



2017 U.S. Department of Energy Race to Zero Student Design Competition Guide

January 2017



FOREWORD

It's been extremely rewarding during the past three years to watch students work together as multidisciplinary teams to solve the real-world challenges delivering high-performance homes that are both cost-effective and meet design constraints of the mainstream housing industry.

This is an exciting time—a time when zero energy ready homes have become achievable and cost-effective. By definition, these high-performance homes are so energy-efficient that renewable power can offset all or most of their annual energy consumption.

The U.S. Department of Energy (DOE) Race to Zero Student Design Competition (Race to Zero) inspires collegiate students to become the next generation of building professionals prepared to meet the growing imperative for environmentally responsive buildings. Specifically, this competition will help provide future architects, engineers, construction managers, and entrepreneurs with the skills and experience to fully integrate building science in ultra-efficient buildings. After all, building science is vital to whether buildings will work or fail. That's why, as part of DOE's Building America and Zero Energy Ready Home programs, the Race to Zero is also designed to advance and enhance building science curricula at collegiate institutions.

The students who have participated in past competitions have exceeded all expectations by bringing exceptional energy, creativity, and practicality into their designs. Students partnered with a variety of local builders, architects, home energy professionals, and nonprofit organizations to grapple with the same challenges our nation's builders face daily—affordability, comfort, health, durability, disaster resilience, and marketability.

I look forward to your team's design at the 2017 competition event!

Sam Rashkin
Race to Zero Director
Chief Architect
U.S. Department of Energy



**INSPIRE &
DEVELOP**
the next
generation of
residential
design and
construction
professionals.



SUMMARY OF IMPORTANT DATES

The following dates are the milestones for the 2017 Race to Zero competition:

- **June 30, 2016:** Release of 2017 Race to Zero Competition Guide and team application opens.
 - Once an 'interest to compete' form or full team application is complete (both linked from the [Race to Zero website](#)), teams are provided access to competition communications and information resources, including the Google Group, the required Building Science Training, and optional REM/Rate™ software.
 - Building Science Training, in the form of pre-recorded webinars, can be accessed via instructions on the Race to Zero Google Group. This training may be waived by the team's faculty lead with confirmation of equivalency for courses the student has successfully completed.
- **November 1, 2016:** The deadline by which teams must complete the team application online.
 - Each team pays a \$200 non-refundable fee at the time of application completion.
 - Teams may optionally submit a three-page design concept, as detailed in [Appendix B](#). Submissions will be reviewed against criteria also given in the Guide.
 - If there are more than 10 applicants per any one contest, the organizers will notify all teams of contest distribution and allow up to seven days for teams to choose an alternate contest, if interested.
- **January 31, 2017:** Release of the final 2017 Race to Zero Competition Guide.

- **February 28, 2017:** The deadline by which teams must submit the Project Progress Report. Also the deadline by which student team members confirm completion of Building Science Training or confirm equivalent coursework.
 - The Project Progress Report, as detailed in [Appendix C](#), must be submitted to the team's Google Drive. If there are more than 10 teams per contest, entries will be evaluated by NREL staff against published criteria, ranked, and teams notified of feedback within ten days.
 - DOE is expected to invite up to 10 teams per contest category to participate in full competition.
 - Event registration opens after finalist teams are notified. Teams may send up to four team members in person (or more, as space allows).
- **April 4, 2017:** The deadline by which teams must submit their final Project Report Submittals to the team's Google Drive.
 - The project submittal requirements are provided in [Appendix D](#).
 - Event registration closes. Participants will not be accepted to register to attend after this date.
- **April 18, 2017:** All final Project Presentations (both long and short) and Project Posters must be submitted to the team's Google Drive as detailed in [Appendices E and F](#). Presentations will not be accepted after this date.
- **April 22–23, 2017:** Invited teams compete as they present to industry jurors at the National Renewable Energy Laboratory in Golden, Colorado.





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**UNIQUE &
VALUABLE**
opportunity to
interact with
knowledgeable
future design
and construction
professionals.

Participation

Participants in the Race to Zero have the opportunity to provide creative solutions to real-world issues in our nation's housing industry. Invited teams will complete the required submissions and attend the competition event where they will present their designs to a panel of expert jurors, compare their efforts with other teams, learn from presentations by thought leaders, and engage a variety of organizations about clean energy careers. The winning teams will be recognized at an awards banquet, and the winning designs will be made available on the U.S. Department of Energy (DOE) Race to Zero website. The competition and winners will all be promoted through a variety of media outreach efforts, which will provide participants and their collegiate institutions an opportunity for national exposure. Collegiate institutions that participate in the Race to Zero will be recognized as leading institutions that are producing job-ready young professionals with cutting-edge skills. Builders who collaborate with teams will gain national and local recognition and will have the opportunity to interact with knowledgeable future design and construction professionals.



The Race to Zero is designed to encourage student participation throughout an academic year that begins during the fall and ends in the spring with the project presentation and awards banquet.

[View Previous Years' Winners](#)

[2016 Race to Zero Results](#)

[2015 Race to Zero Results](#)

1.1 Task Overview

- Read this Race to Zero Guide and form a multidisciplinary team.
- Teams are encouraged to review the **winning teams' presentations** from last year's competition to inform their efforts.
- Submit a team application to the link provided on the Race to Zero website.
- Ensure all team members gain access to the Race to Zero Google Group, where competition updates will be posted regularly.
- All student team members must complete the DOE Building Science Training course online or have the faculty lead waive the requirement on the team application where equivalent training is provided as part of the curriculum. The Building Science Training coursework from world-renowned experts will be provided at no cost to every team member.
- Identify subject areas in which industry partnership is needed or wanted.
- Study the **DOE Zero Energy Ready Home program** requirements, including explanatory footnotes.
- Regularly consult the Race to Zero Student Design Competition **website** and Google Group, your student team lead, and faculty lead for competition updates and announcements.
- Attend optional Race to Zero live webinars as advertised on the Google Group for additional technical and competition guidance. These are also available as recordings.
- Submit all materials for evaluation by the deadlines.
- Submit your questions to **racetozero@ee.doe.gov**.

