U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Building Science Advisor – A Web-Based Design Tool to Manage Moisture Risk in Walls

Panelist
André Desjarlais, Oak Ridge National Laboratory

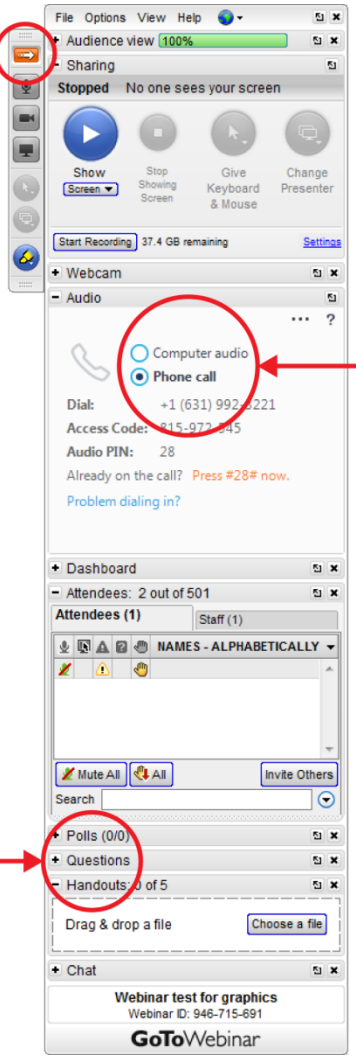
Moderator
Linh Truong – National Renewable Energy Laboratory

February 7, 2018

Building AMERICA
U.S. Department of Energy

Housekeeping

Open and close your control panel



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2 Audio Options:
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Housekeeping

Two Options for Audio (select audio mode):

1. Listen through your computer.

- Please select the “mic and speakers” radio button on the right hand audio pane display

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3. Panelists - Please mute your audio device when not presenting

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Asking Questions

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

If you are having difficulty viewing the materials through the webinar portal:

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

Agenda

- ✓**Welcome and Introductory Remarks**
- ✓**Overview of Building America (buildingamerica.gov)**
  - Linh Truong – National Renewable Energy Laboratory
- ✓**Speaker**
  - André Desjarlais, Oak Ridge National Laboratory
- ✓**Questions and Answers**
- ✓**Closing Remarks**

Building Science Advisor -- A Web-Based Design Tool to Manage Moisture Risk in Walls

André Desjarlais

Program Manager

Building Envelope and Urban Systems Research
Oak Ridge National Laboratory

7 February 2018

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OAK RIDGE National Laboratory | BUILDING TECHNOLOGIES RESEARCH AND INTEGRATION CENTER

Building AMERICA®
U.S. Department of Energy

Bringing Building Innovations to Market

Presentation summary

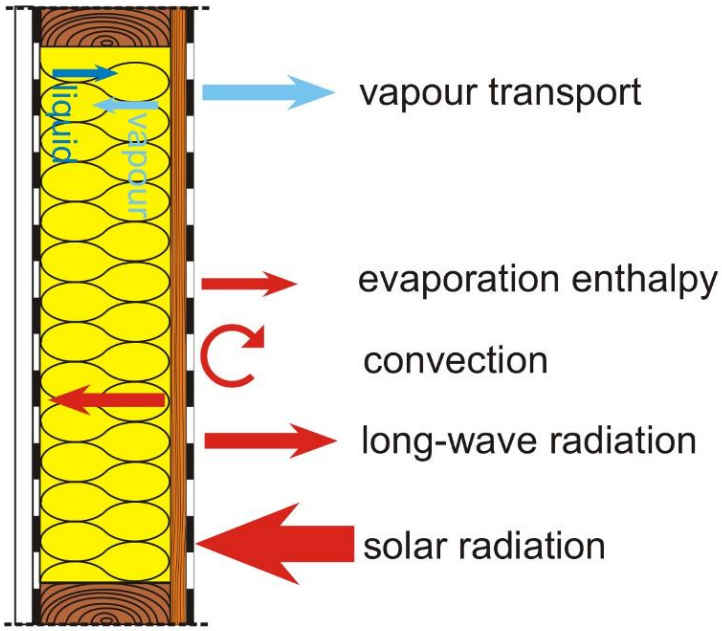
- Why is moisture control important
- What is the Building Science Advisor (BSA)
- Status of the BSA
- Recent activities
- Validating model tools to extend BSA
  - Experts disagree
  - New systems

Introduction

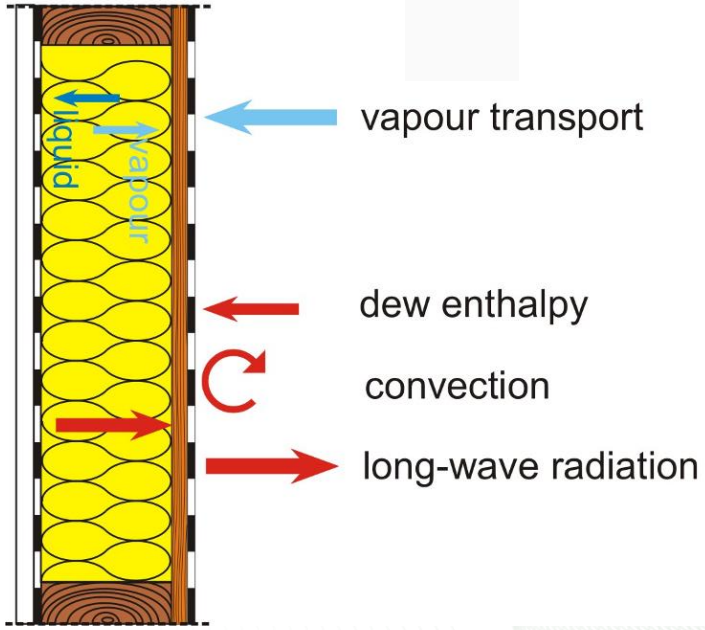
Transient hygrothermal processes through the building envelope

It get's complicated!

During the day…..

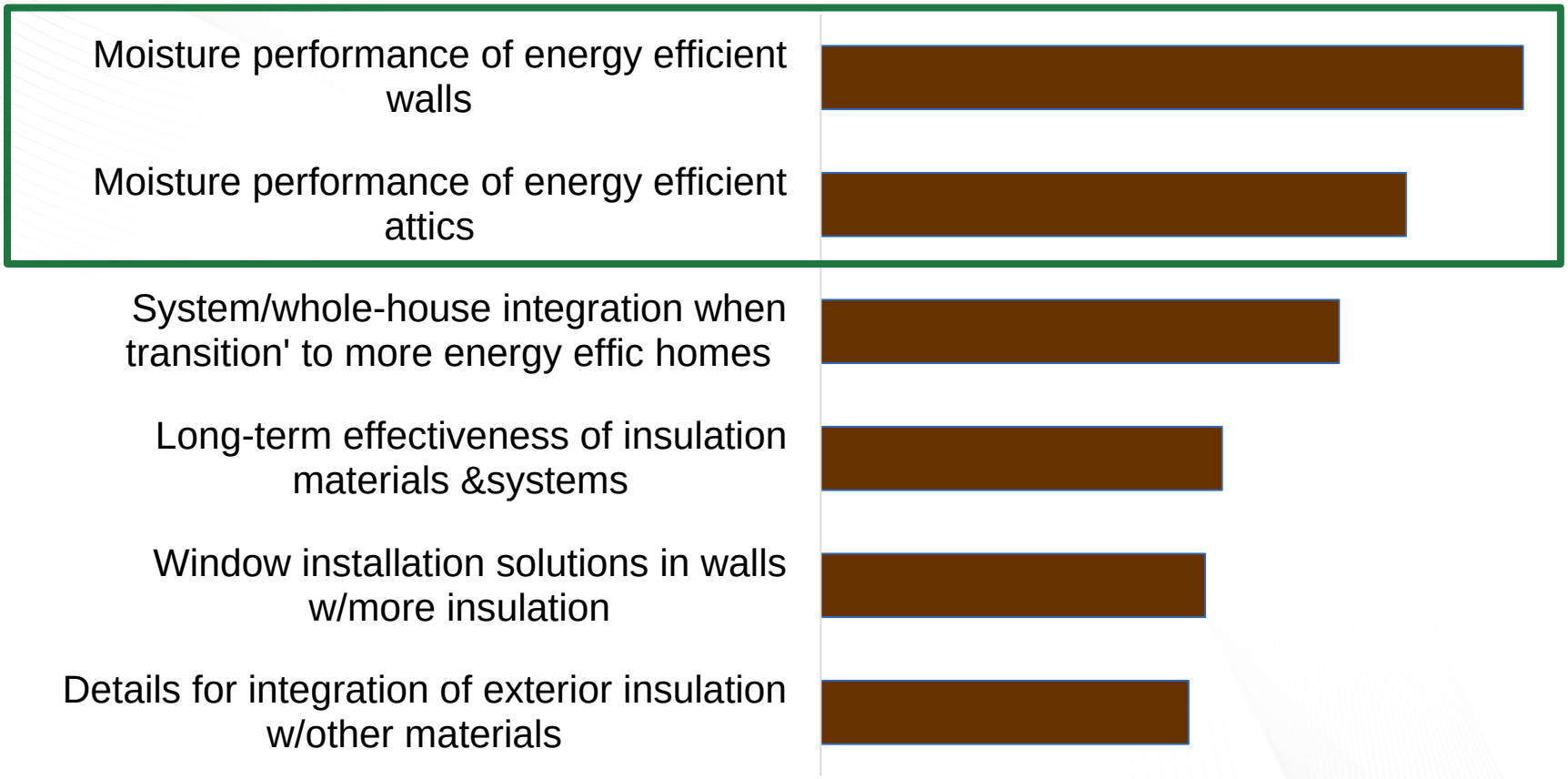


At night…..



