Educating Workforce Professionals for Success
Some Housekeeping Items

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• You may find PDF copies of the presentation at the website listed here and you may follow along as our speaker presents. Today’s webinar is being recorded and the recording will be available on the DOE YouTube channel within a few weeks.
  
  • [http://energy.gov/eere/buildings/building-america-meetings#current](http://energy.gov/eere/buildings/building-america-meetings#current)
Welcome and Introductory Remarks
Overview of Building America (buildingamerica.gov)
  - Linh Truong - National Renewable Energy Laboratory
Presentations
  - Sam Rashkin – U.S. Department of Energy
  - Cheryn Metzger – Pacific Northwest National Laboratory
  - Sara Farrar – National Renewable Energy Laboratory
  - Priya Swamy – U.S. Department of Energy
Questions and Answers
Closing Remarks
• **Building America Website:**

  - Program information
  - Top Innovations
  - Climate-specific case studies
  - *Building America Update* newsletter
  - Building America Solution Center
  - Publications Library

www.buildingamerica.gov
As Chief Architect for the Department of Energy’s Building Technologies Office, Sam’s primary role is leading deployment of proven innovations for new and existing high-performance homes. In his prior position, he managed the growth of ENERGY STAR for Homes from its inception in 1996 to more than 8,500 builder partners, over one million labeled homes, and over 25 percent market penetration nationwide. Mr. Rashkin has been recognized for his contributions to sustainable housing with the 2012 Hanley Award and authored a new book titled “Retooling the U.S. Housing Industry: How It Got Here, Why It’s Broken, and How to Fix It”.

Sam Rashkin, Chief Architect, U.S. Department of Energy’s Building Technologies Office
Cheryn Metzger has worked at PNNL since 2014. Mrs. Metzger primarily supports the Department of Energy's (DOE) Building Technologies Office and focuses on large scale energy efficiency programs in residential and commercial buildings. Prior to joining PNNL, Mrs. Metzger worked for NREL as an engineer and research coordinator for the Building America Program. In addition to overseeing dozens of projects related to minimizing the risks of highly energy efficient buildings, Cheryn specialized in developing simulation and field test protocols for a wide range of stakeholders. Mrs. Metzger has also supported a variety of efforts related to translating fundamental research results into information suited for general audiences. She has enjoyed organizing market transformation efforts such as outreach programs, website development and multi-track technical conferences.
Sara Farrar has worked at the National Renewable Energy Laboratory since 1994, and her career focus is to increase the sustainability of the built environment with performance and studies in energy efficiency, commissioning, renewable energy, and grid interconnection. She has also applied that experience to leading the project team and technical production of an award-winning collegiate competition and educational exhibit for demonstrating cost-effective, energy-efficient and attractive zero-energy houses that incorporate clean-energy products and design solutions.
Priya Swamy manages workforce development efforts with the Commercial Buildings Integration group at BTO. Previously, she worked with DOE’s State Energy Program to develop policy and program frameworks to support energy efficiency initiatives at state energy offices. Prior to DOE, Priya worked for the German utility E.ON in their Climate and Renewables Division and the Spanish wind company, Iberdrola Renewables. She holds a MS in Engineering Management from GW’s School of Engineering and a BA in Economics from Bryn Mawr College.
Why Building Science Education

Supply System: Workforce Competent in Building Science

Product on Shelf: Better Buildings
> Savings
> Comfort
> Health
> Safety
> Durability

Market Demand: Consumers and Transaction Process That Value Better Buildings

Big Prize: ROI
ECONOMY
JOBS
HEALTH
SECURITY
Webinar Outline

Inspiring University Students

‘Race to Zero’ Student Design Competition

Integration with Commercial Buildings

Better Building Workforce Guidelines

National Platform for Competency

DOE Guidelines for Building Science Education
Race to Zero (RTZ) Vision

**Inspire** and develop the next generation of building science professionals

**Advance** and enhance building science curriculum at universities
RTZ Overview

• **Annual Competition (Starting 2014)**
  – Easily Integrated in Existing Curriculum

• **Critical Skill Development**
  – Building Science Training
  – Collaborative Teamwork Experience
  – Comprehensive Integrated Design
  – Market Ready Solutions (Design+Cost+Construction)

• **Two-Day Competition Event at NREL**
  – Team Presentations to Expert Jurors
  – Networking
  – Thought Leaders
  – Career Connections
Play Race to Zero video on YouTube
Project Requirements

• Achieve DOE Zero Energy Ready Home requirements

• Effectively integrate building science principles and best practices

• Demonstrate marketplace relevance
Choose One of Four Contests

1. Suburban Single-Family Detached House
2. Urban Single-Family Detached House
3. Attached Housing
4. Small Multifamily Building
Multi-Disciplinary Teaming

- Architecture
- Engineering
- Construction Management
- Business
- Environmental/Sustainability
- Other

“The inter-disciplinary nature helped me learn more than in a typical classroom. Interacting and understanding the priorities of engineers, building scientists etc.”