1.2 Developing a Team

Each team must be associated with a collegiate institution and include a faculty lead. The competition is open to all universities and degree institutions, including community colleges. International institutions are welcome to participate. Each team must have at least three students along with the faculty lead, with one student designated as the student team lead. Teams are encouraged to be multidisciplinary. Multiple collegiate institutions may combine to form a team. A collegiate institution may submit only one team per design contest (**Section 2**).

1.3 Student Qualifications

Great teams are cross-functional. Student team members can be from any discipline and any level of collegiate schooling. Past teams have included students who majored in architecture, engineering, building science, construction management, interior design, marketing, management, landscape architecture, and other fields. All team members should have relevant education and training to meet project goals. Each student should be pursuing a degree and be currently enrolled in at least one class at a participating collegiate institution at the time of the project presentation.

1.4 Faculty Lead Role

The faculty lead, along with the student team lead, is responsible for communicating competition details from the Race to Zero organizers to the team members. The faculty lead is encouraged to closely engage with the students on the project. The faculty lead provides support in many areas including:

- Ensuring familiarity with this Race to Zero Guide and additional guidance as appropriate.
- Ensuring that all student team members complete the building science training. The faculty lead must ensure the team meets this requirement or indicate that building science is part of the core curriculum. Also, by understanding the strengths of the students, the faculty lead can encourage the students to view additional webinars and access training materials that are most relevant to the team.
- Ensuring the necessary information is provided for team members who will be onsite at the competition event. The faculty lead may attend the competition in person or should join the presentation remotely.

1.5 Project Requirements

A Zero Energy Ready Home is a high-performance home so energy-efficient that a renewable energy system can offset all or most of its annual energy consumption. The program builds on the comprehensive building science requirements of the latest **ENERGY STAR® Certified Homes Version** along with proven Building America innovations and best practices.

For the Race to Zero, teams may develop projects based on updates of house plans from builders or work from conceptual approaches to the design competition. Teams may also take advantage of opportunities to work on redevelopment projects to complete building retrofits. Eligible scenarios are varied, and the submission must conform to the conditions in **Section 2**. The mandatory minimum design target is the **DOE Zero Energy Ready Home Requirements (Rev. 05)**. Teams must demonstrate the effective integration of building science principles and best practice guidelines for the building envelope and mechanical systems.

CREATIVE SOLUTIONS

for real-world issues in our nation's housing industry.

1.6 Industry Partnerships

Industry partnerships are encouraged to provide a market-ready perspective for proposed design solutions and for the selection and implementation of building systems. In this competition, “market-ready” is understood to be a house design that can be constructed in today’s housing market by typical trade contractors and offered for sale at reasonable cost of ownership in the neighborhood proposed for its location. Partnerships that are formed to support specific projects under consideration for construction should be clearly described in the project submission. Teams are encouraged to engage industry advisors such as local home builders, architects, and Home Energy Rating System (HERS) professionals who can help inform the students’ decision making process and provide reviews of the design materials.

1.7 Resources

[DOE Building America Solution Center](#)

[DOE Building Technologies Office, Building Science Education](#)

[DOE Zero Energy Ready Home National Program Requirements \(Rev. 05\)](#)

[Excellence in Building Science Education](#)

[National Association of Homebuilders](#)

[Air Conditioning Contractors of America \(ACCA\)](#)

[Indoor Air Quality Association](#)

[Association of Energy Engineers](#)

[The Association of Mortgage Professionals](#)

[National Association of Affordable Housing Lenders](#)

[National Association of Realtors](#)



**RACE TO
ZERO IS**
producing job-
ready young
professionals
with cutting-
edge skills.

Design Contests

The Race to Zero is comprised of four design contests. Each collegiate institution may submit one entry per contest.

In the project report, each team defines a specific location, building lot, and neighborhood characteristics as context for the house design and its relationship to surrounding homes and the community.

Projects must conform to one of the four contest definitions indicated below as measured using ANSI Z765-2003, which states that the finished square footage is the sum of finished areas measured at floor level to the exterior finished surface of the outside walls.

1. **Suburban Single-Family (SSF)**

- a. Size: 1000–3000 ft²
- b. Lot: 4000 ft² minimum

2. **Urban Single-Family (USF)**

- a. Size: 600–2500 ft²
- b. Lot: 5000 ft² maximum

3. **Attached Housing (two- to six-units, duplex or townhouse style) (AH)**

- a. Size: 500–2500 ft²
- b. Lot: 3000 ft² maximum per dwelling unit

4. **Small Multifamily (three or fewer stories above-grade) (SMF)**

- a. Size: 350–2000 ft² per dwelling unit
- b. Lot: no minimum or maximum.

A dwelling unit, as defined by the **2012 International Energy Conservation Code**, is a single unit that provides complete independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking, and sanitation.

Evaluation

Projects submitted to Race to Zero will demonstrate competency by applying principles of building science and best practice solutions. The teams will be assessed on their project report submissions, including the design and technical documentation, project plans, reports on required analyses, and the quality of their project presentations. These submissions should demonstrate the teams' ability to design, analyze, and plan for the construction of quality, high-performance homes that meet or exceed the DOE Zero Energy Ready Home requirements.

The jurors will evaluate how well teams meet or exceed the contest evaluation parameters and complete the requirements of the project submittal.

The project submissions will be evaluated by jurors in the following 10 parameters. Jurors will score each parameter of the contest on a scale of 0 to 10, which add up to the 100-point total.

Table 1. Evaluation Parameters

Evaluation Parameter	Available Points
1. Architectural Design	10
2. Interior Design, Lighting, and Appliances	10
3. Energy Analysis	10
4. Constructability	10
5. Financial Analysis	10
6. Mechanical, Electrical, and Plumbing Systems Design	10
7. Envelope Performance and Durability	10
8. Indoor Air Quality (IAQ) and Ventilation	10
9. Innovation	10
10. Presentation and Documentation Quality	10

3.1 Architectural Design

The Zero Energy Ready Home level of home performance will only achieve meaningful market acceptance when it is integrated with architectural designs that meet or exceed consumer aesthetic and functional expectations and requirements.