Top challenges in energy efficiency

Home Innovation RESEARCH LABS



*Total of 14 issues and challenges presented to respondents

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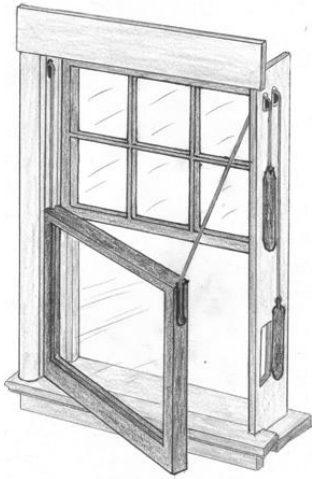
Tools and solutions

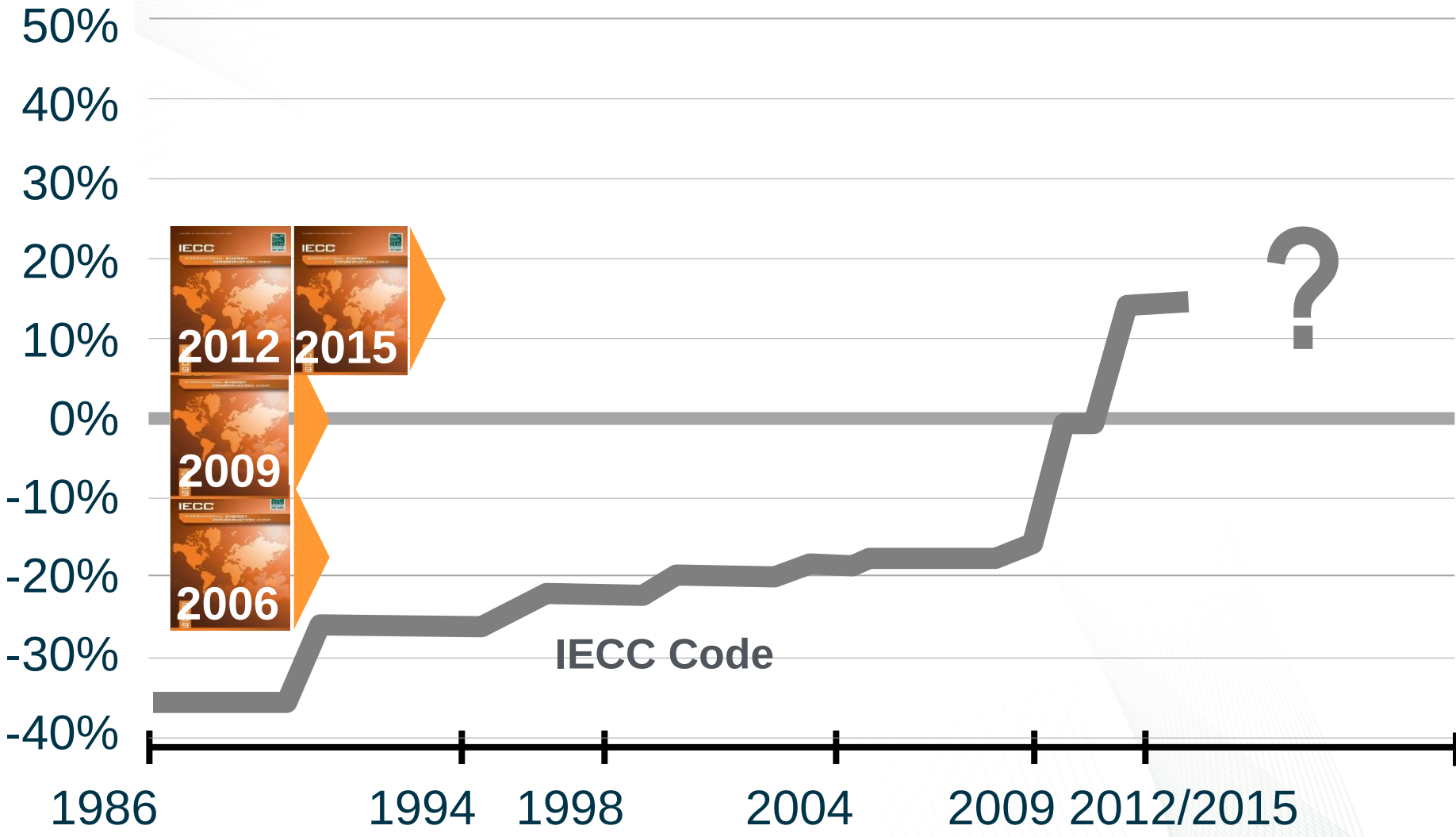
- **76%** of builder respondents stated that the following tool would be **"Very Helpful"** to them:

  Simplified product or system selection tool based on user input of key specifications, climatic information, and design & construction preferences (i.e., expert system)

Building materials are changing

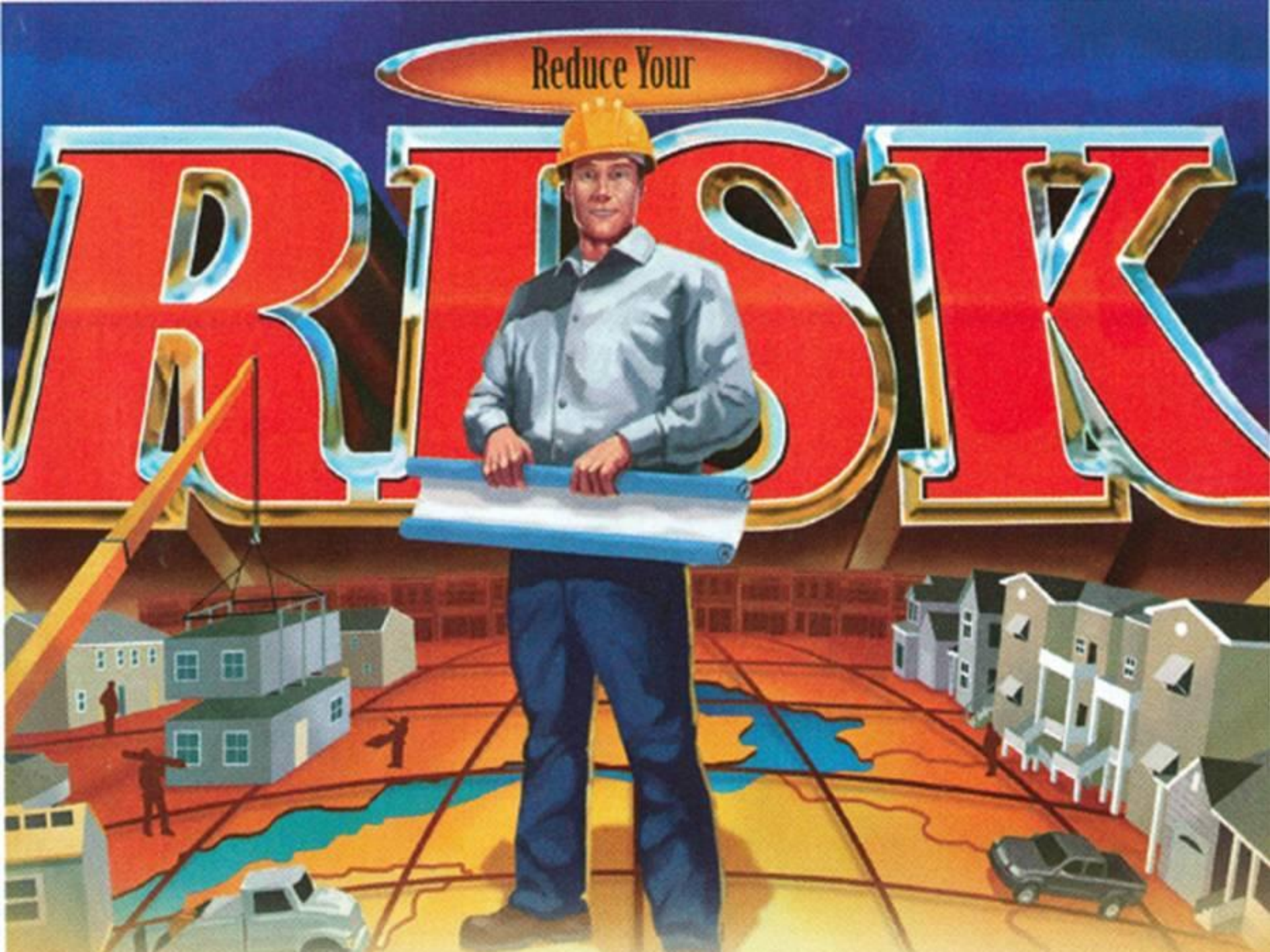


Energy code requirements are changing



Technology & expectations are changing

Anyone who looks can find defects

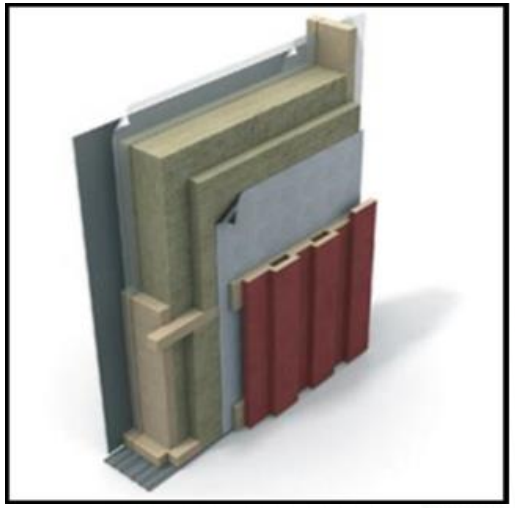

Reduce Your
RISK

What is the BSA

Building Science Advisor (BSA)

ORNL and the Building America team are developing an online decision-making tool to mitigate market uncertainty regarding the durability of high-performing building envelope systems

- Subject matter experts input moisture-durable design guidelines
- Guidelines are also based on field data and simulations
- Simulations allow probabilistic wall assembly evaluations by considering all possible parameter variations
- BSA analyzes builders' proposed design to yield most robust assembly



OAK RIDGE National Laboratory BSA v0.1

Home | Account

Welcome to

Building America Building Science Advisor

Building America Building Science Advisor (BSA) is a website that provides expert advice on building envelope system performance from industry's best researchers and building scientists. This knowledge tool promotes better-informed decisions regarding energy efficient and moisture durable building envelope solutions. BSA communicates uncertainty associated with moisture durability in a simplified manner. Please refer to the Security & Privacy Notice before using Building Science Advisor.

