U.S. DEPARTMENT OF ENERGY
SOLAR DECATHLON

Competition Guide:
2021 Design Challenge
2023 Build Challenge

February 2021

Foreword

Congratulations on your decision to pursue participating in the U.S. Department of Energy (DOE) Solar Decathlon® and all the excitement that comes with the competition! The Solar Decathlon showcases the future of the built environment: high-performance buildings so energy efficient that their annual energy use can easily be offset with renewable energy. This is an opportunity to help take buildings to the next level through a variety of advancements, including making them more affordable for families; incorporating grid-interactive technologies; improving construction productivity; providing greater comfort and healthier indoor environments; and optimizing operational efficiency with resilient solutions that will stand the test of time.

In support of this ambitious challenge, the Solar Decathlon tasks collegiate teams with developing innovative building solutions. Participating students get hands-on experience and unique training that prepares them to enter the clean energy workforce and influence others to pursue energy efficiency and renewable energy technologies. The winners of the Solar Decathlon competition are the teams that best blend technology, market potential, and design excellence with smart energy efficiency and renewable energy production.

Structured to reward projects that pursue thoughtful and influential innovation, teams are expected to demonstrate how the techniques, products, and solutions integrated into their competition entries can significantly impact the buildings market. The projects are developed by multidisciplinary teams, providing the opportunity to learn not only about building science but also about financial analysis, teamwork, oral and visual presentation, and other skills key to ensuring the viability of building projects in the competition and beyond.

As we enter this Solar Decathlon, we continue to be inspired and energized by you and your ideas for the future. The outstanding quality of participating students is also noticed by our sponsors, jurors, and the buildings industry at large. With each new competition, we see significant growth and interest in how they engage students about job and professional development opportunities.

DOE is very excited to engage collegiate teams to become part of the next generation of building designers and engineering professionals. This document is designed to help ensure your success. We encourage you to read it in full and closely follow the guidance within to help position your team most effectively and to enhance the value of your participation.

We look forward to seeing your work!

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Solar Decathlon Competition Guide Authors: NREL's Rachel Romero, Joe Simon, and Taylor Ryan.

The Solar Decathlon

The U.S. Department of Energy (DOE) Solar Decathlon® is a collegiate competition, comprising 10 Contests, that challenges student teams to design and build highly efficient and innovative buildings powered by renewable energy.

1 Inspiring Tomorrow's Building Industry Leaders

Energy efficient. Productive. Innovative. Creative. Resilient. Smart. These words describe more than the ideal building. They distinguish the students who have participated in DOE's premier building competitions.

The Solar Decathlon offers collegiate teams a unique experience to develop critical career skills, learn from both national experts and peers, and gain valuable insights from world-class thought leaders. Specifically, student teams are challenged to design and (if part of the Solar Decathlon Build Challenge) build highly energy-efficient buildings powered by renewable energy. The winners are those teams that best blend architectural and engineering excellence with innovation, market potential, building efficiency, and smart energy production.

2 History

The award-winning Solar Decathlon began with a public event on the National Mall in Washington, D.C., in 2002. DOE has since hosted a total of nine Solar Decathlon Build Challenge competitions in the United States, growing technology and workforce benefits with each event. The Solar Decathlon has also expanded internationally, including six international regions that have hosted their own events and have several more upcoming.

The Solar Decathlon Design Challenge competition began in 2014 and has been held annually ever since. The competition's impact has grown continuously, including an expansion to allow commercial buildings and more diverse residential building types, a significant increase in the number of competing teams and participating students, and substantial integration of the program into collegiate institution curricula across the country.

3 Building Science to Ensure High-Performance Buildings

The Solar Decathlon challenges students to fully integrate comprehensive building science with energy efficiency and renewable energy innovation. This helps ensure designs include the foundational requirements for comfort, durability, health, resilience, and safety—all attributes of high-performance buildings.

To help meet these objectives, participating students are provided with a comprehensive building science seminar series designed to enhance their academic curriculum. This seminar series is available online to the collegiate team members at no cost to them, including 10 on-demand, 1-hour modules with additional special lessons. In addition, other topical webinars are provided to support their skill development and technical progress. Through the seminar and webinar series, students have the opportunity to learn more about strategies for high performance, energy efficiency, and energy production than they would otherwise gain in the classroom alone.

4 Two Challenges, Ten Contests

This Solar Decathlon, which spans 2021 Design Challenge and 2023 Build Challenge, gives teams the option to participate in one of two Challenges: the ***Design Challenge*** or the ***Build Challenge***. Teams entering the Design Challenge must select from seven allowable building types ("Divisions") to create their design. Teams entering the Build Challenge will build a residential unit locally and compete nationally. Whether participating in the Design Challenge or the Build Challenge, all teams are evaluated across 10 Contests. Just like athletic decathlons, teams must perform well across all 10 Contests to be victorious. Figure 1 provides a graphic depiction of the various competition options.