-2017 Race to Zero Participant
The Shark Tank

1. Develop a project report of design
2. Travel to NREL for competition weekend
3. Present to the jurors and peers
4. Receive real time feedback from jurors
Evaluation Parameters

- Architectural Design
- Interior Design, Lighting, and Appliances
- Energy Analysis
- Constructability
- Financial Analysis
- Mechanical, Electrical, and Plumbing Systems Design
- Envelope Performance and Durability
- Indoor Air Quality
- Innovation
- Documentation and Presentation
Race to Zero: Valuable Educational Resources

- Building Science Training
  - Seminar: Principles of high-performance homes taught by renowned industry leaders
  - Webinars: REM/Rate, BEopt, HVAC/IAQ, + more
- REM/Rate software license
- Expertise from industry partners
  - Competition sponsors
  - Individual team partners
- Financial analysis tools
- Past winning presentations and designs
- Competition Guide
- FAQ
Team Accomplishments on Project

- Learn Critical New Skills
- Apply Those Skills
- Collaborate Effectively
- Design a Visionary Home
- Prepare a Compelling Project Package
Competition Weekend Experience

- Network/Benchmark
- Present to National Experts
- Learn from Thought Leaders
- Make Career Connections
- Tour World-Class Facilities
- Get Recognition
New Perspectives and Real Life Experiences
2017 Race to Zero Competition

- 39 teams
- 33 universities
- 4 countries
- 500 students
Previous Star Status

2014-2016 stars
- 51 Collegiate Institutions
- 92 Teams
2017 Stars of Race to Zero

2017 stars
- 33 Collegiate Institutions
- 39 Teams
What a group!
“What a great experience to collaborate with peers (jurors), learn from the next generation of practitioners, and share/mentor the next generation of peers.”

- 2017 Juror
“This competition is a great opportunity to go beyond regular materials and resources that are introduced in the typical classroom.”
- 2017 Student Participant
2017 Grand Winner!
Keynotes & Thought Leaders
Tours of NREL
“I enjoyed the exposure to the NREL facility with the tour and meeting with people who work there.”
- 2017 Student Participant
The students love competing against others, getting an opportunity at this platform, and meeting other teams and seeing their work. So what RTZ offers is something much more than what we can do in the classroom alone.”

-2017 Faculty Advisor
Feedback from Faculty

“Trying to fit everything in a 120-credit format and creating interdisciplinary courses with cross-college faculty is a challenge.”

– “The competition encouraged collaboration with local industry partners, which increased the rate at which students were able to process through the various design phases and topics. The industry collaboration and real-world design scenario also added a practical motivation that stretches students beyond classroom examples.”

– “This is essentially a capstone course opportunity to put together a lot of parts and pieces that they have in the classroom. And the students bring their classroom knowledge into a singular optimized package with all the challenges and trade-offs that entails.”

– “This competition forced students to get involved with the local industry and government agencies. This pushes them out of their comfort zone and prepares them for their careers.”
2017 Race to Zero Sponsors

- SIPA: Structural Insulated Panel Association
- Plastics Pipe Institute®
- Mitsubishi Electric
- Tyvek®
- ASHRAE®
- SPFA: Spray Polyurethane Foam Alliance
- NAHB: National Association of Home Builders
- American Chemistry Council
- Owens Corning®
- NORESCO

Shaping Tomorrow’s Built Environment Today
Questions?

http://energy.gov/eere/buildings/us-department-energy-race-zero-student-design-competition

OR

racetozero@ee.doe.gov
Webinar Outline

Inspiring University Students

Integration with Commercial Buildings

Updated Guidelines

‘Race to Zero’ Student Design Competition

Better Building Workforce Guidelines

DOE Guidelines for Building Science Education
The Better Buildings Initiative is a broad, multi-strategy initiative to make commercial and industrial buildings 20% more energy efficient over the next 10 years. DOE is currently pursuing strategies across five pillars to catalyze change and accelerate private sector investment in energy efficiency.