About BSA | New | Continue

Feedback Survey | Disclaimer

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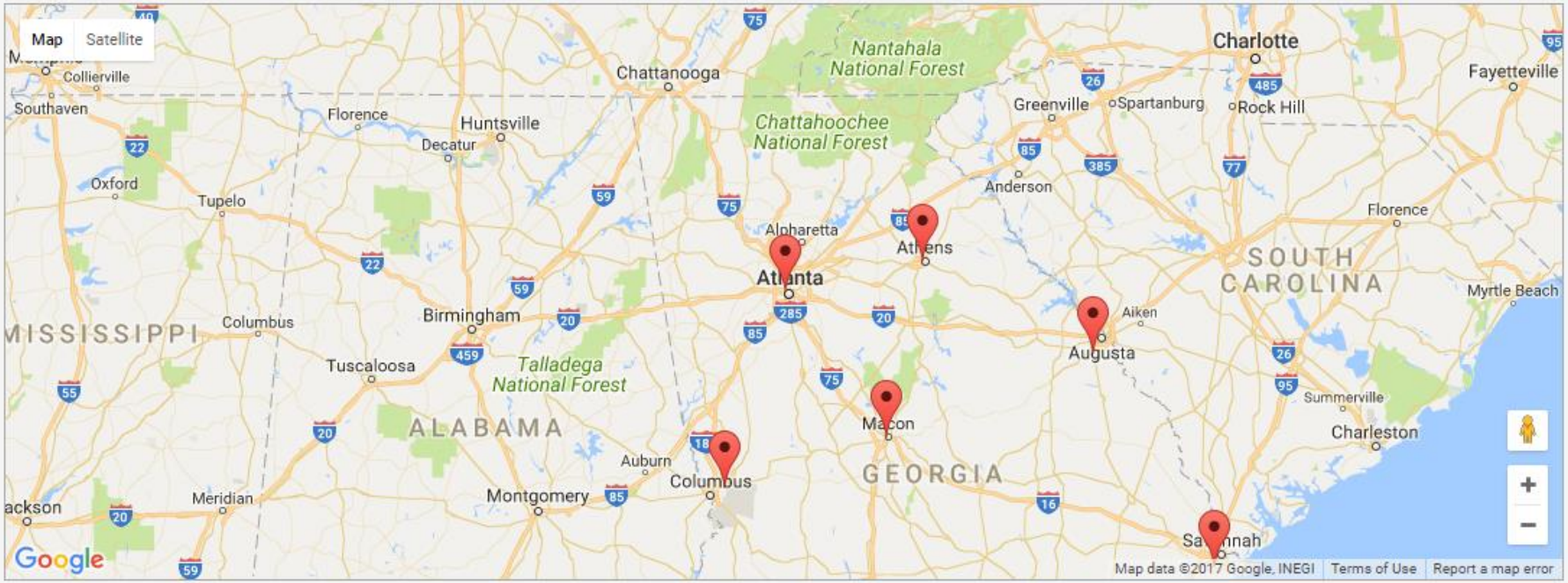
Security & Privacy Notice

To report issues with the site please contact site administrator.

Climate | Cladding | Structure | Insulation | Decision



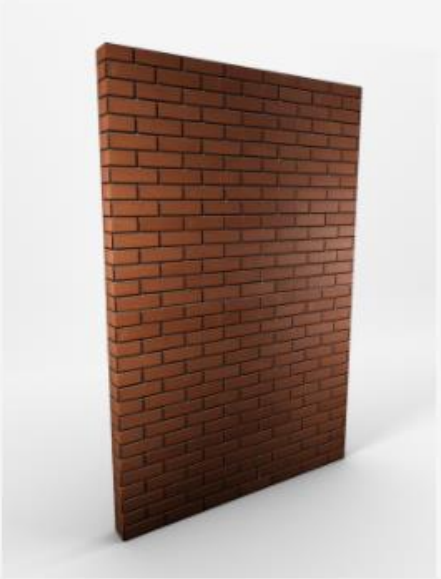
Georgia

Atlanta

Climate | Cladding | Structure | Insulation | Decision

What is your cladding?

- Brick
- Stucco
- Fiber Cement Siding
- Vinyl Siding
- Stone
- Treated Wood Clapboard
- Treated Wood Shakes
- Untreated Wood Clapboard
- Untreated Wood Shakes
- Metal Siding



Climate | Cladding | Structure | Insulation | Decision

What is your structure?

- 2 x 4 16" o.c.
- 2 x 4 24" o.c.
- 2 x 6 16" o.c.
- 2 x 6 24" o.c.
- Structural Insulated Panels
- Insulated Concrete Form System
- Masonry Block (Interior Insulated)
- Masonry Block (Exterior Insulated)

Climate | Cladding | Structure | Insulation | Decision

Cavity Insulation and Type

- Low Performance Fiberglass (R-11)
- **Medium Performance Fiberglass (R-13/R-19)**
- High Performance Fiberglass (R-15/R-21)
- Cellulose Loose Fill
- Open Cell Spray Foam
- Closed Cell Spray Foam
- Flash and Batt (with 3/4-in. CCSPF)
- SIPS - Expanded Polystyrene (EPS)

Continuous Insulation

- **None**
- Expanded Polystyrene (EPS)
- Extruded Polystyrene (XPS)
- Polyisocyanurate Foam
- Mineral Fiber Board

Climate | Cladding | Structure | Insulation | Decision

What do you want to do for the next step?

Recommended Walls

This option provides you with wall assemblies that are moisture durable under the chosen climate and materials selections.

Go to recommended walls

Advanced Analysis

Specify all materials of the wall assembly for moisture durability assessment of the chosen wall design. This option will also provide guidance for best performance if needed.

Go to advanced analysis

Back/Decision | Air Gap | Water/Air Barrier | Sheathing | Vapor Retarder | Interior Finish | Air Tightness | Results

Air gap between sheathing & cladding?

- None
- Vented Air Space
- Ventilated Air Space

Back/Decision | Air Gap | Water/Air Barrier | Sheathing | Vapor Retarder | Interior Finish | Air Tightness | Results

Type of resistive & air barrier?

- None
- **Housewrap**
- Building Paper
- Liquid-Applied Coating
- Permeable Fully-Adhered Membrane
- Impermeable Fully-Adhered Membrane
- Insulated Sheathing
- Uninsulated Sheathing
- Spray Foam

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Home Account

Back/Decision | Air Gap | Water/Air Barrier | Sheathing | Vapor Retarder | Interior Finish | Air Tightness | Results

Exterior sheathing?

- None
- Plywood
- **Oriented Strand Board**
- Fiberboard
- Expanded Polystyrene (EPS)
- Extruded Polystyrene (XPS)
- Polyisocyanurate Foam
- Mineral Fiber Board

Back/Decision | Air Gap | Water/Air Barrier | Sheathing | Vapor Retarder | Interior Finish | Air Tightness | Results

Type of vapor retarder?

- None
- Polyethylene Sheet
- **Kraft Paper**
- Aluminum Foil
- Smart Vapor Retarder

OAK RIDGE National Laboratory BSA v0.1

Home Account

Back/Decision | Air Gap | Water/Air Barrier | Sheathing | Vapor Retarder | Interior Finish | Air Tightness | Results

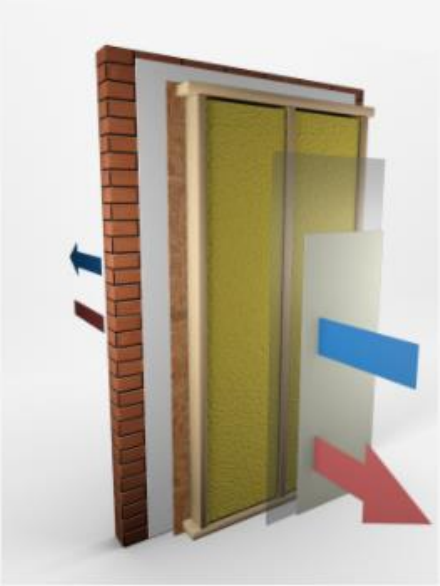
Interior finish on drywall?

- Vapor Barrier Paint
- **Latex Paint**

Back/Decision | Air Gap | Water/Air Barrier | Sheathing | Vapor Retarder | Interior Finish | Air Tightness | Results

Expected air tightness of your building?

- 1 ACH50
- 3 ACH50
- **5 ACH50**
- 7 ACH50

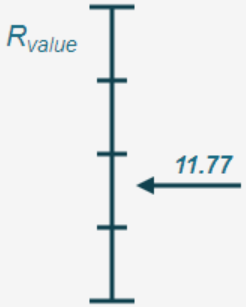


Back/Decision | Air Gap | Water/Air Barrier | Sheathing | Vapor Retarder | Interior Finish | Air Tightness | Results

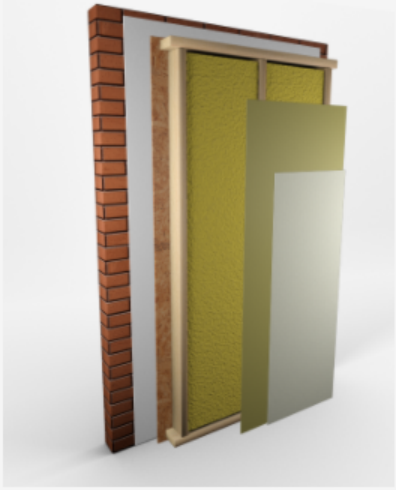
Map Location	Atlanta, GA
Exterior Cladding	Brick
Structure	2 x 4 16" o.c.
Cavity Insulation	Medium Performance Fiberglass
Continuous Insulation	None
Insulation Thickness	0 in
Air Space	None
Water/Air Barrier	Housewrap
Exterior Sheathing	Oriented Strand Board
Vapor Retarder	Kraft Paper
Interior Finish	Latex Paint
Air Tightness	5 ACH50
ID	13931

Moisture Durability Performance

Thermal Performance



Email a question about this wall.