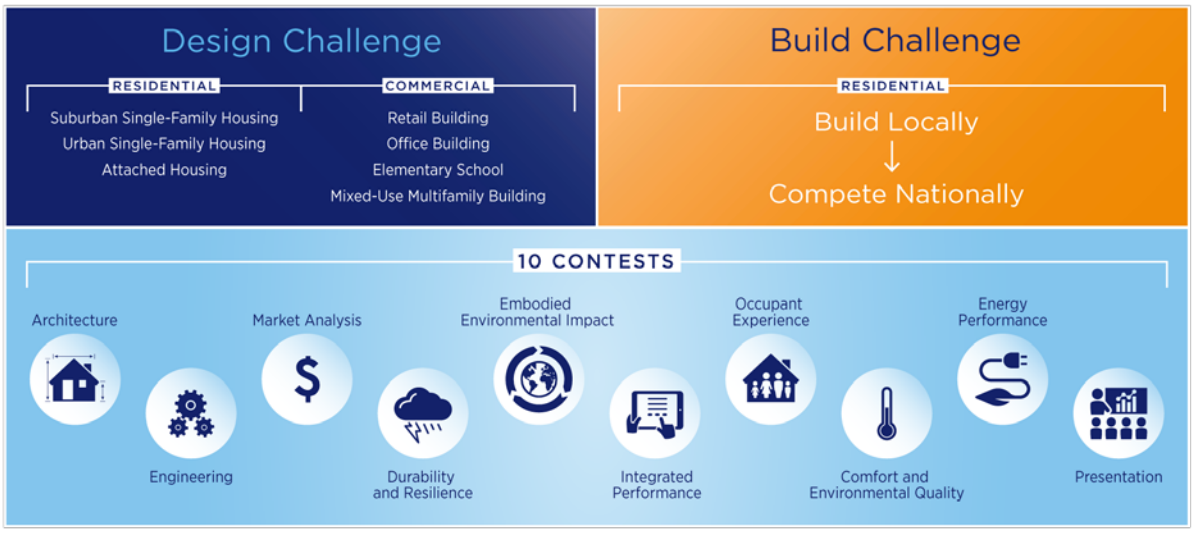

Figure 1. Structure of the Solar Decathlon

Figure 2. Timeline of the Solar Decathlon

To understand how the Challenges occur in parallel, Figure 2 demonstrates the 2-year 2023 Build Challenge, which begins active recruiting in April 2021, and the Design Challenge, which has a competition event annually. A similar timeline could be developed for international programs.

5 Design Challenge (Annual)

Teams that compete in the annual Solar Decathlon ***Design Challenge*** create residential or commercial building designs over one or two semesters. Designs are evaluated on how well they meet the nation's rapidly evolving demand for buildings that are innovative, cost-effective, quick to build, high quality, resilient, grid interactive, efficient, and locally responsive. Teams choose one of seven building type Divisions in which to compete.

Teams interested in participating in the Design Challenge should look carefully at the Solar Decathlon Design Challenge Rules (see separate Design Challenge Rules document). A few key points are noted here:

- Design Challenge teams choose to compete in one of seven Divisions:
    - Suburban Single-Family Housing
    - Urban Single-Family Housing
    - Attached Housing
    - Mixed-Use Multifamily Building
    - Elementary School
    - Office Building
    - Retail Building.
- Teams may apply and begin projects as early as August of the preceding year (for example, beginning in August 2020 for the 2021 Design Challenge). For the Design Challenge application, each team:
    - Identifies a Faculty Lead
    - Selects the Division in which it intends to compete
    - Pays a nonrefundable $100 application fee.
- Participating teams are confirmed and announced by December.
- Participating teams each submit a Project Proposal the following February for evaluation.
    - Finalist Teams are selected and invited to compete further with a final Design Portfolio of their building at the Competition Event, held annually in April at the National Renewable Energy Laboratory (NREL) main campus in Golden, Colorado.
- Winners from each Division are determined by juried evaluation across all 10 Contests and awarded with trophies at the annual Competition Event. Two Design Challenge Grand Winners (one for Residential and one for Commercial building types) are also selected from

the pool of winners. See respective Rules related to Design Challenge for more information on awards.

6 Build Challenge (Biennial)

Teams that compete in the Solar Decathlon ***Build Challenge*** design and construct fully functional houses. Teams build a house compliant with the guidelines and build, exhibit, and operate houses in their own communities. All teams compete against each other, equally. Each house is extensively measured for its real-world performance, and students present to multiple juries. In the Build Challenge, each of the 10 Contests are scored independently, and the team with the most points at the end of the competition wins.

Teams interested in participating in the Build Challenge should carefully review the Solar Decathlon Build Challenge Rules (see separate Build Challenge Rules document)[1]. A few key points are noted here:

- **Applications will close in October 2021.**
- Applying teams will design and build a house for their local communities, competing nationally against other teams.
- Interested teams may begin projects in advance, but must apply by October 2021.
- For the Build Challenge application, each team:
    - Identifies a Faculty Lead or student Team Lead with a preliminary roster of student members
    - Submits a required Build Challenge Proposal composed of a conceptual house design, letters of team support from collegiate institution leadership and industry partners, and a project management plan
    - Pays a nonrefundable $100 application fee.
- Participating teams are confirmed and announced by December. All teams that successfully complete their Build Challenge application are accepted.
- Participating teams each present their solutions at the Competition Event, held annually in April at the National Renewable Energy Laboratory (NREL) main campus in Golden, Colorado.
    - Up to 20 teams will be selected to receive prize funding from DOE and receive an approval to proceed to the construction phase of the competition. Additional teams may receive an approval to proceed to the construction phase of the competition, but would not receive prize funding. Teams that are not selected have the option to enter the subsequent Design Challenge.
- All Build Challenge teams are required to submit a variety of interim deliverables and present their designs and other required materials at the Competition Events, held in April 2022 and 2023 at the NREL main campus in Golden, Colorado.