3.1.1 Criteria

The jury will evaluate each submission according to the following criteria:

- Quality of the architectural design and project aesthetic
- The design's responsiveness to the site; natural comfort; careful integration of residential building systems; and connection to the outdoors
- How well the design approach responds to relevant national, regional, and local programs and knowledge
- The general success of the team's approach to integrate high-performance home and building science principles within an architecturally appealing design
- Effective design and specification of materials, products, and building elements.

3.1.2 Resources

National Building Museum Principles of Sustainable Design

DOE Zero Energy Ready Home

DOE Guidelines for Participating in the DOE Zero Energy Ready Home

ENERGY STAR Certified New Homes

DOE Zero Energy Ready Home Recommended Quality Management Provisions

American Institute of Architects

3.2 Interior Design, Lighting, and Appliances

Creative and technical solutions are applied within a structure to achieve a successful interior environment. These solutions must be functional, enhance the quality of life and culture of the occupants, and be aesthetically attractive. Consideration for the environmental sustainability of materials is encouraged in interior design.

Additionally, thoughtful selection of lighting and appliances can significantly affect the overall home energy use. This is typically achieved with ENERGY STAR certified or better fixtures and appliances throughout the home.

3.2.1 Criteria

The jury will evaluate each submission according to the following criteria:

- The interior design's functionality, attractiveness, and enhancement of the occupants' quality of life
- Extent to which the interior design complements the exterior architecture
- Environmental sustainability of materials used for finishes and furniture
- Appropriateness, effectiveness, and attractiveness of the home's floorplan to the intended occupant
- Resource efficiency, resiliency, and attention to local resources
- The overall approach to lighting including specified equipment and control scenarios and analysis of artificial lighting and daylighting for specific rooms
- The overall approach to, and specification of, appliances that are energy efficient, appropriate for the needs of the occupants, and responsive to modern techniques and capabilities.

3.2.2 Resources

National Building Museum, Principles of Sustainable Design

DOE, Zero Energy Ready Home

ENERGY STAR, Energy Efficient New Homes

LEED, Guide to Certification: Homes

Kruger, A., and C. Seville. 2012. *Green Building: Principles and Practices in Residential Construction (Go Green with Renewable Energy Resources)*. Independence, KY: Cengage Learning.

Foster, K., A. Stelmack, and D. and Hindman. 2014. *Sustainable Residential Interiors*, 2nd edition. Hoboken, NJ: John Wiley and Sons.

Residential Energy Services Network, Lighting, Appliance and Miscellaneous Energy Usage Profile Amendment

Lighting Research Center, Energy Efficient Residential Lighting

ENERGY STAR, Energy-efficient Lighting and Appliances

3.3 Energy Analysis

The basis of high-performance homes is grounded in energy analysis. Early energy analysis demonstrates how the various efficiency features interact for whole-house energy reductions.

The building industry often uses the HERS Index to indicate the energy efficiency of residences. The index provides a score in which the lower the number, the more energy-efficient the home. Homes are compared against a benchmark based on the 2006 International Energy Conservation Code to determine the score. HERS can be calculated through any accredited HERS software.

REM/Rate Software is used by many organizations that conduct HERS Ratings. The software calculates heating, cooling, hot water, lighting, and appliance energy loads, consumption, and costs for new and existing single and multifamily homes. The REM/Rate program is provided to teams at no charge after registration but is not required to be used.

The BEopt™ (Building Energy Optimization) software provides capabilities to evaluate residential building designs and identify cost-optimal efficiency packages at various levels of whole-house energy savings along the path to zero energy. The BEopt software is available to download for free. Energy efficiency optimization can be calculated through a variety of tools.

3.3.1 Criteria

The jury will evaluate each submission according to the following criteria:

- Comprehensive energy efficiency and optimal interaction of efficiency features across design elements
- The appropriateness of the technology options chosen for the location and climate
- The quality of the HERS whole-house annual energy consumption calculations
- The final plan-based HERS Index Score calculated with and without renewable energy systems
- The opportunities, tradeoffs, and house design modifications needed to incorporate renewable energy systems sufficient to achieve zero annual energy use and offset nonrenewable energy sources
- Design and component analyses for active renewable energy systems that are necessary to achieve zero energy use across all nonrenewable energy sources used in the home.

3.3.2 Resources

[DOE Zero Energy Ready Home National Program Requirements \(Rev. 05\)](#)

[DOE Guidelines for Participating in the DOE Zero Energy Ready Home](#)

[ENERGY STAR Renewable Energy Ready Homes](#)

[Florida Solar Energy Center Zero Energy Homes](#)

[NREL: PVWatts](#)

[NREL: BEopt](#)

[Noresco REM/Rate](#)

[EnergyGauge Energy and Economic Analysis Software](#)

3.4 Constructability

Construction details are important for clear and precise communication to the trades and others who are responsible for reviewing or building the design as well as for technical analysis of the design. Well-drafted details in the drawings clarify design elements and help ensure a team's design and strategy are successfully implemented.

3.4.1 Criteria

The jury will evaluate each submission according to the following criteria:

- How effectively the drawings and associated documentation communicate the design and would enable successful review and construction by industry professionals, including trades, suppliers, fabricators, code reviewers, and purchasers
- The proactive design and detailed approach to prevent common problems in construction, which often occur at transitions or discontinuities in control layers (e.g., water, air, thermal, vapor)
- Level at which typical construction practices by readily available labor are considered as part of the design process.

3.4.2 Resources

[American Institute of Architects Construction Documentation Drawings](#)

[Building America Strategy Guideline: Advanced Construction Documentation Recommendations for High Performance Homes](#)

[U.S. Environmental Protection Agency \(EPA\) Moisture Control Guidance for Building Design, Construction, and Maintenance](#)

Oak Ridge National Laboratory Building Foundations Handbook, Basement Construction Details

Building Science Consulting Deep Energy Retrofit Details

3.5 Financial Analysis

The purpose of the financial analysis is to relate the team's unique design to the marketplace by estimating the overall cost of home ownership. Elements of the financial analysis include the estimated sales price, financing (mortgage), insurance, household debt, taxes, monthly utility costs, and maintenance costs.