Moisture Performance

The selected wall cladding can absorb water. If there is no ventilation behind the cladding water could infiltrate the wall assembly. To ensure moisture durability add at least a 1/4" (2" for brick or stone cladding to avoid mortar contacting sheething) ventilation cavity behind cladding.

General Guidances

The airtightness of the wall design does not meet 2015 IECC code requirements (< 5 ACH50 in CZ 1 and 2, < 3 ACH50 elsewhere). Air leakage may increase humidity levels inside the wall which should be avoided. Installing the air barrier per manufacturers instructions increases the likelihood that the wall will meet air tightness requirements.

OAK RIDGE National Laboratory BSA v0.1

Home Account

Back/Decision | Air Gap | Water/Air Barrier | Sheathing | Vapor Retarder | Interior Finish | Air Tightness | Results

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Moisture Durability Performance

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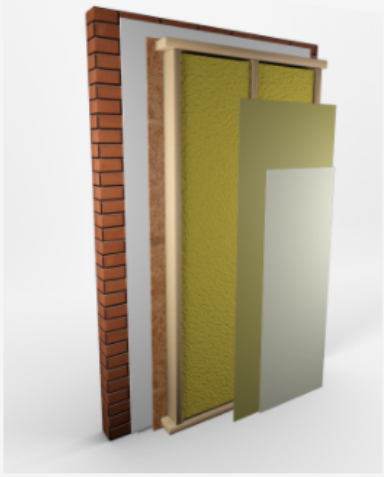

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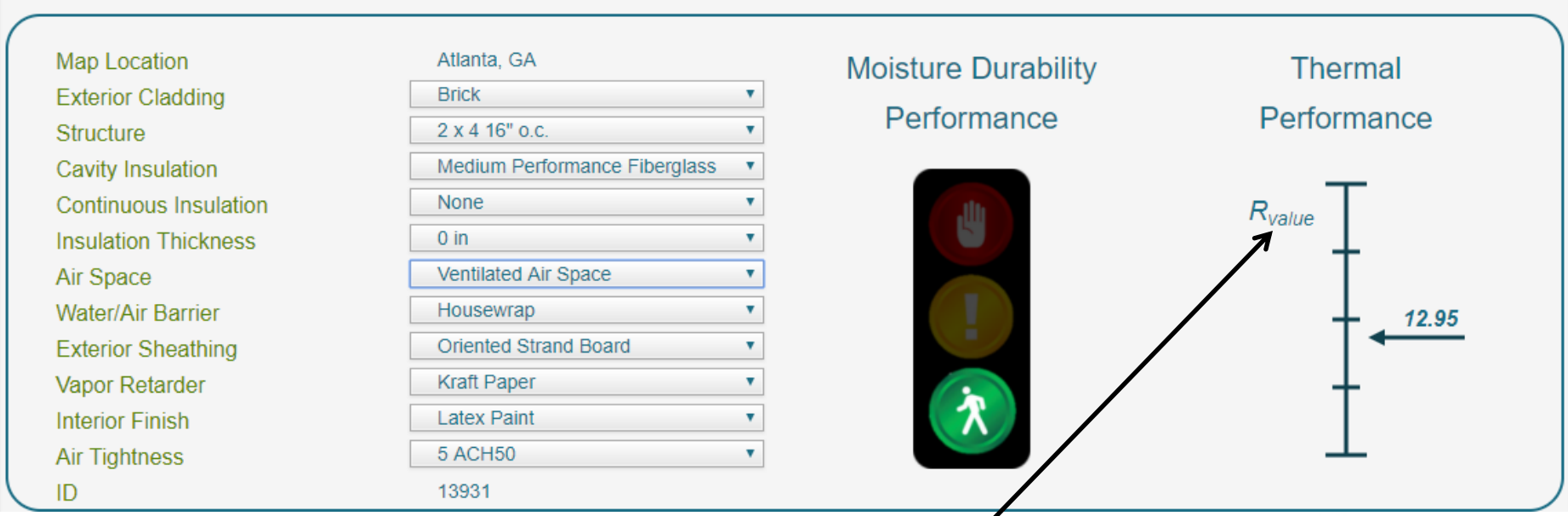
BSA thermal performance calculator



Parallel Path Equivalent R-value

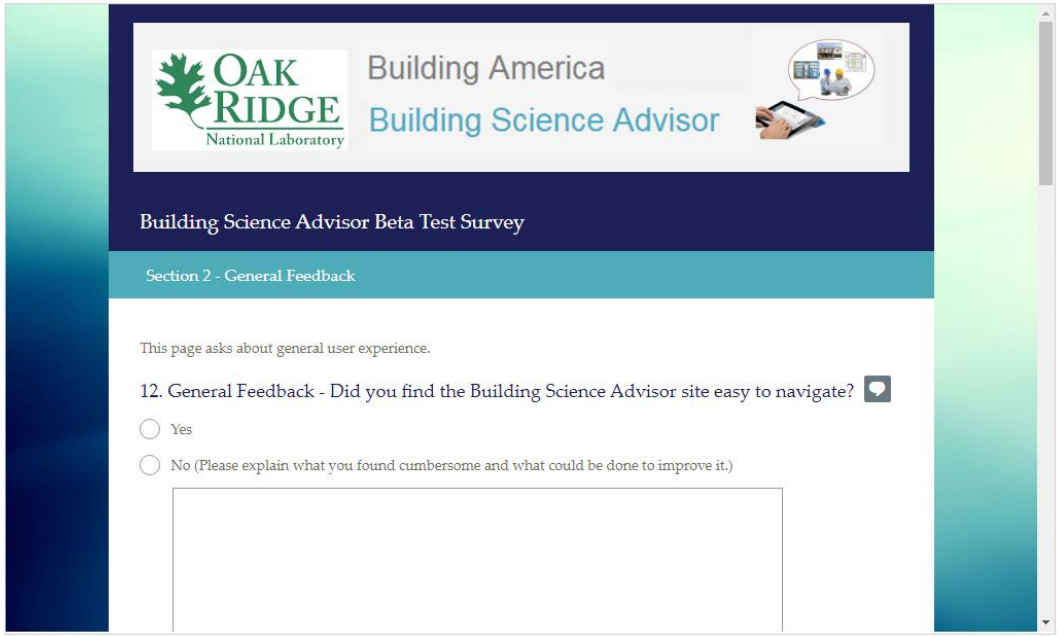
- Sum of R-values computed through cavity (R_{cavity}) and through stud (R_{stud})
- Framing factor (FF) used for computation of weighted average of wall R_{value}

$$R_{value} = \frac{1}{\frac{FF}{R_{stud}} + \frac{1-FF}{R_{cavity}}}$$

BSA beta release

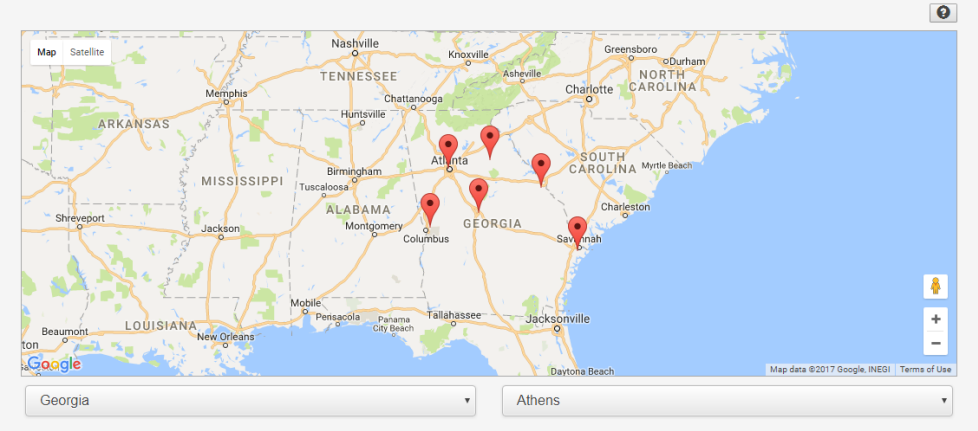
Building Science Advisor: survey mechanics

- For one month starting in mid-August, a survey was circulated. 50 percent of the 170 people surveyed supplied feedback.
- Questions about the specific website pages were asked.
- Asked those who disagreed with BSA results to give us their contact information.

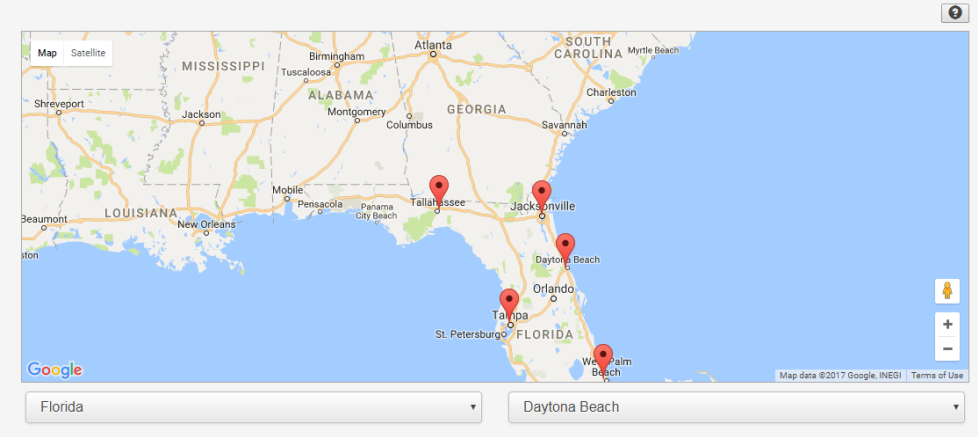


Building Science Advisor: Climate Locations

- In the BSA, we allow users to choose their location so the software will know which climate zone the user is in.

