.energy.gov



...At Your
Fingertips

Program Checklists

Access guides directly from checklists for Zero Energy Ready Home, ENERGY STAR Certified Home, and Indoor airPLUS.



Building Components

Access guides for new and existing homes based on building components of interest.



Sales Tool

Translate building science technical terms into a new language of value.



Climate Packages

Review new home energy efficiency specifications and case studies that exceed 2009 IECC by 30%.



Building Science Pubs

Search library of building science publications from Building America.



Mobile App

Join our mobile community to access saved field kits wherever you need them.



Program Checklists
Access guides directly from checklists for Zero Energy Ready Home, ENERGY STAR Certified Home, and Indoor airPLUS

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Program Checklists

Access guides directly from checklists for Zero Energy Ready Home, ENERGY STAR Certified Home, and Indoor airPLUS.



Building Components


Access guides for new and existing homes based on building components of interest.



Multiple overlapping screenshots of the BASC guides website, showing various content pages such as 'Scope', 'Description', 'Ensuring Success', 'Climate', 'Training', 'CAD Images', 'Compliance', 'More Info', and 'Double-Stud Wall Framing'.


Program Checklists

Access guides directly from checklists for Zero Energy Ready Home, ENERGY STAR Certified Home, and Indoor airPLUS




Sales Tool

Translate building science technical terms into a new language of value.



Building Science Pubs

Search library of building science published via Press Building America



Building Components


Access...

Clim

...


Mo

...



VIVID LIVING
INNOVATIVE HOME BUILDERS

VIVID LIVING HEALTHFUL ENVIRONMENT



Fresh Air

- Supply Fresh Air System
- Door and Moisture Control Fans
- High-Capture Filtration Technology

Quiet

- Quiet Window Technology
- Quiet Wall Technology

Moisture Control

- Dry-by-Design Construction
- Moisture Control System - Whole House
- Moisture Controlled Comfort System
- Moisture Controlled Windows
- Moisture Controlled Lower Level

Pest Control

- Bug Control Barrier
- Pest Screened Home

Outdoor Contaminant Control

- Contaminant Sealed Construction
- Contaminant Sealed Comfort Delivery
- Dust and Pollen Barrier
- Radon Controlled Home

Chemical Control

- Formaldehyde Controlled Home
- VOC Controlled Home

Fume Control

- Carbon Monoxide Controlled Equipment
- Carbon Monoxide Controlled Fireplace
- Fume Controlled Garage

Vivid Living • 42 Temple Street, Suite 500, Anytown, MA 02800 • 617.867.1900 • www.vividliving.com

BASC ZERH Climate Packages

ENERGY Energy Efficiency & Renewable Energy

Building America's Optimized Solutions for New Homes

Cold Climate

The U.S. Department of Energy's (DOE's) Building America program has been a source of innovation in residential building energy performance, durability, and affordability for over 20 years. This world-class research program partners with many of the top U.S. home builders, contractors, and manufacturers to bring cutting-edge construction and design solutions and resources to market.

The most recent goal of the Building America program is to demonstrate how cost-effective strategies can reduce home energy use by about 30% in new homes, in all climate regions, by 2025. As part of the strategy to prove that the level of performance is achievable in the market, DOE created a pilot program called the ZERH Zero Energy Ready Home program.

Working together, Building America and the DOE Zero Energy Ready Home program have created this series of optimized solutions to demonstrate how builders can achieve these high savings goals, most effectively, in each climate zone.

Building America's three major climate regions include: cold-very-cold, mixed-humid, hot-humid, hot-dry/mixed-dry and warm. These climate regions are outlined in Figure 1, along with a map of the International Energy Conservation Code (IECC) climate regions as a reference for regional applications. This document outlines the Building America recommendations for achieving incremental savings in the cold climate region (approximately IECC zones 5-8).

Due to the tradeoff decisions that are made when building a home, there are hundreds of ways to meet Building America's savings target. The packages listed in Table 1, show just one way to cost-effectively meet this goal. The fact sheets provide options for common building practices that can be used to offset each particular performance objective. Unless otherwise noted, the performance values in the table are minimums. In-depth descriptions, ventilation practices and code compliance solutions for most of the options listed in Table 1 are available on the Building America Solution Center (see energy.gov).

Photo Courtesy: L&L, Alternative Power Enterprises, Inc.

AMERICA'S
U.S. DEPARTMENT OF ENERGY

BUILDING TECHNOLOGIES OFFICE

Checklists

Get home checklists for
Climate, ENERGY STAR
and Indoor airPLUS

Building Components

Access guides for new and existing homes
based on building configuration of interest.