Teams are expected to complete the organizer-provided financial analysis form and provide explanations for all values entered. The form is posted to the Race to Zero Competition Google Group site.

3.5.1 Criteria

The jury will evaluate each submission according to the following criteria:

- Quality of the construction cost analysis completed based on standard cost databases such as RSMeans or standard cost data provided by DOE including federal, state, and local financial incentives for use of renewables or for energy efficiency upgrades
- Integration of the utility cost estimate based on the energy analysis
- Quality of the maintenance cost analysis
- Affordability of the design for the targeted market segment(s) (e.g., entry level, move-up) including the necessary household income required to purchase and live in the project home assuming a 30-year fixed mortgage.

3.5.2 Resources

Description of the NREL National Residential Efficiency Measures Database

National Residential Efficiency Measures Database

RSMeans

BEopt

Clemson Extension: How Much House Can You Afford?

Database of State Incentives for Renewables & Efficiency

Open EI Database

3.6 Mechanical, Electrical, and Plumbing Design

The space-conditioning system is designed to maintain uniform comfort conditions via successful temperature control, humidity control, air movement, and distribution systems. Optimal comfort conditions depend on and respond to the interactions of climate and building envelope.

Space-conditioning system selection and design involve choosing the appropriate technology and evaluating the system performance, installed cost, reliability, operations and maintenance costs, and environmental performance.

Responsible household water use is a result of appropriately selected fixtures, occupant behavior, and energy-efficient domestic water systems.

3.6.1 Criteria

The jury will evaluate each submission according to the following criteria:

- The approach to choosing and meeting performance objectives for the mechanical system equipment selection and integration
- The systems approach relative to the structure and climate including design principles, operation and control, the thermal conditioning for each type of space, and energy source options
- The system design conforms to the requirements of Air Conditioning Contractors of America (ACCA) Manuals J, S, D, and T protocols or other industry practices such as ASHRAE or equipment manufacturer specifications
- Consideration of the maintenance requirements, working to minimize overall costs
- Reasonableness of assumptions and technical justifications for prototype equipment that may not be commercially available
- The potential for load monitoring and control of large appliances and general miscellaneous electric loads
- The application of advanced technologies to automate the control of energy use and provide energy information that can reduce energy consumption and costs.
- Selection of water conservation fixtures throughout the home
- The overall design principles of the hot water system including estimated loads, water heating equipment, supply piping, and layout to minimize wait time, losses, and wasted water.

3.6.2 Resources

[DOE, Building America Solution Center](#)

[Pacific Northwest National Laboratory, Building Science Publications](#)

[Air Conditioning Contractors of America \(ACCA\), Resources](#)

[ACCA Spreadsheets, Technical Manuals, Standards](#)

[ENERGY STAR, Heat and Cool Efficiently, Maintenance Checklist](#)

[ASHRAE, Education & Certification Fundamentals of Air System Design](#)

[Advanced Strategy Guideline: Air Distribution Basics and Duct Design](#)

[Trane, VariTrane Duct Designer](#)

[Elite Software, Ductsize - HVAC Duct Sizing and Analysis](#)

[Wrightsoft, Simple, Powerful HVAC Design and Sales Software](#)

[Design Master, Duct Layout](#)

[Lawrence Berkeley National Laboratory, Hot Water Draw Patterns in Single-Family Houses](#)

[NREL, Tool for Generating Realistic Residential Hot Water Event Schedules](#)

[Building America, “Top Innovations: Model Simulating Real Domestic Hot Water Use”](#)

[EPA, WaterSense](#)



3.7 Envelope Performance and Durability

The building envelope separates the living environment from the outdoor environment and provides the enclosure for all the systems in the home. The building envelope includes the foundation, walls, attic, windows, doors, and roof.

3.7.1 Criteria

The jury will evaluate each submission according to the following criteria:

- The design's consideration of major mechanisms that affect envelope durability and integrate the building science concepts of air transport, moisture management, and thermal and hygrothermal performance based on specific environmental conditions
- The level with which construction details and material specifications address the physical principles for air movement control based on air sealing and air barrier designs
- The level with which specifications address thermal control using insulation systems that are properly installed without gaps, voids, compression, and/or thermal bridging
- The level with which specifications address comprehensive water and moisture management including flashing details, water barriers, and capillary breaks to control bulk moisture; control of moisture movement through the wall system; and considerations for other potential moisture problems (e.g., condensation)
- The design's consideration of resiliency related to prevalent natural disaster risks for the project location.

3.7.2 Resources

ASHRAE (ASHRAE provides several relevant resources, such as Chapter 25 of the Handbook of Fundamentals)

DOE Building Technologies Office Building Science Education

DOE Zero Energy Ready Home Recommended Quality Management Provisions

Pacific Northwest National Laboratory, Building Science Publications

EPA Moisture Control Guidance for Building Design, Construction, and Maintenance

Efficient Windows Collaborative

Oak Ridge National Laboratory Foundation Design Handbook

National Institute of Building Sciences Whole Building Design Guide

WUFI

EPA, Moisture Control Guidance for Building Design, Construction and Maintenance
(Note Appendix A, Pen Test)

ASHRAE Handbook — Fundamentals (Edition 2013)

John Straube, High Performance Enclosures

3.8 Indoor Air Quality and Ventilation

IAQ can significantly impact the health and comfort of occupants. Many factors can affect IAQ including ventilation rates and methods, contamination sources and control, and effective filtration.

3.8.1 Criteria

The jury will evaluate the team's approach to addressing each criterion as follows:

- The overall approach and details of the IAQ contaminant control and filtration solutions used to provide a healthy indoor environment
- The overall approach and details of ventilation systems for occupant health and comfort
- The appropriate consideration of materials and details to improve indoor air quality
- The approach of the design to limit the introduction of contaminants into the home.