The pillars are:
- Developing Innovative, Replicable Solutions with Market Leaders
- Making Energy Efficiency Investment Easier
- Improving Effectiveness of Federal Incentives
- Federal Government Leading by Example
- Developing a Skilled Clean Energy Workforce

Interested in aligning your program with Better Buildings Workforce Guidelines: Download Job Task Analyses and Certification Schemes at the NIBS resources site

www.eere.energy.gov/workforce
Workforce Barriers

• **Patchwork** of Technical Standards, Codes and Work Specifications

• **Lack of National Skill Standards** for Emerging Energy-Related Jobs

• **Nonalignment** with Training Content, Platforms, and Programs

• **No Infrastructure** to Support National Credentials

• **Minimal Uptake** of Accreditation Std.s. for Training & Certification Programs

• **Lack of Recognition** of Quality Workforce Credentials
Critical Path

Serves as secretariat, convener, and facilitator under DOE contract

National Institute of Building Sciences

Commercial Workforce Credentialing Council (CWCC)

Board of Advisors → Board of Direction

Nominates SMEs and makes recommendations to Board of Direction

New NIBS Council comprised of public- and private-sector stakeholders

Establishes CWCC policies and procedures; decides committee compositions; builds support for guidelines

Subject Matter Expert (SME) Committees

Revise and validate job task analyses; develop certification schemes and certificate program requirements

Building Energy Auditor

Building Commissioning Professional

Energy Manager

Building Operations Professional

OUTCOMES

Voluntary guidelines for industry-delivered Better Buildings Workforce credentials

Professional certification schemes AND Certificate program requirements
A Government and Industry Partnership to Advance Commercial Workforce Quality

- NIBS* CWCC** develops Better Buildings Workforce Guidelines
- Industry Technical Standards
- Job task analyses***
- Guidelines for certification programs (common certification schemes)
- Guidelines for certificate programs (content outlines and learning objectives)
- Which are implemented by:
  - Industry certification bodies
    - ISO/IEC 17024
  - Certificate program providers
    - IREC 14732 and/or others TBD
- Which seek accreditation under appropriate standard:
  - Department of Energy recognizes accredited programs meeting voluntary Better Buildings Workforce Guidelines

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*National Institute of Building Sciences
**Commercial Workforce Credentialing Council
***Building Energy Auditor; Building Commissioning Professional; Energy Manager; Building Operations Professional
Who are the skilled and qualified workers in advanced energy occupations?

**Define Skills**
Voluntary Better Buildings Workforce Guidelines, defined by industry and government

**Verify**
Third-party accreditation of certification or training programs

**Recognize**
DOE recognition of accredited programs = consumer trust in program quality and workforce performance

CONFUSION...CONFIDENCE
## Four Job Titles

### Project Scope

<table>
<thead>
<tr>
<th>Job Titles</th>
<th>Job Descriptions</th>
</tr>
</thead>
</table>
| **Building Energy Auditor**      | • Assesses building systems and site conditions  
• Analyzes and evaluates equipment and energy usage  
• Recommends strategies to optimize resource utilization.                                                                                       |
| **Building Commissioning Professional** | • Lead, plan, coordinate and manage a commissioning team to implement commissioning processes in new and existing buildings.                                           |
| **Energy Manager**               | • Manage and continually improve energy performance in commercial buildings  
• Establish and maintain an energy program management system supporting organization mission and goals                                                      |
| **Building Operations Professional** | • Manage the building systems O&M and installed equipment  
• Perform general maintenance to maintain operability and optimize performance  
• Ensure comfort, productivity and safety of the occupants.                                                                                                |
DOE Recognized Certifications

1. **Association of Energy Engineers, CEM®**
   - Individuals who optimize energy performance
   - CEM® is a systems integrator

2. **Association of Energy Engineers, CEA®**
   - Individuals who evaluate and analyze how energy is being used
   - Identify energy conservation opportunities
   - Make recommendations for reducing or optimizing consumption

3. **Building Commissioning Association, CCP**
   - Individuals who lead, plan, coordinate and manage commissioning for new and existing buildings.