[1] At this time, the 2023 Build Challenge Rules have not yet been released. Review the 2020 Build Challenge Rules as reference.

- Winners will be awarded trophies at the 2023 Competition Event.

7 Ten Contests

Teams in both Challenges are evaluated to determine how effectively they integrate energy efficiency into well-designed, high-performance buildings that "push the envelope" for consumers and industry. More specifically, all participating teams compete in the following 10 Contests. See the Solar Decathlon Design Challenge Rules and Solar Decathlon Build Challenge Rules for specific evaluation criteria.

1. Architecture

This Contest evaluates the building's architecture for creativity, overall integration of systems, and ability to deliver outstanding aesthetics and functionality.

Architecture marries aesthetics with sound building science, energy efficiency, natural ventilation, energy production, and resilience. Cutting-edge energy-efficient buildings are better positioned to achieve meaningful market acceptance if integrated into architectural designs that creatively meet or exceed aesthetic and functional expectations of both industry and consumers.

2. Engineering

This Contest evaluates the effective design of high-performance engineering systems, technologies, and techniques through the use of energy efficiency and renewable energy.

Effective designs for buildings systems incorporate careful considerations of structural performance, occupant comfort, environmental conditions, and regulatory constraints. Heating, cooling, water, and ventilation system types and design should reflect different technology and integration options, including analysis of implications for energy and environmental performance, up-front and long-term costs, and reliability. Opportunities for water efficiency should be reflected in smart engineering solutions for domestic hot water delivery and landscaping irrigation as well as plumbing fixture and landscaping choices. Energy consumption and production is evaluated against specific site constraints and designed accordingly.

3. Market Analysis

This Contest evaluates the building's appeal, affordability, and attainability to its stated target market; this includes the likelihood of adoption by intended occupants and the construction industry for impactful, cost-effective design.

To ensure uptake in the market and drive both demand and supply, effective energy-efficient designs take into account the interests of intended building occupants and owners as well as the construction industry. On the consumer side, designs should reflect how occupants can best use and enjoy the built environment and accommodate potentially changing preferences of occupants over time. On the supply side, a successful design will consider how to reduce construction cycle time, ensure outstanding quality, and improve productivity of building industries. A successful design should also include high-quality construction documentation.

Financial analysis should include estimated costs of construction, monthly utilities, and maintenance to determine an overall cost of ownership and provide a basis for comparison to the

financial capabilities of the target market and overall affordability. The cost of construction, as well as the extent to which the design would cost more than a code-compliant building, should be carefully considered and justified.

4. Durability and Resilience

This Contest evaluates the building's long-term ability to endure local environmental conditions and anticipate, withstand, respond to, and recover from disruptions.

Durability reflects the ability of the building envelope to maintain long-term performance despite routine environmental conditions. Resilient design enables the building to maintain critical operations during disruptions and quickly restore normal operations. The benefits of investing in highly efficient buildings are compounded by also investing in resilient design. Teams must demonstrate how their buildings effectively address all of these challenges.

5. Embodied Environmental Impact

This Contest evaluates the full life cycle of a building, from cradle to grave.

"Circular economy" for a building refers to an economic system in which buildings are designed with a focus on minimizing environmental impact from material extraction and manufacturing to transportation, construction, and use, while also considering "Re-X"—reclamation, refurbishment, repair, reuse, recycle, etc.—of materials throughout its life cycle. Within the sphere of a circular economy, various measurements and calculations are used to quantify the environmental impacts that are embodied into the building at each life cycle stage. As buildings become more resource efficient during occupancy, the environmental impact during this stage decreases. Consequently, the other life cycle stages—such as material production, manufacturing, construction processes, and end of life—become larger contributors to a building's total environmental impact and, therefore, become more important to address. The building industry must go beyond the occupancy stage to address these impacts in all life cycle stages.

6. Integrated Performance

This Contest evaluates how effectively the whole building performance is optimized through passive and active strategies across multiple building disciplines.

An integrated design utilizes architectural and engineering elements that complement each other to help the building achieve optimal performance. For example, a building that is properly oriented will more effectively capture passive heating, cooling, ventilation, and lighting. Without one design element (e.g., building orientation), additional energy-consuming systems are required to provide the dependent design element for interior conditions (e.g., mechanical HVAC). In a truly integrated design, when any element is altered or removed from the building, energy consumption of the overall building could increase.

7. Occupant Experience

This Contest evaluates how the building optimizes occupants' quality of life while also meeting the energy performance goals of the design.

Technologies and appliances should be thoughtfully selected and integrated into the overall design. This includes strategies for efficiency, comfort, health, and safety that address operational expectations of consumer.