3.8.2 Resources

EPA, Indoor airPlus Program

National Institute of Building Sciences, Whole Building Design Guide

ASHRAE, 10 Tips for Home Indoor Air Quality

Lawrence Berkeley National Laboratory, Indoor Air Quality Scientific Findings
Resource Bank

Armin Rudd, Ventilation Guide – Fully Updated

3.9 Innovation

The residential building industry can often be slow to adopt the latest building science knowledge, technologies, and practices. Unique and innovative approaches to smart building design and construction that improve the status quo are necessary to transform the nation's energy future. This evaluation parameter seeks to award points to teams that take an innovative and beneficial approach to addressing residential architecture and reaching the goals of the Zero Energy Ready Home while still addressing suitability for mainstream builders. The jury will evaluate innovation across the entire design and within each scoring parameter.

3.9.1 Criteria

The jury will evaluate each submission according to the following criteria:

- Overall approach to the design competition with regard to integration of innovations that improve the design solution
- Unique integration of building science principles in ways that are achievable, beneficial, cost-effective, and functional
- Smart consideration and development of unique design parameters in the submission that respond to a market need, such as regional and local issues
- Collaboration with industry partners to evaluate and provide feedback on innovations.

3.9.2 Resources

Building America: Bringing Building Innovations to Market

Building America Top Innovations

DOE Housing Innovation Awards

National Institute of Building Sciences Innovation Conference Proceedings

U.S. Department of Housing and Urban Development: The Diffusion of Innovation in the Residential Building Industry

3.10 Presentation and Documentation Quality

Presentation quality often determines how a client receives and implements work and how effectively innovation is adopted. Complete and consistent documentation will clearly convey the goals of the team and its home design. Presentations should tell the story of the project without verbose language or cluttered slides. Planning ahead for spoken presentations, coordinating deliverables, and focusing on the visual representation of complex data can increase audience interest and commitment to the ideas undertaken.

3.10.1 Criteria

The jury will evaluate each presentation according to the following criteria:

- Completion and quality of project submittals
- Quality of presentation package of visual aids and spoken remarks
- Timeliness of project submittals.

3.10.2 Resources

[Race to Zero 2016 Presentations](#)

[Ignite Presentations](#)

[TED Talks](#)

[DOE-hosted Presentations](#)



3.11 Evaluation Rating Scale

Jurors will evaluate each parameter within the following rating scale:

Juror Rating Scale, 0 to 10 Points

0-1	Missing all items and no explanation of how the design addresses the criteria
2-3	Missing some items and minimal explanation of how the design addresses the criteria
4-5	All minimum requirements met, but with minimal explanation of how the design addresses the criteria
6-8	All minimum requirements met with a full description of how the design addresses the criteria
9-10	All minimum requirements met with distinguished excellence in describing how the design exceeds the criteria

3.12 Contest Evaluation Process

The evaluation process is multilayered and includes the following details:

- Contest juror panels, each with three to five jurors, will be convened to assess the team designs.
- One jury panel will be convened for each of the four design contests. Each contest juror panel will assess up to 10 team designs.
- Individual contest jurors will pre-score the project reports before the project presentations.
- Individual contest scores will be modified by the jurors based on the project presentations and question-and-answer period during the final evaluation event.
- Contest jurors will assign an integer value from 0 to 10 for each parameter and add them up to a total score for each team.

- Contest juror panels will select first and second place award winners in each contest based on the following attributes and others that the individual jurors will highlight:
 - Highest AVERAGE score for the juror panel
 - Does not include any juror grade lower than 4 in any subject area
 - Is considered as meeting the overall design intent of the competition
 - Demonstrates an excellent level of understanding in the individual subject areas.
- The four contest first-place award winners will then deliver a 10-minute presentation at the awards banquet.

3.13 Grand Jury Evaluation Process

A Grand Jury will select a Grand Winner from among the four first place contest-winning teams based solely on the short 10-minute presentations given at the awards banquet.

The Grand Jury will enter the review process under the understanding that the four first place contest winners have demonstrated a design that represents the quality expected for Zero Energy Ready Home through the details listed in **Section 3.12**.

The Grand Jury represents a consortium of clients who are deciding which project to invest in. The 10-minute summary presentation markets the project to the home builder, architect, and engineer clients, demonstrating how the design meets the Grand Jury parameters listed below:

- Quality of the architectural design and aesthetic
- Design's functionality for the occupants
- Comprehensive energy efficiency features across design elements
- Appropriateness of the design for the location and climate
- Proactive design to enable successful construction
- Affordability of the design for the target market
- Innovative integration of solutions that are achievable, beneficial, and cost-effective
- Quality of presentation package of visual aids and spoken remarks.

The Grand Jury will evaluate each of the criteria on the scale in **Section 3.11** to facilitate their selection of the Grand Winner.

A

Appendix A: Project Summary Submittal Instructions

The Project Summary is a one-page document that provides the basic information necessary to communicate the salient points of projects to all competition participants. It should be considered a one-page marketing summary to sell the project to those who are responsible for promoting the competition, and it should provide the key points of the project in one place.

Teams submit this Project Summary integrated with the Design Concept and the Project Progress Report. Then teams submit the Project Summary alongside the Project Report, as an individual document.

A **template** is available on the Google Group for the Project Summary. It uses “Greek text” as a placeholder for the content your team will insert. To complete this requirement, please do the following in the space provided in the template file:

Format Requirements

- Package into single PDF
- Maintain 1-inch side margins and portrait orientation
- Name the file according to the instructions in **Appendix G**.

Content Requirements

- List your project name, team name, and collegiate institution(s) in the header.
- Swap out the “logo” in the upper right corner with your team or collegiate institution’s logo.
- Swap out the “house images” with one or two graphics that best represent your project.
- Provide a concise Project Summary including a brief identification of the target market.
- Describe the relevance of your project to the goals of the competition.
- Summarize your design strategy and any relevant key points.
- List the project data.
- Provide technical specifications for your project.

Past Project Summary submissions can be viewed on the **Race to Zero website**.

B

Appendix B: Design Concept Submittal Instructions

Teams are encouraged to submit a Design Concept to the [team application site](#).