4. **AABC Commissioning Group, CxA**
   - Certification available to independent professionals who implement commissioning processes in new and existing buildings.
   - Serve building owners’ best interests by delivering facilities with systems that perform as intended.
Benefits for the Entire Industry

**Workers**
- Better credentials
- Clearer career paths

**Employers**
- Better workforce
- Increased customer demand
- Greater profits

**Building Owners/Managers**
- Confidence and trust in certified contractors
- Higher quality work
- Faster payback

**EE Program Administrators or Regulators**
- Increased demand for clean energy services
- Job creation
- Criteria to recognize credentials

**Training and Certification Programs**
- Able to distinguish their programs as “Better Buildings” recognized
- Tool to increase demand for workforce credentials
BBWG Materials & Resources

- **DOE**
  https://www4.eere.energy.gov/workforce/projects/workforceguidelines
  - BBWG Factsheet
  - Community College Guidance
  - Apply for DOE Recognition

- **NIBS**
  https://www.nibs.org/?page= cwcc_resources
  - Job Task Analysis and Certification Schemes
Integration of BBWG into Existing Curriculum

1. Sort BBWG Student Learning Objectives (SLOs)
2. Categorize SLOs
3. Categorize SLOs Level of Learning
4. Design Modules
5. Design Courses
Webinar Outline

Inspiring University Students

Integration with Commercial Buildings

Updated Guidelines

‘Race to Zero’ Student Design Competition

Better Building Workforce Guidelines

DOE Guidelines for Building Science Education
Critical Starting Point

Guidelines for Building Science Education (GBSE) Shall be Fully Coordinated with Better Buildings Workforce Guidelines (BBWG)
GBSE/BBWG Similarities

• **Goals:**
  – Improving building performance
  – Better credentials for a better workforce
  – Critical mass of knowledgeable workforce

• **Development**
  – Industry involvement
  – Many input opportunities for stakeholders
  – Partnering with education programs for alignment
  – Aligning with other private and federal efforts

• **Collective Impact Process:**
  – Adoption of guidelines by education/training programs
Complementary Programs

Better Buildings Workforce Guidelines

Framework
- 4 Specific Workforce Classifications (specific task training)

End Goal
- Workforce Full Certification Programs

Partner Strategy
- Exclusive Involvement

Guidelines for Building Science Education

Framework
- Full Spectrum Workforce Classifications (general BS knowledge)

End Goal
- National Platform and Resources for Consistent Competency

Partner Strategy
- As Much Involvement as Possible
### Career Classifications

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Plumber</td>
<td></td>
<td></td>
<td></td>
<td>Civil/Struct.</td>
<td>Mat. Sci.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home Perf.</td>
<td></td>
<td></td>
<td></td>
<td>Designers</td>
<td>Landscape</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Const. Man</td>
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<td></td>
</tr>
</tbody>
</table>

= Content covered by Better Buildings Workforce Guidelines  
= New commercial buildings content
## Building Science Skills

### 1. Integration of Whole-Bldg. Sys.
- 1.1 Performance
- 1.2 Life-Cycle Cost Eff.
- 1.3 Disaster Resistance
- 1.4 Int. Design & Const.
- 1.5 Quality Management
- 1.6 Bldg/Energy Model’g
- 1.7 Cost Trade-Off Anal.

### 2. Building Science Principles
- 2.1 Heat Transfer
- 2.2 Material Selection
- 2.3 Moisture Transport
- 2.4 Control Layers
- 2.5 Convective Transprt.
- 2.6 Hygrothermal 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

### 3. Operations & Maintenance
- 3.1 User Interface/Cont.
- 3.2 Preventative Maint.
- 3.3 Replacement/Renov.

### 4. Building Testing
- 4.1 Commissioning
- 4.2 Diag. & Forensics
- 4.3 Perf. Mon./Assess.
- 4.4 Ntl. Codes & Std’s
- 4.5 Cert. Programs
Consistent Framework – Proficiency Levels

Building Science Proficiency Based on Blooms Taxonomy

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Create (Design)</td>
</tr>
<tr>
<td>5</td>
<td>Evaluate (Synthesis)</td>
</tr>
<tr>
<td>4</td>
<td>Analyze (Analysis)</td>
</tr>
<tr>
<td>3</td>
<td>Apply (Application)</td>
</tr>
<tr>
<td>2</td>
<td>Understand (Comprehension)</td>
</tr>
<tr>
<td>1</td>
<td>Remember (Knowledge)</td>
</tr>
</tbody>
</table>
### Building Science Education Matrix v10