NEW HOMES: COLD CLIMATE

Cold Climate

1. Insulate floor	2. Insulate foundation	3. Insulate roof	4. Seal air leaks
5. Seal windows	6. Seal doors	7. Seal ducts	8. Seal attic
9. Seal basement	10. Seal crawlspace	11. Seal garage	12. Seal porch
13. Seal stairs	14. Seal utility rooms	15. Seal vent pipes	16. Seal chimney
17. Seal roof	18. Seal gutters	19. Seal eaves	20. Seal soffits
21. Seal fascia	22. Seal siding	23. Seal trim	24. Seal doors
25. Seal windows	26. Seal doors	27. Seal porches	28. Seal patios
29. Seal decks	30. Seal balconies	31. Seal stairs	32. Seal utility rooms
33. Seal garage	34. Seal porch	35. Seal patio	36. Seal deck
37. Seal balcony	38. Seal stairs	39. Seal utility rooms	40. Seal garage
41. Seal porch	42. Seal patio	43. Seal deck	44. Seal balcony
45. Seal stairs	46. Seal utility rooms	47. Seal garage	48. Seal porch
49. Seal patio	50. Seal deck	51. Seal balcony	52. Seal stairs
53. Seal utility rooms	54. Seal garage	55. Seal porch	56. Seal patio
57. Seal deck	58. Seal balcony	59. Seal stairs	60. Seal utility rooms
61. Seal garage	62. Seal porch	63. Seal patio	64. Seal deck
65. Seal balcony	66. Seal stairs	67. Seal utility rooms	68. Seal garage
69. Seal porch	70. Seal patio	71. Seal deck	72. Seal balcony
73. Seal stairs	74. Seal utility rooms	75. Seal garage	76. Seal porch
77. Seal patio	78. Seal deck	79. Seal balcony	80. Seal stairs

Climate Packages

Review new home energy efficiency
specifications and case studies that
exceed 2009 IECC by 30%.

AMERICA'S
U.S. DEPARTMENT OF ENERGY

Mobile App

Join the mobile community by getting
updates for all the information you need there.

Table 1. Cold Climate Package

Component	Requirement	Recommended Solution
Roof	ENERGY STAR	• Insulate Attic • Seal Air Leaks
Floors	ENERGY STAR	• Insulate Floor
Windows	ENERGY STAR	• High Performance Windows (UFI) • Light Emitting Diode (LED)
Doors	ENERGY STAR	• Insulate Doors
Ductwork	ENERGY STAR	• Insulate Ductwork
Attic	ENERGY STAR	• Insulate Attic
Basement	ENERGY STAR	• Insulate Basement
Crawlspace	ENERGY STAR	• Insulate Crawlspace
Garage	ENERGY STAR	• Seal Garage
Porch	ENERGY STAR	• Seal Porch
Patio	ENERGY STAR	• Seal Patio
Deck	ENERGY STAR	• Seal Deck
Balcony	ENERGY STAR	• Seal Balcony
Stairs	ENERGY STAR	• Seal Stairs
Utility Rooms	ENERGY STAR	• Seal Utility Rooms
Garage	ENERGY STAR	• Seal Garage
Porch	ENERGY STAR	• Seal Porch
Patio	ENERGY STAR	• Seal Patio
Deck	ENERGY STAR	• Seal Deck
Balcony	ENERGY STAR	• Seal Balcony
Stairs	ENERGY STAR	• Seal Stairs
Utility Rooms	ENERGY STAR	• Seal Utility Rooms
Garage	ENERGY STAR	• Seal Garage
Porch	ENERGY STAR	• Seal Porch
Patio	ENERGY STAR	• Seal Patio
Deck	ENERGY STAR	• Seal Deck
Balcony	ENERGY STAR	• Seal Balcony
Stairs	ENERGY STAR	• Seal Stairs
Utility Rooms	ENERGY STAR	• Seal Utility Rooms

BASC Building Science Publications



BASC Mobile Application



- 209+ full guides
- 1,500+ images
- 115+ CAD drawings
- 270+ proven performance case studies
- 500+ peer-reviewed references
- 80+ Videos

- Register as a User
- Provide Feedback
 - Errors
 - Improvements
 - Additional Content
- Use as Sales Tool
 - Power Words
 - Customized Point-of-Sale
 - Reference Binders
 - Sales Training
- Use for Training
 - University Classes
 - Building Science
 - Presentations
 - Field Crews
- Use for Precedence
 - Code Officials
 - Decision-Makers
- Use for Reference
- Spread the Word

Thank you!

Contact:

Sam Rashkin

Samuel.rashkin@ee.doe.gov