Format Requirements

- Packaged into single, bookmarked PDF
- 8.5-inch × 11-inch ANSI A sheet size
- ½-inch minimum borders, except for tables, figures, and images
- 3-page maximum
- Name the file according to the instructions in [Appendix G](#).

Content Requirements

1. Project Summary: preliminary version, one page as detailed in [Appendix A](#)
2. Names of the student team members with academic majors and degree levels; identify the student team leader
3. Contest category (see [Section 2](#), Design Contests)
4. Project approach
5. Summary of industry partners and expected form of support
6. Potential structural and mechanical systems to be pursued
7. Floorplan, exterior renderings, or interior renderings (optional).

Evaluation Criteria

- Quality of the formation of a team
- Quality of the formulation of a project approach
- Quality of a design strategy
- Level of content inclusion and completion
- Other factors, such as geographic and technology diversity, will be considered for the benefit of the program.

C

Appendix C: Project Progress Report Submittal Instructions

The Project Progress Report provides an interim submittal to demonstrate the team progress towards completing the Project Report.

Submit the Project Progress Report to the team Google Drive link which will be provided to all team members on the roster after the team application is complete.

Format Requirements

- No more than 10 pages. The cover, back pages, and table of contents are not included in the page count. For convenience of the reviewers, please number the pages.
- Single-spaced, 11-point font for body text (diagrams may have smaller fonts).
- Standard paper size, 8.5-in. × 11-in, ANSI A.
- Packaged into single, bookmarked PDF.
- ½-inch minimum borders, except for tables, figures, and images.
- Name the file according to the instructions in **Appendix G**.



Content Requirements

Table of Contents

List of Tables

List of Figures

Team Qualifications (1 to 3 pages)

- Team profile and qualifications for each student member
- Academic institution profile with particular focus on building science

Industry Partnerships (1 to 2 pages)

- Summary of partnerships with industry professionals, including builders or developers, for the overall project design and site development
- Summary of partnerships with trade professionals in specific areas such as site development, construction, building materials, mechanical systems, lighting systems, financing, and sales.

Design Constraints Description (1 to 3 pages)

- Summary of the lot size, shape, orientation, climate, and relationship to road(s)
- Summary of the intended occupants and their characteristics
- Identify any programs or standards that form the basis for design and their roles in achieving the goals of the competition
- Describe the neighborhood and/or community setting, including density, access to, and reliance on various transportation modes.

Design Goals (1 page)

- Summarize the goals the team considered when creating and developing the design.

Project Summary (See Appendix A)

Evaluation Criteria

- Quality of design strategy constraints and goals
- Level of content inclusion and completion
- Other factors, such as geographic and technology diversity, will be considered for the benefit of the program.

Appendix D: Project Report Submittal Instructions

A team's project report submittal shall be in two volumes: Volume I—Project Report and Volume II—Supporting Documentation. Both submissions are required.

In addition, each team needs to submit the one or two graphics that best represent its project separately as high-resolution image files. These graphics may be used for competition promotional purposes and can include renderings, photos, or drawings.

Volume I is limited to 40 pages and should include all the information the team deems essential to portraying its competition solution to the jury. A summary and discussion of analytical results should be provided in Volume I—Project Report; other supporting information such as detailed calculations and equipment data sheets should be relegated to Volume II—Supporting Documentation. Citations may be in the team's chosen format but should be consistent throughout the submission.

Format Requirements

- Volume I. No more than 40 pages. The cover, back page, and table of contents are not included in the page count. For convenience of the jurors, please number the pages. Front matter can have page numbers using Roman numerals (e.g., i, ii...iv).
- Volume II. 100-page limit. Please number the pages. The jurors evaluating your submission will have a limited amount of time to review the entire submission, so teams should plan accordingly. Links should be provided for manufacturer documentation, etc.
- Single-spaced, 11-point font for body text (diagrams may have smaller fonts).
- Standard paper size, 8.5-in. × 11-in, ANSI A.
- Packaged into single, bookmarked PDF.
- ½-inch minimum borders, except for tables, figures, and images.
- Name the file according to the instructions in **Appendix G**.

Content Requirements

Volume I—Project Report

Table of Contents

List of Tables

List of Figures

Team Qualifications (1 to 3 pages)

- Team profile and qualifications for each student member
- Academic institution profile with particular focus on building science

Industry Partnerships (1 to 2 pages)

- Summary of partnerships with industry professionals, including builders or developers, for the overall project design and site development
- Summary of partnerships with trade professionals in specific areas such as site development, construction, building materials, mechanical systems, lighting systems, financing, and sales.

Design Constraints Description (1 to 3 pages)

- Summary of the lot size, shape, orientation, climate, and relationship to road(s)
- Summary the intended occupants and their characteristics
- Identify any programs or standards that form the basis for design and their roles in achieving the goals of the competition
- Describe the neighborhood and/or community setting, including density, access to, and reliance on various transportation modes.

Design Goals (1 page)

- Summarize the goals the team considered when creating and developing the design.

Evaluation Parameters Narratives, Images, and Figures (1 to 30 pages)

1. Architectural Design
2. Interior Design, Lighting, and Appliances
3. Energy Analysis
4. Constructability
5. Financial Analysis
6. Mechanical, Electrical, and Plumbing Design
7. Envelope Performance and Durability
8. Indoor Air Quality (IAQ) and Ventilation
9. Innovation.