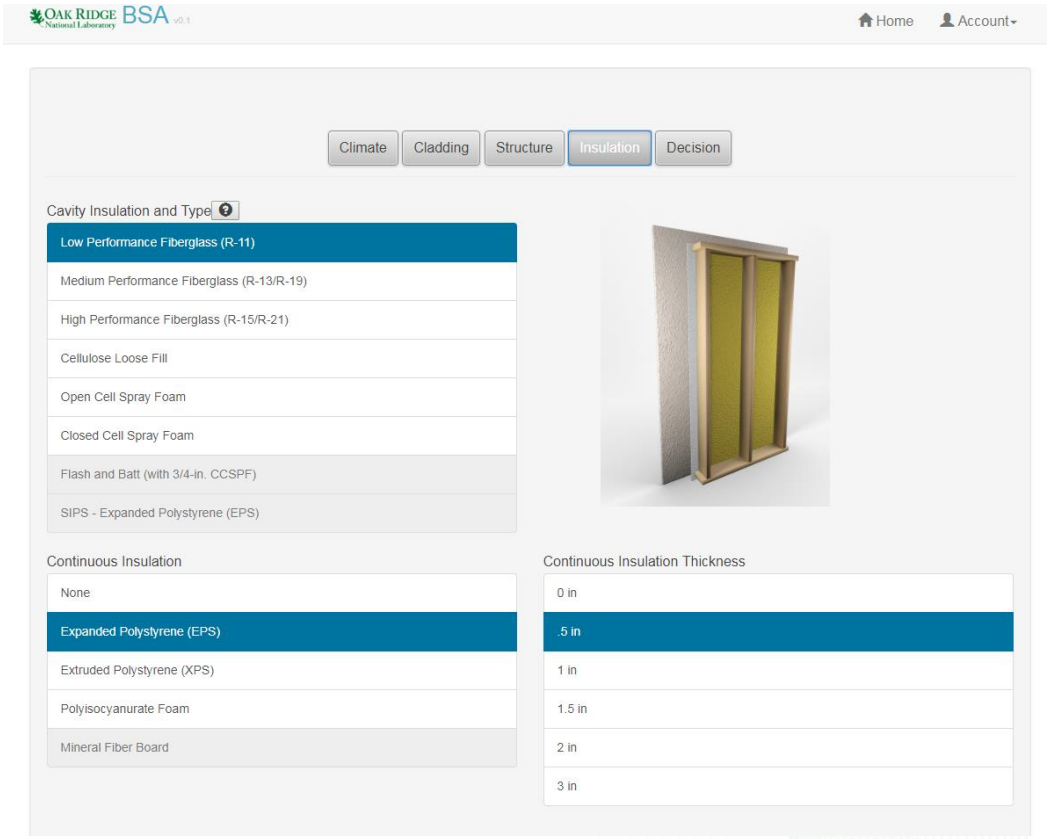


- Some users pointed out that because locations were limited by state, it made it inconvenient to use a location in a state different to the one you were in.



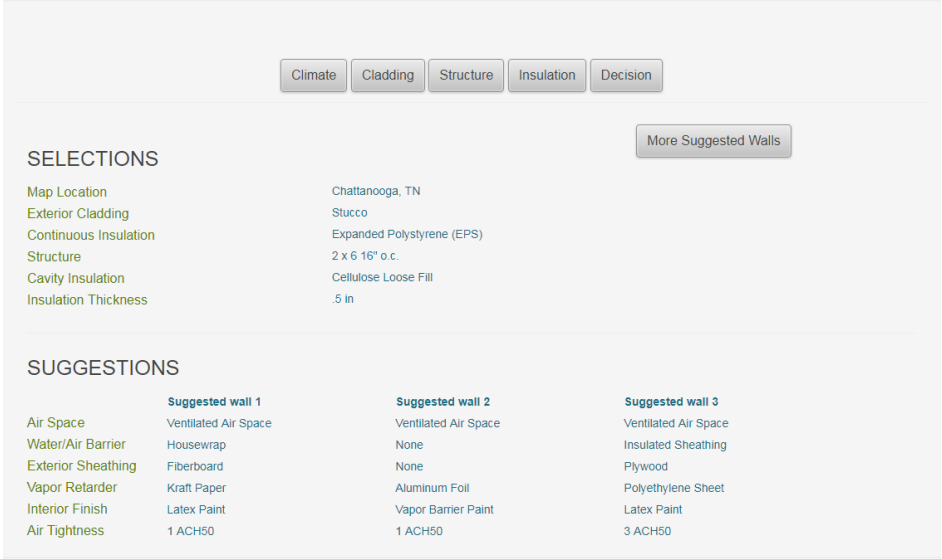
Building Science Advisor: wall construction options

- Everyone who commented wanted their specific material incorporated into the BSA.



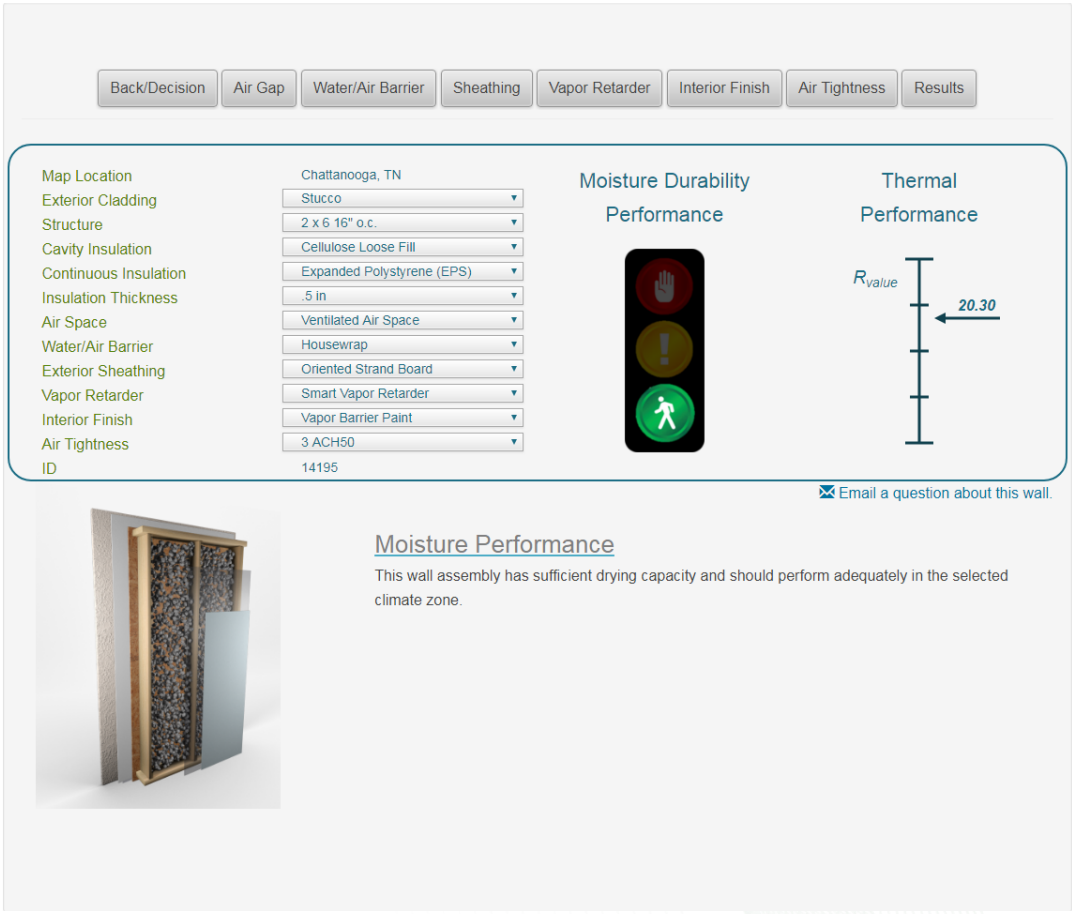
Building Science Advisor: recommended walls

- People criticized that because only three walls showed up at a time, that it was difficult to tell if there were more options.
- Commentators wanted images to go with the suggested walls to know the order that the wall components would be arranged.



Building Science Advisor: results page

- Those who liked the traffic light performance indicator wanted a better description to what the different colors of the light meant.
- Many people wanted more/different performance indicators for the inputted wall.



Performance Summary

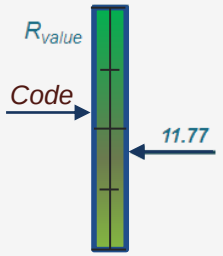
Print Report?

Map Location	Chattanooga, TN
Exterior Cladding	Brick
Structure	2 x 4 16" o.c.
Cavity Insulation	Medium Performance Fiberglass
Continuous Insulation	None
Insulation Thickness	0 in
Air Space	None
Water/Air Barrier	Housewrap
Exterior Sheathing	Oriented Strand Board
Vapor Retarder	Kraft Paper
Interior Finish	Latex Paint
Air Tightness	5 ACH50

Moisture Durability Performance

Details

Thermal Performance



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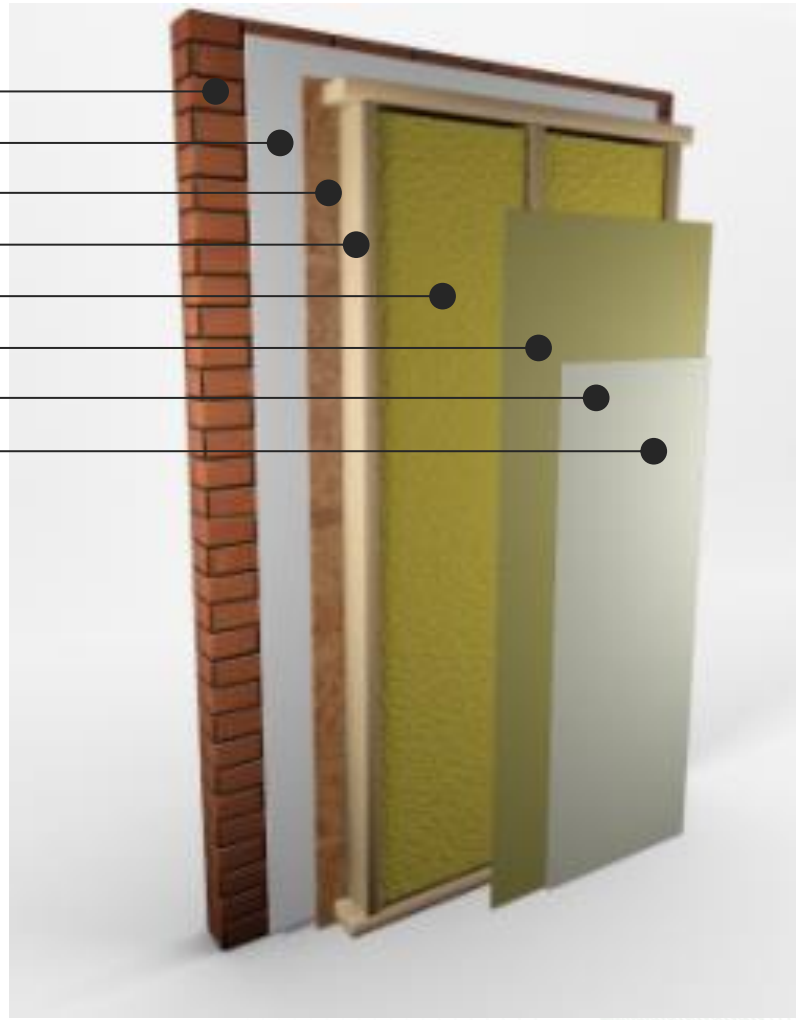
(Click on image for technical summary)