#### Workforce Classifications

<table>
<thead>
<tr>
<th>Career Classifications</th>
<th>Mechanical Engineer Guideline</th>
<th>Work in Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proficiency Levels:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 = Remember (knowledge)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 = Understand (comprehension)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 = Apply (application)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 = Analyze (analysis)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 = Evaluate (synthesis)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 = Create (design)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Integration of the Whole-Building System

- **Proficiency Levels:**
  - 1 = Remember (knowledge)
  - 2 = Understand (comprehension)
  - 3 = Apply (application)
  - 4 = Analyze (analysis)
  - 5 = Evaluate (synthesis)
  - 6 = Create (design)

#### Skills

- **Building Science Education Matrix v10**
  - Workforce Classifications
  - Mechanical Engineer Guideline
  - Work in Progress
Building Science Education Guidelines for Mechanical Engineers

A summary of the proficiency levels for the core competencies is displayed in the graphic below. 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

<table>
<thead>
<tr>
<th>Topic</th>
<th>Proficiency Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integration of the whole-building system</td>
<td>Average = 5</td>
</tr>
<tr>
<td>Building science principles</td>
<td></td>
</tr>
<tr>
<td>Operations and maintenance</td>
<td></td>
</tr>
<tr>
<td>Building testing</td>
<td></td>
</tr>
</tbody>
</table>

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

#### Topic

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

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

Signature ____________________________

---

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

<table>
<thead>
<tr>
<th>Skills</th>
<th>Proficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Integration of Whole-Building System</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>1.1: Performance: Energy, Durability, Comfort, IAQ</td>
<td></td>
</tr>
<tr>
<td>1.2: Life-Cycle Cost-Effectiveness Analysis</td>
<td></td>
</tr>
<tr>
<td>1.3: Disaster Resistance/Resiliency</td>
<td></td>
</tr>
<tr>
<td>1.4: Integrated Design and Construction</td>
<td></td>
</tr>
<tr>
<td>1.5: Quality Management</td>
<td></td>
</tr>
<tr>
<td>1.6: Building and Energy Modeling</td>
<td></td>
</tr>
<tr>
<td>1.7: Cost Trade-Off Analysis</td>
<td></td>
</tr>
<tr>
<td>2. Building Science Principles - 2.1 Heat Transfer</td>
<td></td>
</tr>
<tr>
<td>Level 1: Identify and state the units for: heat flux, heat rate,</td>
<td></td>
</tr>
<tr>
<td>thermal conductivity, temperature gradient, emissivity, heat</td>
<td></td>
</tr>
<tr>
<td>transfer coefficient</td>
<td></td>
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<tr>
<td>Level 2: Define key terms including conduction, convection,</td>
<td></td>
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<tr>
<td>radiation, energy, steady state.</td>
<td></td>
</tr>
<tr>
<td>Level 3: Calculate heat transport, conductivity, area or temperature</td>
<td></td>
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<tr>
<td>difference through a solid using Fourier’s law.</td>
<td></td>
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<tr>
<td>Level 4: Draw a heat transfer diagram that shows each mode of heat</td>
<td></td>
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<tr>
<td>transfer in context with the geometry</td>
<td></td>
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<tr>
<td>Level 5: Determine the mode of heat transfer most important or likely</td>
<td></td>
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<tr>
<td>to occur in a system if given information about the substances/</td>
<td></td>
</tr>
<tr>
<td>processes involved.</td>
<td></td>
</tr>
<tr>
<td>Level 6: Design an integrated hybrid thermal envelope</td>
<td></td>
</tr>
</tbody>
</table>

