DOE Building Science for Race to Zero Reading List

This is a reading list designed to aid the study of building science for Net-Zero and Low Energy Housing. It is specifically used to support the U.S. Department of Energy's Race to Zero Student Design Competition.
A variety of topics are covered related to the building science needed to design net-zero and low energy housing. These materials will help provide a better understanding of building science physics, building performance, and simulation.
We will continue to update and add to this list. If you find a broken link or would like to suggest something to add, please contact us.

Top Things to Read:

BSI-081 Net Zero Housing
Joseph Lstiburek, BSC, www.buildingscience.com
So what does "net zero" mean anyway? And what is the difference from a "zero energy house"? These and other fundamental questions about net-zero housing are answered in this Building Science Insight.

BSI-001 The Perfect Wall
Joseph Lstiburek, BSC, www.buildingscience.com
Describes the perfect wall as an environmental separator and provides an ideal model for controlling rain, air, vapor and heat.

BSD-011 Thermal Control in Buildings
John Straube, RDH, www.buildingscience.com
Providing thermal comfort without excess space conditioning costs is one of the primary requirements of buildings. To reach net-zero, a thorough understanding of thermal control is critical. This Building Science Digest provides an overview of key concepts, including insulation materials, thermal bridging, and air leakage.

BSD-014 Air Flow Control in Buildings
John Straube, RDH, www.buildingscience.com
The control of air flow is important for achieving low-energy performance, but also for several other reasons, such as controlling moisture damage and ensuring occupant comfort and health. This Digest covers fundamental aspects of air flow control.

BSD-152 Building Energy Performance Metrics
Kohta Ueno, BSC, www.buildingscience.com
Putting metrics on building energy performance is a required step to make any progress on low-energy use and/or "green" buildings. However, there are many confusing and contradictory metrics available. This Digest clarifies some commonly used terms and concepts, including site vs. source energy, modeled results vs. measured results, US average energy use figures, and methods of normalizing energy use.

BSI-049 Confusion About Diffusion
Joseph Lstiburek, BSC, www.buildingscience.com
Explains the basics of diffusion, condensation, dewpoints and other often misunderstood concepts.

BSD-013: Rain Control in Buildings
John Straube, RDH, www.buildingscience.com
This document will consider the control of rain penetration from a general to a specific level.

Sections cover: basic moisture control principles that should be employed in the design of above-grade building enclosures; driving rain as a moisture load on walls; a classification system of the various rain control strategies available for walls; and finally, good design practices for walls.

Research Papers and Reports

BA-0903: Building America Special Research Project—High-R Walls Case Study Analysis

John Straube and Jonathan Smegal, RDH, www.buildingscience.com

This report compares the performance of 12 different wood-framed above-grade enclosure wall systems that can achieve high thermal resistance (High-R). Hygrothermal simulation is used to compare the moisture performance, quasi-3D modelling is used to define R-value, and experience used to assess cost, and buildability attributes.

BA-1003: Building America Special Research Project—High-R Foundations Case Study Analysis

Jonathan Smegal and John Straube, RDH, www.buildingscience.com

Using the same approach as report BA-0903, this report compares the performance of different below-grade enclosure wall systems that can achieve high thermal resistance (High-R). Hygrothermal simulation is used to compare the moisture performance, quasi-3D modelling is used to define R-value, and experience used to assess cost, and buildability attributes.

BA-1006: Building America Special Research Project—High-R Roofs Case Study Analysis

John Straube and Aaron Grin, RDH, www.buildingscience.com

Using the same approach as report BA-0903, this report compares the performance of different wood-framed enclosure roof systems that can achieve high thermal resistance (High-R). Hygrothermal simulation is used to compare the moisture performance, quasi-3D modelling is used to define R-value, and experience used to assess cost, and buildability attributes.

BA-1316: Moisture Management for High R-Value Walls

Robert Lepage, Chris Schumacher, Alex Lukachko, RDH, www.buildingscience.com

High-performance enclosure walls have different types of moisture-related challenges. This reports steps through some of the building science driven concerns of High-R walls and uses simulation to explore the impact of climate zone on performance.

San Francisco Bay Area Net Zero Urban Infill

Kohta Ueno, BSC, and John Straube, RDH, www.buildingscience.com

This ASHRAE paper reports on a net zero energy project in a benign climate that explored prefabrication, air-water heat pumps, and night-time flushing appropriate for the Bay area.

Other General Resources

BSI-083 Mea Culpa Roofs

Joseph Lstiburek, BSC, www.buildingscience.com

This short article provides some ideas about how to go about insulating pitched wood roofs. Vented, unvented, and highly-insulated roofs are described.

BSD-106 Understanding Vapor Barriers

Joseph Lstiburek, BSC, www.buildingscience.com

BSI-071 Joni Mitchell, Water and Walls (Drying Wood Walls)

Joseph Lstiburek, BSC, www.buildingscience.com

Thermal Bridging From Cladding Attachment Strategies Through Exterior Insulation

James Higgins, Colin Shane, and Graham Finch, RDH, buildingsciencelabs.com

Excellent summary of modeling work that provides a wide range of results of the impact of thermal bridging and cladding attachment for very well-insulated wall systems.