Volume II—Supporting Documentation

Table of Contents

1. Design Renderings
 - a. Exterior
 - b. Interior
 - c. Floorplan with furnishings
2. Construction Drawings
 - a. Site plan
 - b. Dimensioned floorplan(s)
 - c. Building elevations (all)
 - d. Building sections
 - e. Interior details including a required furniture layout and option details on finishes, cabinetry, and other fixtures
 - f. Wall, floor, and roof sections
 - g. Window and door details (including flashing), schedule, and specifications
 - h. Air sealing details
 - i. Mechanical plans and schedules, indicating duct sizing and layout, equipment locations and specifications, control design and specification, and minimum installation requirements
 - j. Plumbing plans and schedules, including fixture locations, piping system layout and design, equipment location and specifications, and minimum installation requirements
 - k. Electrical and lighting plans and schedules including outlet locations, fixture specifications, control systems, and photovoltaic systems
 - l. Construction schedule and size of the project

D

3. Energy Analysis

a. HERS Rating Documentation

- i. Include the house size adjustment factor calculations as required for homes exceeding the square feet specified in the Size Adjustment Factor table
- ii. Perform a HERS Index analysis to include the home with and without the renewable energy system

4. HVAC Commissioning requirements referenced to manufacturer and trade protocols

5. Financial Analysis, using provided template and appropriate references

6. Optional additional documentation to support team design goals and submission.

Project Summary (see Appendix A)



E

Appendix E: Project Presentations Submittal Instructions

Each team shall develop two presentations. The long presentation will be a 25-minute presentation of the submission to deliver in person to the contest jurors at the event; an additional 10 minutes of the presentation time must be reserved for questions for a 35-minute total time slot for the team presentation.

The second presentation will be a 10-minute version. First place winners in each contest category will give a 10-minute presentation to the Grand Jury as well as all competition participants at the awards banquet. No time is reserved for questions. See **Section 3.13** for the Grand Jury evaluation process.

Teams are not required to include their project presentations within the Project Report Submittal.

Name the files according to the instructions in **Appendix G**.



F

Appendix F: Project Poster Submittal Instructions

Each team shall develop a project poster that showcases its design and response to contest parameters. A poster session will be offered during the competition event during which all team projects will be on display.

- Content should, at a minimum, include the Project Summary content in Appendix A.
- A team may include additional information, graphics, and images as desired.
- Size to be 3' wide x 2' tall.
- Submitted as a PDF.
- Name the files according to the instructions in **Appendix G**.
- Teams should print their poster and bring it to the competition event.



Appendix G: Electronic File Naming Instructions

Project submittals are considered to be on time if they are uploaded to the appropriate Race to Zero team folder by 5:00 p.m. Eastern Time on the due date of submittal. Refer to the **Summary of Important Dates** for submittal due dates and the corresponding appendices for required file formats for each of the respective project submittals. Teams are encouraged to submit at least a few hours prior to the deadline to ensure that project submittals are received. Jurors will receive notification about late project submittals.

All electronic files shall be uploaded to the Google Drive link sent to teams. All team members on the current roster will be provided access. Contact the organizers at racetozero@ee.doe.gov with questions.

Electronic File Naming Convention

The required file naming convention for all electronic files follows:

[COLLEGIATE SHORT NAME]_[CONTEST ABBREVIATION]_[DELIVERABLE ABBREVIATION]_[SUBMISSION DATE (YYYY-MM-DD)].[EXTENSION]

Following is a list of contest and deliverable abbreviations. Collegiate short name abbreviations will be made available on the Google Group in a separate document.

Example: A Project Progress Report submitted by Illinois State University team in the Urban Single-Family contest on February 28, 2017, would have the following file name:

IllinoisState_USF_PROGRESS_2017-02-28.pdf

G

Contest Abbreviations:

Suburban Single-Family: SSF

Urban Single-Family: USF

Attached Housing: AH

Small Multifamily: SMF

Deliverable Abbreviations:

Project Summary: SUMMARY

Design Concept: DESIGN

Project Progress Report: PROGRESS

Project Report Volume I: VOLI

Project Report Volume II: VOLII

Project Presentation – 25 minute: PRESLONG

Project Presentation – 10 minute: PRESSHORT

Project Poster: POSTER

Project Photo 1: PHOTO1

Project Photo 2: PHOTO2



Appendix H: Frequently Asked Questions

Some of the frequently asked questions from the 2016 competition follow with answers.

Additional questions can be sent to racetozero@ee.doe.gov.

Team Application

Question:

Is there a fee to participate?

Answer:

Yes, each team pays \$200 to register.

Question:

Will we be refunded if we do not complete the competition?

Answer:

Refunds will not be issued for teams who choose not to compete or are not invited to participate in the competition event.

Guide/Rules

Question:

I have a student who is graduating in December. Can this student continue to participate in the competition?

Answer:

Team members that graduate prior to the competition date may continue to participate as industry partners in the competition, but they may not present at the competition event.

Question:

Can teams have more than one faculty advisor?

Answer:

Yes, a team may have more than one faculty advisor, but one faculty lead must be designated to serve as a primary contact, oversee the team, and maintain responsibility for students completing the building science training or curriculum.

Question:

Do we have to develop both a long and short presentation?

Answer:

A: Yes, as a (long) 25-minute presentation cannot be packed into 10 minutes. The evaluation parameters for the (short) 10-minute presentation are different, so consider how the audience has changed and develop your short presentation accordingly.

Question:

Where do we find information about the Building Science Training?

Answer:

The Building Science Training access instructions can be found on the Google Group.

Question:

In order to waive the Building Science Training, can you provide a list of the topics covered?

Answer:

The following lessons are covered in the Building Science Training:

Lesson 1: Intro

Lesson 2: Enclosure Fundamentals

Lesson 3: Rain Control

Lesson 4: Air Flow Control

Lesson 5: Heat Flow Control

Lesson 6: Vapor and Condensation Control

Lesson 7: Roofs

Lesson 8: Ventilation and Air Pressure Management

Lesson 9: Windows

Lesson 10: Durable, Healthy, Efficient Housing

Special Lesson: Unique Solutions (optional)

Special Lesson: Multi-Family/Multi-Unit Housing (optional).

Project

Question:

Does the building have to be shown furnished in drawings and renderings?

Answer:

Yes, the rendered floorplan must show furniture, but the dimensioned floorplan does not need to show furnishings. A good design must consider how the occupants will live in the home and that includes furniture. This will help move the housing market away from a total square footage to an effective square footage metric. Moreover, furnishings provide a better visual presentation and help jurors better understand scale and functionality of the design.

Question:

Should we use metric units or English units?

Answer:

English units are preferred. Most of the jurors are oriented to English units, not SI or metric. However, a submission with metric units would be accepted. If metric units are used, please also include English units in parentheses.

Question:

Does our project have to have onsite renewable energy?