8. Comfort and Environmental Quality

This Contest evaluates the building's capability to deliver intended comfort and indoor environmental quality.

Well-designed buildings provide both a comfortable and healthy indoor environment. For occupants to be comfortable, the building must be able to control temperature and relative humidity levels, as well as reduce exterior noise infiltration. To provide a healthy indoor environment, the design must include a comprehensive approach to indoor air quality that incorporates ventilation, filtration, dilution, and material selection strategies.

9. Energy Performance

This Contest evaluates reduction of whole-building energy consumption, ability to generate clean energy that is needed on-site, and interaction with local grid operations.

Effective whole-building energy analysis and decision-making is the foundation for energy performance. Energy performance incorporates energy consumption, clean energy generation, and the capability of the building to provide grid services.

10. Presentation

Successful evaluation of each Contest depends on the team's ability to accurately and effectively convey its design and approach to energy performance to relevant audiences.

In order to inspire future professionals, incumbent industry leaders, and the public at-large to pursue energy efficiency and renewable energy opportunities, the value proposition must be clearly conveyed, both verbally and visually.

A smart design on its own is insufficient. Presentation quality can dramatically affect consumer perception and the likelihood of innovation being adopted. As such, each jury evaluates not just the criteria of the individual Contest but also the team's presentation of the design solution.

8 Two Challenges

Within the Design Challenge, multiple teams from a collegiate institution may apply in different Divisions (e.g., Attached Housing, Office Building, Elementary School); however, an institution can only support one team in a particular Division. Once your team chooses which Division you are in, consult the detailed Design Challenge Rules.

Table 1. Considerations for Challenge Participation

Consideration	Design Challenge	Build Challenge
Scope of Project	Design and present	Design, build, operate, and exhibit
Team Commitment	One to two semesters	Two academic years
Building Type(s)	Residential and commercial	Residential
Industry Engagement	Design Partners and industry mentors	Hands-on support for site, construction, and oversight
Exhibit Activities	No public events; presentations only open to competitors and jurors	Local community exhibition and tours of built house plus presentations to competitors and jurors at the Competition Event
Financial Resources Required	Cost of student and faculty travel to the annual Competition Event at NREL in Golden, CO; Cost of time for faculty leadership	Cost of building house, including all materials and infrastructure (often a mix of institution, alumni, industry, and sponsorship); Cost of 12–20 student and faculty travel to multiple events (2022 Competition Event and 2023 Competition Event, both at NREL); Cost of time for faculty leadership, student stipends, and scholarships
Financial Resources Provided by Competition Organization	None	$50,000 for each of 20 teams, distributed as Prize Funding

All competition options are designed to integrate into a variety of collegiate curricula and provide positive, life-changing experiences for students. They are also invaluable for helping faculty prepare students to meet future opportunities. Most importantly, the Challenges are designed to help students launch their careers and have a substantial impact on the energy future of the United States and the world.

U.S. DEPARTMENT OF ENERGY
SOLAR DECATHLON

2021 Design Challenge Rules

January 2021

List of Acronyms

AH	Attached Housing
ANSI	American National Standards Institute
Btu	British thermal unit
DOE	U.S. Department of Energy
ES	Elementary School
EUI	energy use intensity
HERS	Home Energy Rating System
HVAC	heating, ventilating, and air conditioning
kBtu	kilo-British thermal unit
MM	Mixed-Use Multifamily Building
NREL	National Renewable Energy Laboratory
OB	Office Building
RT	Retail Building
RESNET	Residential Energy Services Network
SSF	Suburban Single-Family Housing
USF	Urban Single-Family Housing

Foreword—Why Solar Decathlon Design Challenge?

High-performance buildings include comprehensive building science, energy efficiency, optimized mechanical systems, indoor air quality, resilience, and water conservation. However, building occupants expect more, so it's imperative to integrate high-performance building solutions with great design. All of these attributes will ultimately determine whether buildings succeed or fail in terms of the human experience: affordability, comfort, health, durability, safety, and adequate resources.

Professional curricula across the United States and around the globe can do more to consistently provide architecture, engineering, and construction management students the skills needed to effectively integrate high-performance measures with design. In fact, emerging crises related to affordability, health, disaster risks, and water shortages are making these skills imperative. At the same time, degree programs are working to effectively integrate them into their curricula. Enter the U.S. Department of Energy (DOE) Solar Decathlon® Design Challenge.

Since 2014, the competition has focused on two critical goals: first, to integrate high performance with design in degree programs; and second, to inspire students to enter into sustainable building careers. Competition results during the past six years demonstrate substantial success toward these goals, including:

- More than 150% growth in the number of teams participating
- Feedback from Faculty Advisors suggesting more than 500% growth in the number of participating programs that have integrated the Design Challenge into their curricula
- Deep engagement with participating students reinforcing how life-changing the competition experience has been, solidifying their commitment to sustainable building careers.

A movement has started. The Solar Decathlon Design Challenge is equipping the next-generation building workforce with the skills and passion to create future-ready buildings.

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Solar Decathlon Design Challenge Competition Rules Authors: NREL's Rachel Romero, Zachary Peterson, and Paul Torcellini.