Technical Summary

Cladding:	Brick
Weather/Air Barrier:	Housewrap
Exterior Sheathing:	OSB
Structure:	Wooden Studs /
Insulation:	Fiber Glass
Vapor Retarder:	Kraft Paper
Interior Sheathing:	Interior Drywall
Interior Surface:	Latex Paint



Downloads

CAD Section Drawing
(dwg) *(pdf)*

WUFI simulation model
(w5p) *(w6p)*

EnergyPlus
(idf)

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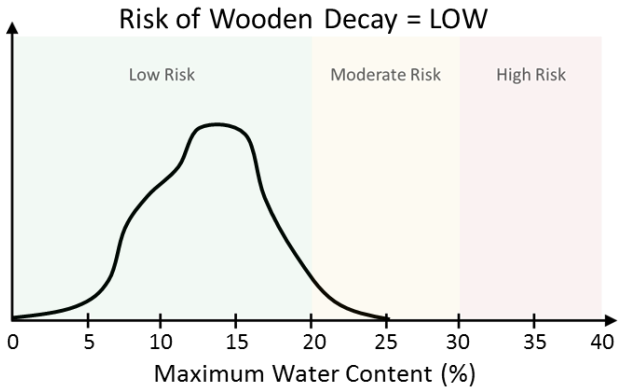
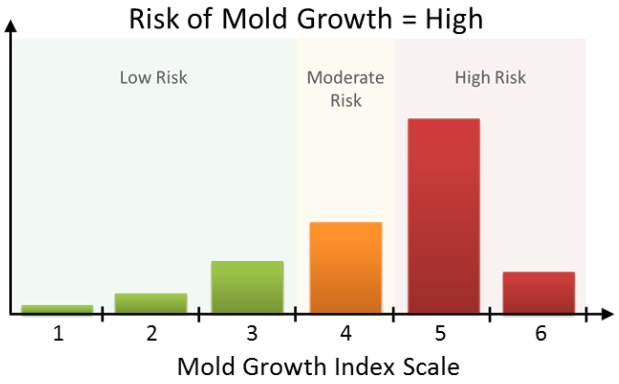
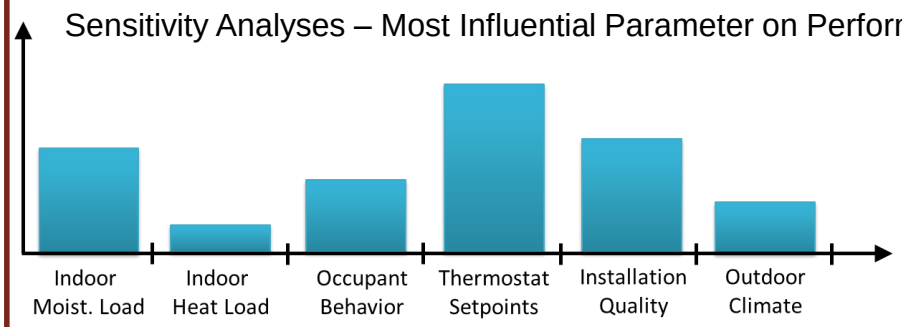
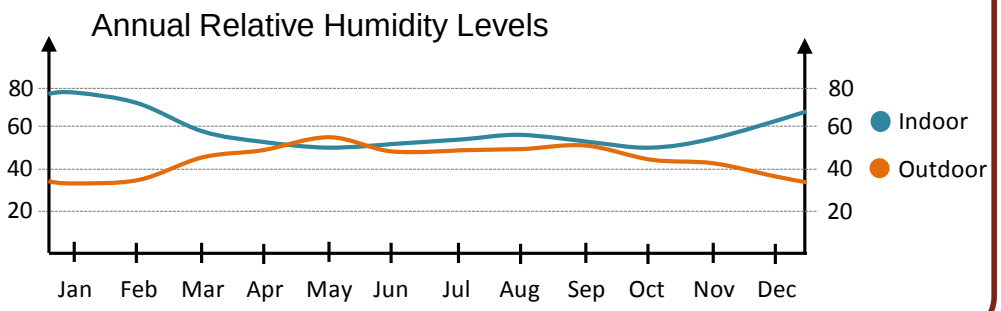
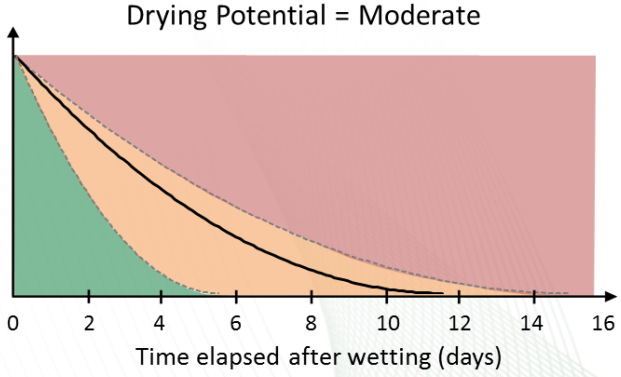
Moisture Durability Performance



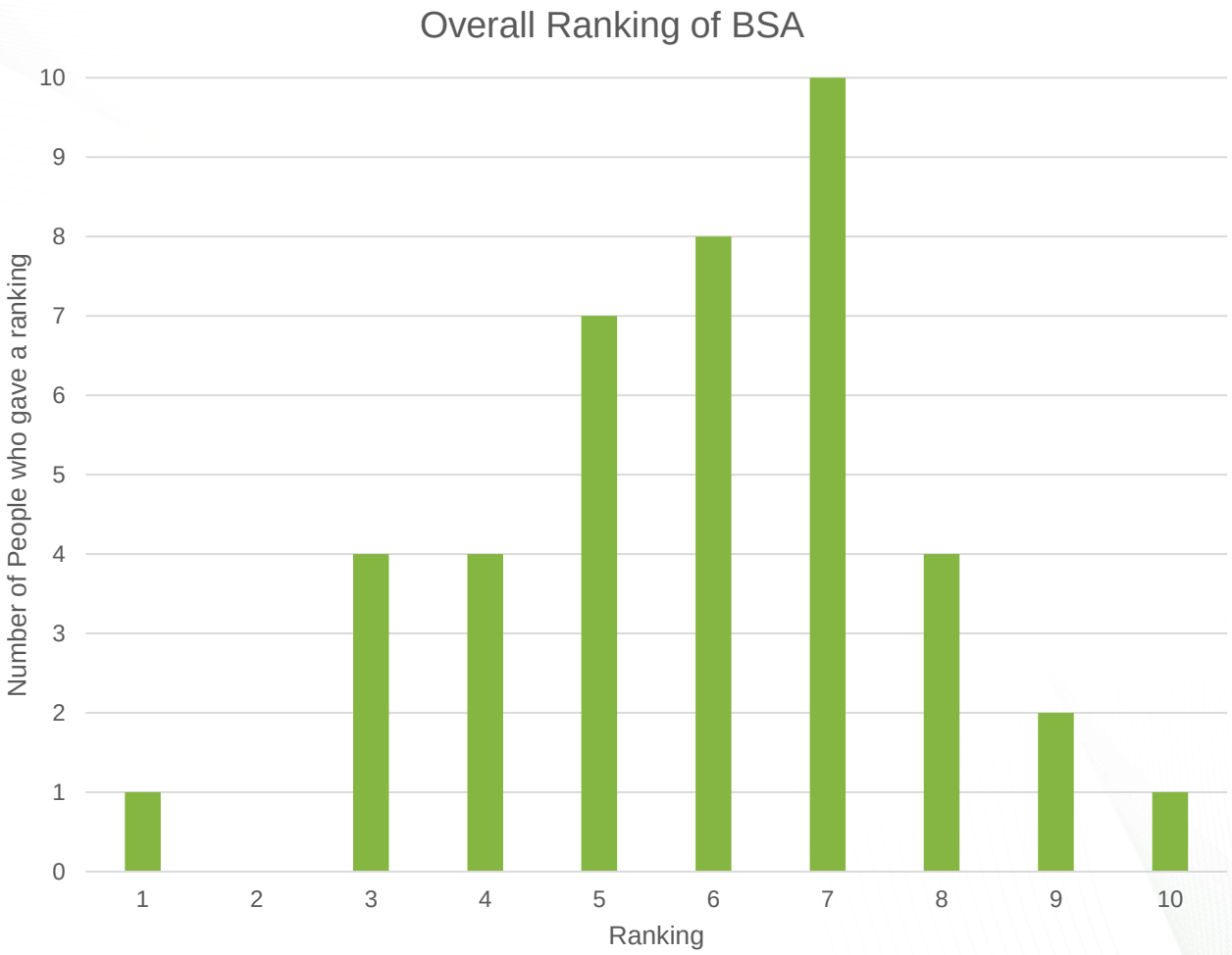








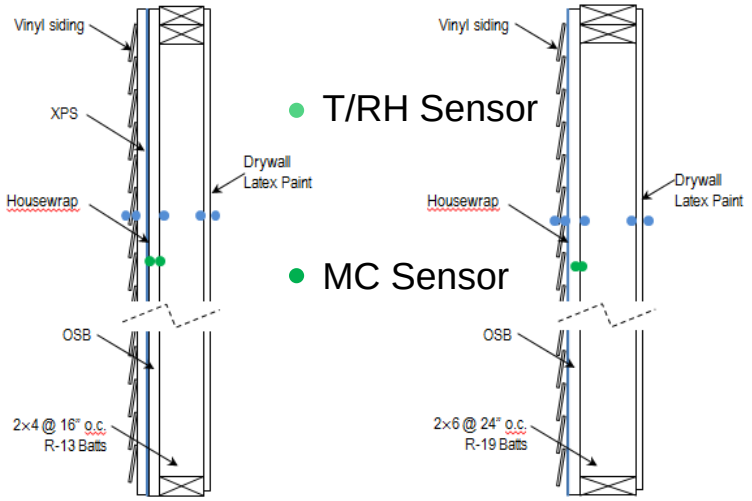
Building Science Advisor: overall impressions