**Building Science Education Solution Center Engine**

**U.S. DEPARTMENT OF ENERGY**

**Energy Efficiency & Renewable Energy**
<table>
<thead>
<tr>
<th>Skills</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> Integration of Whole-Building System</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1.1: Performance: Energy, Durability, Comfort, IAQ</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2: Life-Cycle Cost-Effectiveness Analysis</td>
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<tr>
<td>1.3: Disaster Resistance/Resiliency</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1.4: Integrated Design and Construction</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1.5: Quality Management</td>
<td></td>
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</tr>
<tr>
<td>1.6: Building and Energy Modeling</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.7: Cost Trade-Off Analysis</td>
<td></td>
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</tr>
<tr>
<td><strong>2</strong> Building Science Principles</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2.1: Heat Transfer (Conduction, Radiation, Convection)</td>
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<td></td>
</tr>
<tr>
<td>2.2: Moisture Transport (Liquid, Vapor, Psychrometrics)</td>
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</tr>
<tr>
<td>2.3: Convective Mass (air) Transport (Pressure/Flow)</td>
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<td>2.4: Material Selection (IAQ, Thermal Mass, Moisture)</td>
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<td>2.5: Control Layers (Thermal, Vapor, Water, Air, Solar Gain)</td>
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<td>2.7: HVAC Systems (Heating, Cooling, and Ventilation)</td>
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<td>2.8: HVAC Interactions with Enclosure</td>
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<td>2.9: Fenestration</td>
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<td>2.10: Plumbing Systems (Heating, Distribution, Conservation)</td>
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<td>2.12: Lighting/Applicances and Miscellaneous Loads</td>
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<td>2.13: Indoor Envir. Quality (Thermal Comfort, Health, Safety)</td>
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<td>2.14: Control/Automation Systems</td>
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<td><strong>3</strong> Operation &amp; Maint.</td>
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<td>3.1: User Interface and Controls</td>
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<td>3.3: Replacement and Renovation</td>
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<td><strong>4</strong> Building Testing</td>
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<td>4.2: Diagnostics and Forensics</td>
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<td>4.3: Performance Monitoring/Assessment</td>
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Guidelines Timeline

- 2013
- 2015
- 2016
- 2017
## Building Science Skills

<table>
<thead>
<tr>
<th>Job Classifications</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
<th>Level 5</th>
<th>Level 6</th>
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<tr>
<td>1. Integration of the Whole-Building System</td>
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<td>a. Simultaneous consideration of energy, durability, comfort, IAQ</td>
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<td>b. Life cycle cost-effectiveness analysis</td>
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<td>c. Disaster resistance/resiliency</td>
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<td>d. Integrated design and construction (R/C)</td>
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<td>e. Quality management</td>
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<td>f. Building and energy modeling</td>
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<td>g. Cost trade-off analysis</td>
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<td>a. Heat transfer (conduction, radiation, convection)</td>
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<td>b. Moisture transport (liquid, vapor, psychrometrics)</td>
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<td>c. Convective mass (air) transport (pressure/flow)</td>
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<td>e. Control layers (water, air, vapor, thermal, solar)</td>
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<td>g. HVAC Systems (heating, cooling, ventilation, dehumidification)</td>
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<td>h. HVAC interactions with enclosure</td>
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<td>i. Fenestration</td>
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<td>l. Lighting, appliances &amp; misc. loads</td>
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Target Stakeholders:

• Educational Institutions (small programs to big universities)
• Trade associations and general public

Trade Associations
• Licensing Exams
• Continuing Education

Universities/Colleges
• Existing curriculum infusion
• New classes
• Structured minor
• State Licensing Exams

General Public
• High Schools
Collaborators

- Content used on Building Science Education Solution Center (BSESC) website
- Integration of building science modules into existing curriculum
- Peer reviewer of content

Stakeholders

- Agreement to collaborate on final guideline content for a given job classification
- Agreement to have curriculum consistent with the guidelines
- Entity and curriculum improvements that entity listed on website
Fenestration (i.e. skylights) provide light, warmth, and ventilation. When designed, selected energy-efficient windows help minimize heating and lighting costs, improving comfort for occupants.

Proficiency Level 1: Remember
Proficiency Level 2: Understand
Proficiency Level 3: Apply
Proficiency Level 4: Analyze
Proficiency Level 5: Evaluate
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.

**Featured Story:**
“The University of Portland’s Shiley School of Engineering recognizes that the high performance building industry is a growing field. Our School is excited to partner with the Pacific Northwest National Laboratory to bring awareness to these job opportunities and support the Department of Energy’s Guidelines for Building Science Education. Thanks to Dr. Heather Dillon of the Mechanical Engineering program, who helped develop this partnership, our students will be some of the first in the country to have access to the world-class teaching materials available through PNNL and DOE.”

Dean Sharon Jones – Shiley School of Engineering

**Partner Website:** [http://engineering.up.edu/](http://engineering.up.edu/)
Thank you!

Sam Rashkin
Samuel.Rashkin@ee.doe.gov

Priya Swamy
Priya.Swamy@ee.doe.gov

Sara Farrar
Sara.Farrar@nrel.gov

Cheryn Metzger
Cheryn.Metzger@pnnl.gov
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