Solar Decathlon Design Challenge Rules

The Solar Decathlon is a collegiate competition, comprising 10 Contests, that challenges student teams to design highly efficient and innovative buildings powered by renewable energy. For more information, read the Solar Decathlon Competition Guide.

The Design Challenge encourages student participation during one or two academic semesters. Participants prepare creative solutions that address real-world issues in the building industry. Teams complete a design project, and finalists present their designs to a panel of industry expert jurors. Students compare their projects to those of other teams, learn from presentations by national thought leaders and collegiate peers, experience zero energy ready building design, and engage with a variety of organizations about careers related to high-performance buildings.

Finalist Teams are recognized at an Awards Ceremony, and project materials from winning teams are published on the Solar Decathlon webpage. The competition and winners are promoted through a variety of media outreach efforts, which provide participants and their collegiate institutions an opportunity for national exposure. Select winners may receive further invitations to present at industry conferences following the Solar Decathlon Competition Event. Collegiate institutions that participate in the Design Challenge are recognized as leaders who are producing career-ready professionals with cutting-edge skills. Industry partners who collaborate with teams gain national and local recognition and have the opportunity to interact with promising future design and construction professionals.

1 Summary of Important Dates

Please note the following key milestones for the 2021 Design Challenge:

- **July 2020:** The 2021 Design Challenge Rules are released; information about the Team Application is available on the Solar Decathlon website. Teams can begin work as early as the release of the Rules.
    - After a team completes its application, the team is provided access to Design Challenge communications and resources, including an on-demand Building Science Training course, topical webinars, and energy modeling software. An important tool for teams is the Project Site, an online platform for participating students to receive timely information from organizers, submit deliverables, and access necessary resources.
- **October 20, 2020, 5 p.m. Eastern Daylight Time (EDT):** All teams must submit their Team Application on the Project Site by this deadline. The Team Application must indicate which Division the team intends to enter. All teams that complete and submit their Team Application by this deadline are accepted as participants.
    - Each team must pay a nonrefundable $100 fee. Teams are required to identify a Faculty Lead, and strongly encouraged to also identify a student Team Lead if available.
- **December 1, 2020, 5 p.m. Eastern Standard Time (EST):** Teams are encouraged to submit an optional Project Pitch.
    - The optional Project Pitch should be submitted via the Project Site.
    - Submissions are evaluated against criteria indicated in this Rules document, and teams will receive feedback on project compliance.
- **January 29, 2021:** An updated version of the Solar Decathlon 2021 Design Challenge Rules is released.
- **February 16, 2021, 5 p.m. EST:** All teams must complete the Project Proposal, finalize their Division selection, and indicate which team members have completed the Building Science Training course online or have received an equivalency waiver from their faculty.
    - The Project Proposal must be submitted via the Project Site.
    - Submissions are evaluated against criteria indicated in this Rules document. Based on the Project Proposal evaluation, up to 10 teams per Division are invited to participate in the Competition Event.
    - All participating teams are encouraged to complete their designs and the associated submissions regardless of finalist status.
- **March 30, 2021, 5 p.m. EDT:** Teams must submit their updated Project Summary, Design Narrative, and Team Photos.
    - The deliverables must be submitted via the Project Site.

- **April 6, 2021, 5 p.m. EDT:** Teams must submit their Presentation Recording.
- **April 13, 2021, 5 p.m. EDT:** Teams must submit their Presentation Slides, optional Project Media, and optional Film Submission. Presentations are not accepted after this date.
- **April 15–18, 2021:** Finalist Teams present to industry leaders at the Solar Decathlon Competition Event. Finalist and Participant Teams also take part in related competition events. Design Challenge winners are announced.
- **May 18, 2021:** The Faculty Report is due to the organizers at SDdesign@nrel.gov.

2 Design Challenge Description

2.1 Task Overview

- ☐ Read the Design Challenge Rules and form a multidisciplinary team.
- ☐ Study the resources provided in Appendix A.
- ☐ Review 2020 winning team presentations, past event photographs, and the Solar Decathlon website to inform efforts.
- ☐ Submit a Team Application and register all team members under one team on the Project Site, where competition updates and materials are posted regularly.
- ☐ Complete the on-demand Building Science Training online or provide confirmation from the team's Faculty Lead that equivalent training is part of the student's curriculum. The Building Science Training coursework is provided at no cost to every team member.
- ☐ Work with a Design Partner to develop project criteria (highly encouraged).
- ☐ Engage with industry to supplement existing knowledge and provide valued feedback on the design.
- ☐ Watch webinars posted to the Solar Decathlon YouTube.
- ☐ Attend Design Challenge Check-Ins as advertised on the Project Site for technical, design, and competition guidance. The recordings are posted to the Project Site if attendance is not possible.
- ☐ Consult the Solar Decathlon website and Project Site for updates and announcements.
- ☐ Ensure your project is compliant with the requirements listed in these Rules.
- ☐ Submit all materials well in advance of the deadlines.

For communications and questions, email the organizers at SDdesign@nrel.gov.