Answer:

Renewable energy should be considered in some form, but is not required. If it is not feasible for onsite generation, other options such as purchasing of renewable energy credits or participation in a community project should be considered and those costs should be factored into the financial analysis.

Question:

From our understanding, our team is supposed to use the RSMeans database or other DOE-provided standard cost data for our construction costs. However, the Interior Design section says that we're also supposed to give attention to local resources. By local resources, does the Guide mean that we can take advantage of local dealers of products, or does that specifically refer to natural resources (i.e., use wood local to the area)? For example, we have a window company nearby and we were hoping to use their windows. If we were to do that, would we use their window cost or the cost of a similar window from RSMeans?

Answer:

For costing, you just need to be able to justify your costs. If RSMeans works, use that. If you are using local materials, cite your resource for the costs.

Question:

We're also supposed to have furnished floor plans. Does that mean that we're supposed to include furniture pricing in our cost analysis?

Answer:

Unless you choose to pursue a design and marketing strategy that indicates all furnishings would be included (for example, if you were designing for small multifamily studios and targeting recent graduates/new-to-the-city people who do not yet own furniture), the cost of furniture should not be included in the cost analysis. It is important to show furniture so that the juries can best understand the functionality of the space. In real life, any cost to demonstrate furniture layouts or to stage a house would be included in the non-construction costs.

Question:

I have a question about the square footage constraints in Section 2 of the Competition Guide. For a single-family urban detached house, the maximum is listed at 2,500 square feet. Is that an absolute maximum, or can we go over that if we use the DOE Zero Energy Ready Home Performance Path and apply a size modification factor?

Answer:

For the purposes of this competition and to help ensure that the juries are evaluating comparable houses, the square footage limits are firm. For example, asking a jury to evaluate both a 2,000-ft² house and a 22,000-ft² house is not practical. While you may be considering something much closer to 2,500 ft², it is a slippery slope if we do not maintain a hard limit at what is listed in the Competition Guide.

Please be sure to read the ANSI Z765-2003 standard, however, to understand how that 2,500-ft² limit is actually calculated. The standard evaluates conditioned, finished areas only, such that a conditioned—but unfinished—basement or garage or a three-season room would not be included in the floor area calculation. Similarly, mechanical rooms are often excluded.

Question:

The urban single-family house is required to be less than 2,500 ft². Usually, below-grade spaces do not count toward a home's square footage, but can be noted separately in the listing. The code for competition reference ANSI Z765-2003 only said the above-grade and below-grade areas should be reported separately. We would like to know if 2,500 ft² includes the square footage of basement. Right now, if the basement is included, our footage will exceed the maximum 2,500 ft². Should we report it separately?

Answer:

The Race to Zero Competition Guide does not distinguish between above-grade or below-grade when setting the 2,500-ft² limit—simply that the total finished square footage is within this total. The calculation only includes areas that are fully finished to a level equal to the remainder of the house and are conditioned and suitable for year-round use. An unfinished basement that is designed and built for easy completion at a later date by a homeowner would not be included in the 2,500-ft² limit (i.e., if the plumbing rough-ins are there and electrical is installed, but drywall is not finished or finished flooring is not laid, it would not be included). In addition, mechanical rooms and other spaces not finished to the same level as the rest of the house are not included.

Question:

The Guide mentions that teams are expected to complete the organizer-provided financial analysis form and provide explanations for all numbers entered. Where do we find this form?

Answer:

The form is posted to the Race to Zero Competition Google Group site.

Question:

Are labor costs included in the construction costs, or should we be including labor separately?

Answer:

For each of the component costs listed in the financial analysis spreadsheet, that is the total loaded cost for that element, inclusive of materials, equipment, overhead, profit, and labor for the subcontractor completing that element. The general contractor would still have separate profit, overhead, and general expenses. As such, even if an oven, for example, was purchased for \$1,500, the total cost when including labor and associated work might be \$2,500. You can read up on cost estimating from a variety of sites and platforms, such as RSMeans or others.

Competition Event

Question:

Will the organizers be able to provide discounted travel and lodging expenses for the final presentation in Colorado?

Answer:

Discounted travel or lodging will not be provided by the competition organizers. There will be a small discount on a lodging room block at the Denver Marriott West and teams may lodge where they wish. Please note that funding for travel and lodging is not available to teams. Teams are responsible for all their own travel plans and costs.

Question:

In the past, have other teams typically received help from their industry partners to help fund team travel and lodging expenses? Is this appropriate to do?

Answer:

Teams receive help from their collegiate institution, industry partners, or pay themselves. Teams definitely should explore sponsorship routes for funding.

Question:

How many team members typically present?

Answer:

We encourage all students who are onsite to participate in the team presentation.

Question:

Can we present remotely at the competition?

Answer:

The organizers encourage each team to send at least one in-person participant student to the competition. The networking opportunities and other presentations provide a rich experience for onsite participants. Remote presentation will be available if the team has travel issues.

Question:

Can faculty participate in the presentation to the jurors?

Answer:

No, faculty may not participate in the team presentation.

Question:

Can we use a video during our team presentation?

Answer:

To ensure that all electronically submitted materials work with the organizer presentation computers, we ask that you submit the video separately at the time of the other project submittals. Teams are encouraged to embed that video in the PowerPoint or PDF of the team slides, but the organizers need to be notified of the additional piece to ensure the appropriate software is available to play the video.

Question:

Is the faculty lead required to attend the competition event?

Answer:

The faculty lead is encouraged to attend but not required.

Question:

Can we bring an architectural scale model to the competition?

Answer:

Yes. If your team is interested in bringing an architectural scale model, your team will indicate this during participant registration for the competition event. Each team will be solely responsible for shipping the model. We recommend arranging for receipt at your hotel or a local shipping facility (such as UPS or FedEx Office). Your team should develop plans for bringing the model to and from NREL on the weekend of the competition. Please make sure to include your collegiate institution(s), contest, and team name on the model. The scale models may be on display during your contest presentation and at the poster session. These physical models are optional.

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ACKNOWLEDGMENTS

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For more information,
visit: eere.energy.gov

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