Hygrothermal model validation

Model validation diffusion with two walls

Wall descriptions (materials from outdoors to indoors)
Vinyl siding, R-5 XPS, mechanically fastened membrane, 7/16” OSB, 2x4 wood studs at 16”o.c., R-13 kraft-faced fiberglass batts, drywall, latex paint
Vinyl siding, mechanically fastened membrane, 7/16” OSB, 2x6 wood studs at 24”o.c., R-19 kraft-faced fiberglass batts, drywall, latex paint

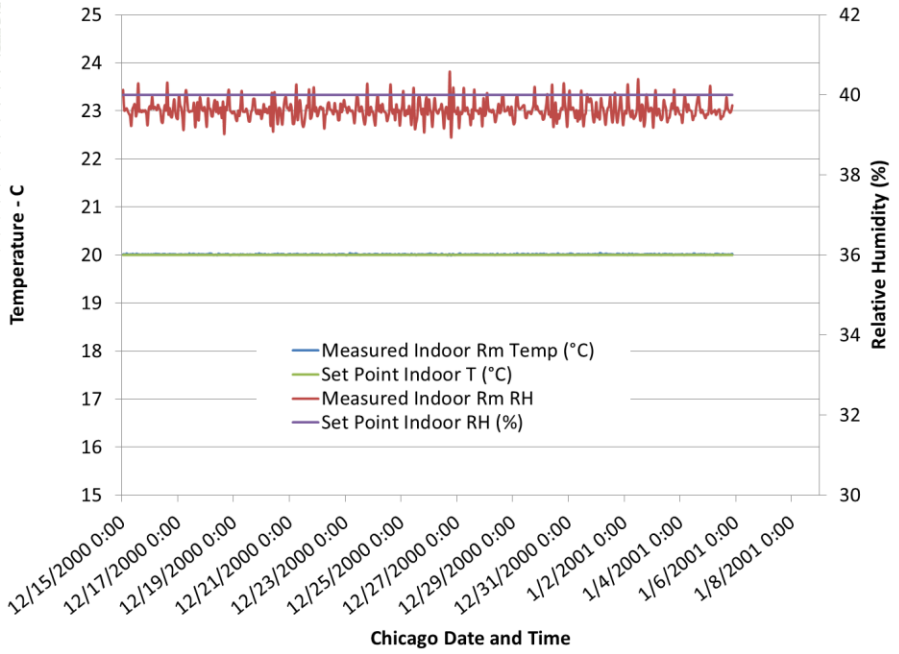


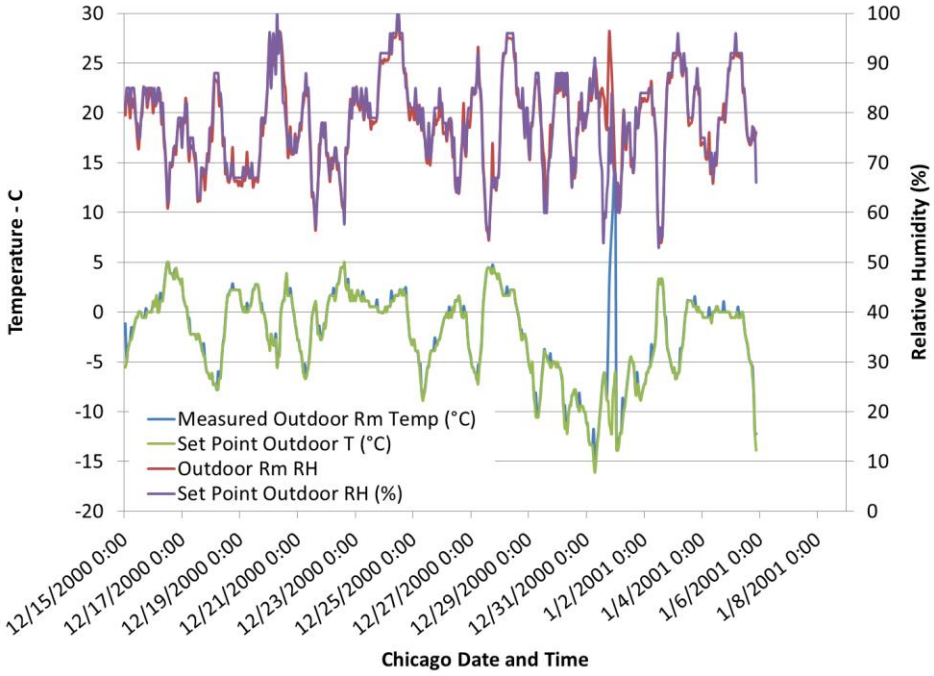
Diffusion test boundary conditions

- Indoor climate – static 68°F at 40% RH
- Outdoor climate – cold year Chicago winter weather from WUFI, began 12/15 and ran for 3 weeks