2.2 Forming a Team

The competition is open to all collegiate and degree-issuing institutions, including community and technical colleges. International institutions are welcome to participate. Teams should abide by the following criteria:

- Each team must be associated with a collegiate institution and include a Faculty Lead. Faculty may counsel multiple teams.
- Each team must have at least three students, with one student designated as the student Team Lead. There is no maximum number of student team members.
- The strongest teams are multidisciplinary, composed of students from a variety of degree programs, and include architecture and engineering students.
- Multiple collegiate institutions may combine to form a team.
- A collegiate institution may only submit one Team Application per Division (see Section 3.1). A team may choose to have several internal groups of students complete designs and then submit only one project design at the submission deadline.

- The Team Application costs $100 per team in each Division and is nonrefundable.
- At least one student and one Faculty Advisor from each Finalist Team are required to participate in the Competition Event.

2.3 Student Qualifications

Great teams are cross-functional. Student team members can be from any discipline and any level of collegiate schooling. Teams may also include students from more than one collegiate institution. Past teams have included students who majored in fields such as architecture, engineering, building science, construction management, interior design, marketing, business, communications, management, and landscape architecture. In addition, students must meet the following:

- Although collegiate institutions may have more than one team, students are limited to one team for the competition year of the Design Challenge.
- Each student must be pursuing a degree and enrolled in at least one class between the Team Application deadline and the Competition Event.

2.4 Faculty Lead Role

The Faculty Lead, with assistance from the student Team Lead, is responsible for communicating competition details from the organizers to the team members. A team may have more than one Faculty Advisor; a Faculty Advisor may counsel multiple teams. One Faculty Lead must be designated to serve as a primary contact, oversee and closely engage with the team, and provide support in the following areas:

- Ensuring familiarity with the Design Challenge Rules and guidance.
- Making sure that all student team members complete the Building Science Training or indicate that building science is part of the core curriculum by providing an equivalency waiver. 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 that the necessary information is provided to team members participating in the Competition Event.

2.5 Design Partners

Teams are strongly encouraged (but not required) to engage a Design Partner in their project. Design Partners are organizations that have a planned construction, major retrofit project, or new construction project in their building portfolio and would like to work with a team to develop a zero energy ready design option for the project. For example, a school district that is planning a major retrofit to an existing school could be a Design Partner and work with a team to receive a basic zero energy ready design and cost analysis for the retrofit.

Design Partners should provide teams with basic project information and requirements. The partner should be willing to provide up to 30 hours of engagement with the team over the course of the competition for design programming, iterative schematics, and feedback. A representative from each Design Partner organization may participate in the Competition Event. Teams should

secure their own Design Partner; a limited number of Design Partner opportunities will be posted on the Solar Decathlon website.

2.6 Industry Engagement

Engagement with industry professionals is expected to provide real-world perspective on proposed solutions and to provide guidance for selecting and integrating building systems into the design. Successful teams often engage with several industry professionals who have a wide range of expertise, such as builders, architects, city officials, contractors, developers, energy auditors, engineers, manufacturers, and tradespeople in areas such as site development, codes, construction, building materials, mechanical systems, lighting systems, financing, and sales. This engagement can help inform the teams' decision-making processes and aid in the review of the project. Industry may provide support, donations, and guidance to students while the students remain responsible for design, detailing, documentation, construction, operation, and competition activities.

3 Design Challenge Project Requirements

Designs should represent a high-performance building so energy efficient that a renewable energy system can be expected to offset all the building's annual energy consumption. Along with achieving this level of performance, teams must demonstrate the effective integration of building science principles and best practices for the building enclosure and mechanical systems.

Designs should meet the following specifications:

- Teams may develop an original design, improve or conceive of a new design for a Design Partner, or chose to retrofit or modernize an existing building.
- Projects must be substantially different from any submitted to DOE competitions in the past. If a school has multiple teams competing in the Solar Decathlon across the Design and Build Challenges, each team must have distinct designs.
- Buildings are often subject to local, state, and national codes or standards governing topics such as minimum bedroom size, fire protection requirements, classroom size, and restroom locations and quantities, along with other specific requirements. Teams should follow applicable codes for the building's expected jurisdiction. If there are conflicts between the Design Challenge conditions and local regulations, the local regulations supersede, and teams should clearly document these local requirements in their project submissions.
- English units of measurement are required; a submission with both metric units and English units is acceptable. If metric units are used, state English units first, followed by metric equivalents in parentheses. Example: 125 feet (ft) (38.1 meters [m]).[1]

3.1 Design Challenge Divisions

Teams participating in the Design Challenge compete in one of seven Divisions. In all Divisions, maximizing both energy performance and building design are critical to success. Building science decisions significantly impact design decisions and submissions associated with the project. Project designs state a specific location, building lot or site, and local characteristics as context for the building design and its relationship to surrounding structures and the community.

Design teams must abide by the following:

- Each collegiate institution may submit up to seven applications, but may ***not*** have more than one team in any Division.
- Only one design per team may be submitted to the organizers for the Project Proposal and Design Portfolio. If more than one is submitted, the organizers will review only the last-received design up to the submission deadline from that team.
- Any school that has multiple teams must have substantially different designs for each, regardless of Challenge or Division.

[1] For quick online conversions of metric to English units of measurement, see the Digital Dutch Unit Converter or the Internet French Property Measuring Units Converter Table.

Renewable energy should be evaluated and integrated into the project in some form, but it is not required to be on-site. If on-site generation is not feasible, other options—such as solar ready construction for future installation, participating in a community-scale renewable energy project, specifying utility-provided renewable power, or purchasing offsets—should be considered, and the associated costs should be factored into the financial analysis.

Suburban Single-Family Housing (SSF)

The parameters for the Suburban Single-Family Housing (SSF) Division are below.

1. Building size: 1,000–3,000 square feet (ft^2) (93–279 square meters [m^2])
2. Lot size: at least 4,000 ft^2 (372 m^2)
3. Meets or exceeds the DOE Zero Energy Ready Home National Program Requirements (Rev. 07).

Urban Single-Family Housing (USF)

The parameters for the Urban Single-Family Housing (USF) Division are below.

1. Building size: 300–2,500 ft^2 (28–232 m^2)
2. Lot size: up to 5,000 ft^2 (465 m^2)
3. Meets or exceeds the DOE Zero Energy Ready Home National Program Requirements (Rev. 07).

Attached Housing (AH)

The parameters for the Attached Housing (AH) Division are below.

1. Row homes or flats, 2–12 dwelling units; building is up to three stories above grade
2. Building size: 500–2,500 ft^2 (46–232 m^2) per dwelling unit
3. Lot size: up to 3,000 ft^2 (279 m^2) per dwelling unit
4. Meets or exceeds the DOE Zero Energy Ready Home National Program Requirements (Rev. 07).

Mixed-Use Multifamily Building (MM)

The parameters for the Mixed-Use Multifamily Building (MM) Division are below. MM is defined as a blend of residential and commercial building area.

1. Minimum of eight dwelling units; building is up to five stories above grade
2. Building size: 350–2,000 ft^2 (33–186 m^2) per dwelling unit
3. Lot size: no minimum or maximum
4. Dwelling units meet or exceed the DOE Zero Energy Ready Home National Program Requirements (Rev. 07).

5. Between 80% and 90% of the building (by floor area) must be used for multifamily dwelling units. This includes circulation spaces required for the dwelling units, including common hallways and stairwells.
6. For the commercial portion of building, the source energy use intensity (EUI) must be less than the source EUI target shown in Section 3.2. As an alternative, the entire building can comply with the source EUI target as shown in Section 3.2.

Elementary School (ES)

The parameters for the Elementary School (ES) Division are below. An ES is defined as a complete educational facility for students in kindergarten through fifth grade, and includes permanent provisions for a cafeteria; gym; offices; classrooms; and other support functions, such as mechanical spaces, circulation, and restrooms.

1. Occupancy: 300–600 students, equally distributed from kindergarten through fifth grade
2. Students per classroom: 20–30
3. Lot size: 15 acres (60,703 m^2) maximum
4. In addition to the classrooms, the following spaces must be included:
    i. Teacher work area (or lounge)
    ii. Office/administration area
    iii. Gym/recreation area
    iv. Music room
    v. Art room
    vi. Library/media center
    vii. Cafeteria, which could be combined with the gym/recreation area, if desired
    viii. Kitchen/service area, which could be used for light food preparation without cooking or ventilation requirements, if desired.
5. The source EUI target before renewables must be less than that shown in Section 3.2.

Office Building (OB)

The parameters for the Office Building (OB) Division are below. An OB is defined as a complete commercial facility with full fit and finish for a defined client(s), including support functions such as mechanical and electrical spaces, circulation, vertical transportation, and restrooms.

1. Building size: 30,000–250,000 ft^2 (2,787–23,226 m^2) comprising 2–15 stories
2. 250–350 gross ft^2 (23–33 m^2) per person
3. Lot size: up to five acres (20,234 m^2)
4. In addition to the office area, the following spaces must be included:
    i. Lobby
    ii. Conference rooms

iii. Copy/print facilities and mail sorting

iv. Loading dock and associated janitorial as well as waste disposal services

v. Break rooms with kitchenettes.

5. The source EUI target before renewables must be less than that shown in Section 3.2.

Retail Building (RT)

The parameters for the Retail (RT) Building Division are below. An RT is defined as a building or a portion of a building where merchandise is sold to customers. The space will include full fit and finish for a defined client(s), including support functions such as mechanical and electrical spaces and circulation.

1. Building size: 7,500 ft^2 (697 m^2) to 250,000 ft^2 (23,226 m^2)
2. Lot size: no minimum or maximum
3. In addition to the retail area, the following spaces must be included:
    i. Point of sale
    ii. Stock room(s)
    iii. Support office(s)
    iv. Restroom
    v. Break room(s) with kitchenette.
4. The source EUI target before renewables must be less than that shown in Section 3.2.

3.2 Evaluating Building Energy Performance

Energy analysis is invaluable for predicting energy performance and evaluating trade-offs to achieve energy goals. Energy analysis can be conducted using a variety of software programs. Tools and resources for these calculations are provided in Appendix A as well as through the Project Site.

Home Energy Rating System Index

The residential building industry commonly uses the Home Energy Rating System (HERS) Index to indicate energy efficiency. A lower score signifies a more energy-efficient home. To determine the score, homes are compared to a benchmark based on the 2006 International Energy Conservation Code. The HERS score can be calculated by using any Residential Energy Services Network (RESNET) accredited HERS software.