- No pressure differential
- No solar
- No rain

Simulated boundary conditions controlled precisely

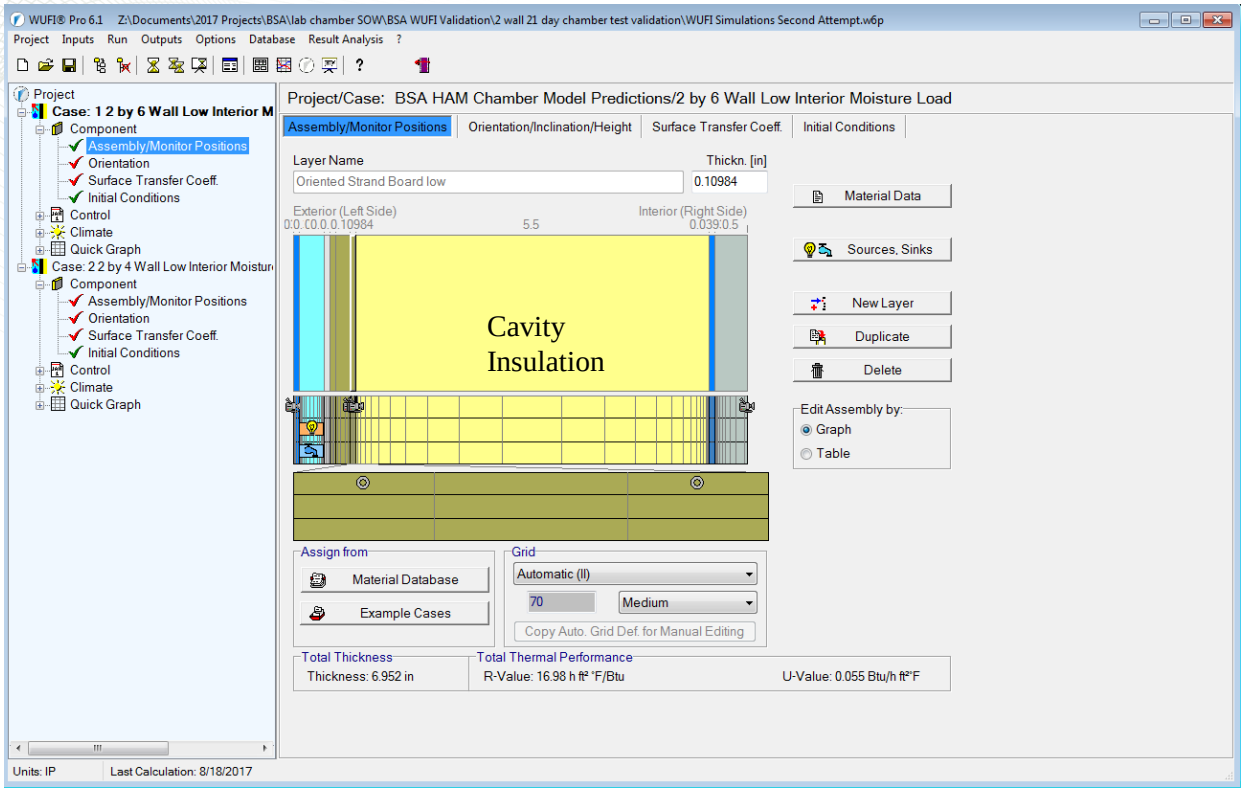




Indoor	RMSE
Temp	0.01°C
RH	0.5 %

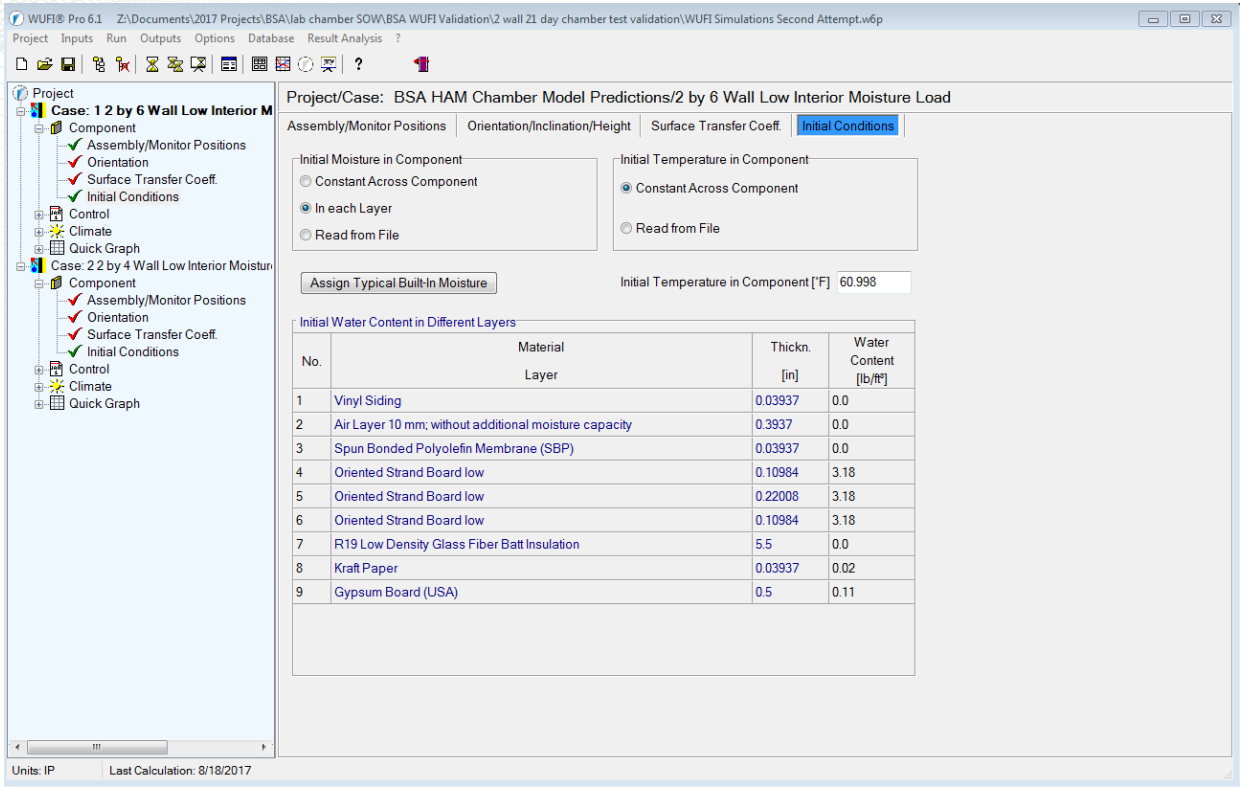
Outdoor	RMSE
Temp	0.5°C
RH	1.7 %

Model inputs



- Climates – same as chamber
- Used WUFI's default material properties
- Split OSB sheathing into three layers (large center layer and two thin outer layers) – to better distinguish between MC at surface for comparison with measured data

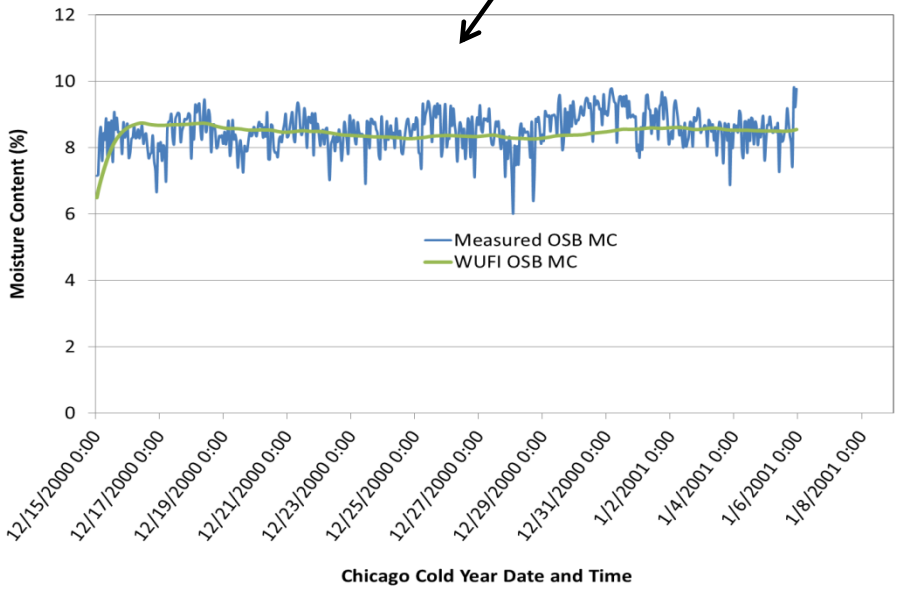
Model inputs

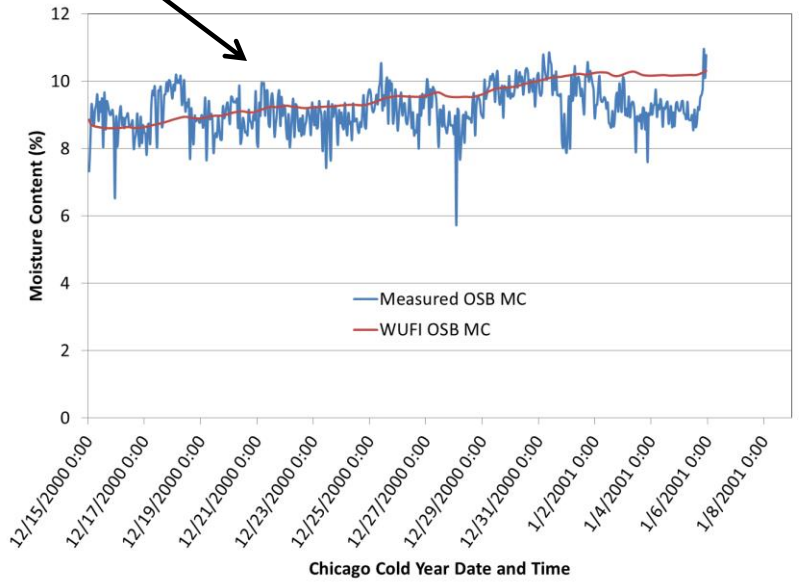


- Changed initial moisture content to match initial measured MC of OSB
- Adjusted air leakage between siding and WRB (initially 200 ACH) to match what occurred in the chamber (0 ΔP across wall) – this was needed to better match the 2x6 wall OSB temp with measurement

Model based moisture diffusion validated against chamber tests

	OSB MC - RMSE	OSB Temp - RMSE
2x4	0.6%	1.3°C
2x6	0.8%	1.6°C





Model based moisture diffusion validated against chamber tests

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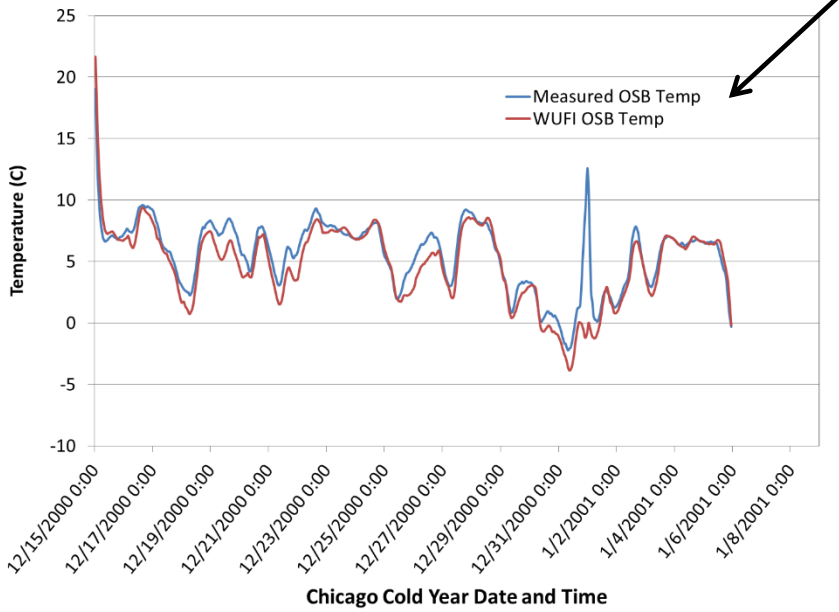

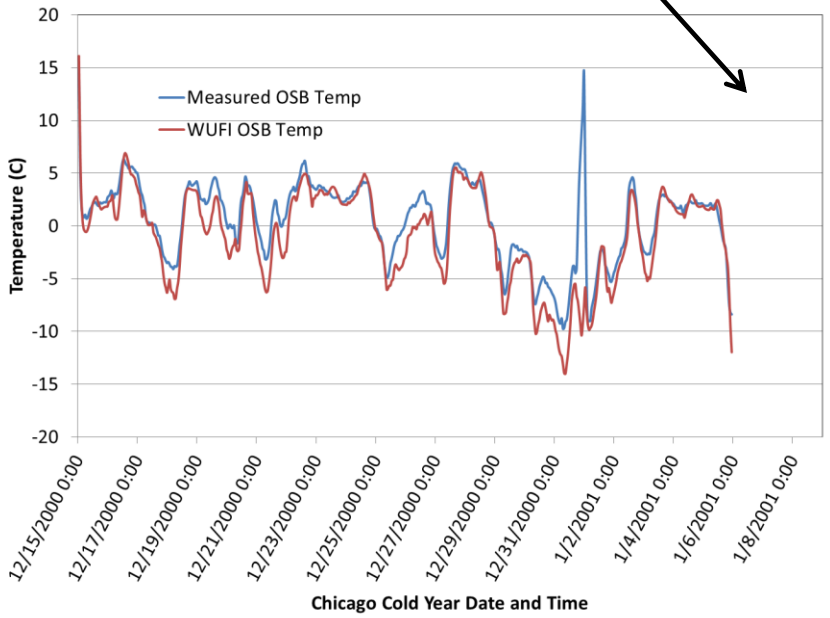

Future plans

- Address issues brought up in the survey as best as possible.
- Complete the database rulesets to include all the materials and systems currently “greyed out”.
- Continue model validation exercises to include rainfall, air leakage, and solar effects.
- Release BSA in summer 2018.

Discussion

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