HERS rating software calculates heating, cooling, hot water, lighting, and appliance energy loads, consumption, and costs for new and existing single-family and multifamily homes. RESNET-accredited programs, REM/*Rate,* and Ekotrope are provided to teams at no charge after completing the Team Application; however, using them is not required.

Energy Use Intensity

Building energy consumption is often evaluated based on the EUI, which is measured as the total energy consumed annually divided by the gross floor area (kilo-British thermal unit [kBtu]/ft^2 or kilowatt-hours/m^2). These numbers can be calculated with respect to source energy as well as site energy. Site energy is measured at the boundary of the site, often by electric or natural gas meters. Source energy accounts for all the upstream losses associated with converting and transporting energy to the building site. It is calculated by taking the site energy and applying a site-to-source multiplier for each energy source.[2] In the case of electricity, it is based on a fuel mix and the mining/extraction of those resources, the power plant losses, and the losses with transmission and distribution of electricity. Alternative metrics for comparison are also useful, such as energy divided by total students (kBtu/student) for the Elementary School Division.

Target EUIs based on source energy for Elementary Schools, Mixed-Use Multifamily Buildings, Office Buildings, and Retail Buildings are shown in Table 1. These EUI values include all building loads, including plug loads; heating, ventilating, and air conditioning (HVAC); and lighting. Plug loads include vertical transportation and any other load in the building. The targets do not include exterior lighting loads, which are covered in Table 2.

[2] See "A Common Definition for Zero Energy Buildings" for calculating EUI.

Table 1. Source Energy[3] Use Intensity Targets for Elementary Schools,[4] Mixed-Use Multifamily Buildings with a Commercial Retail or Office Space,[5] Office Buildings,[6] and Retail Buildings.[7]

Climate Zone	Elementary School Source EUI (kBtu/ft²·yr)	Mixed-Use Multifamily[8] Source EUI (kBtu/ft²·yr)	Office Building Source EUI (kBtu/ft²·yr)	Retail Building Source EUI (kBtu/ft²·yr)
0A	69	80	80	104
0B	71	96	96	101
1A	66	81	81	100
1B	67	89	89	100
2A	64	77	77	89
2B	60	79	79	87
3A	57	74	74	83
3B	58	73	73	84
3C	53	55	55	72
4A	56	75	75	79
4B	55	71	71	81
4C	52	60	60	73
5A	57	80	80	79
5B	56	79	79	80
5C	50	61	61	72
6A	63	96	96	89
6B	58	86	86	84
7	66	88	88	92
8	71	100	100	106

[3] For the methodology for calculating source energy from site energy, see https://buildingdata.energy.gov/cbrd/resource/1938.
[4] This is adapted from the "Advanced Energy Design Guide for K–12 School Buildings: Achieving Zero Energy"; see https://www.ashrae.org/technical-resources/aedgs.
[5] This is based on a simulation result for office and light retail. Documentation is not available at this time.
[6] This is based on preliminary simulations from "Advanced Energy Design Guide for Small to Medium Office Buildings: Achieving Zero Energy," see https://www.ashrae.org/technical-resources/aedgs/50-percent-aedg-free-download.
[7] For retail that requires specialty lighting, an allowance of 15 kBtu/ft² is allowed. The specialty lighting must be justified as critical to the retail operation. For retail that requires refrigerated cases, an allowance of 3,500 kBtu per linear foot of refrigerated cases is allowed in ASHRAE Climate Zone 3 and below, and 4,500 kBtu per linear foot of refrigerated cases in ASHRAE Climate Zone 4 and above.
[8] EUI values for Mixed-Use Multifamily can be applied to either the commercial portion of the space or the entire building, including vertical transportation, common areas, plug loads, HVAC, and lighting.

Table 2. Exterior Lighting Allowances for Mixed-Use Multifamily, Elementary Schools, Office Buildings, and Retail Buildings

Exterior Location	Lighting Power Allowance	Controls
Entry doors	13 watts/linear foot of doorway	Dusk to dawn, reduction of 75% when no motion detected
Exterior stairs	0.70 watt/ft^2	Dusk to dawn, reduction optional depending on local codes
Walkways	0.10 watt/ft^2	Dusk to dawn, reduction of 75% when no motion detected
Driveways and parking lots	0.04 watt/ft^2	Dusk to dawn, reduction of 75% when no motion detected

3.3 Competition Event Details

Based on the quality of the Project Proposals submitted in February 2021, up to 10 Design Challenge Finalist Teams in each Division will be invited to compete at the Competition Event, occurring virtually in April 2021. Finalist Teams will deliver an 8-minute Project Presentation live to the Division Jurors, with an additional 15 minutes for questions. If your team is selected as the first-place team in your Division, your team will also deliver an 8-minute presentation live to the Grand Jurors during the Awards Ceremony. No time is reserved for questions during the Awards Ceremony.

This event provides a rich experience for participants to engage in networking opportunities and attend other team and professional presentations. Attendance at the Competition Event is based on the following criteria:

- At least one student and one Faculty Advisor from each Finalist Team are required to participate in the Competition Event.
- Each team may have a maximum of five student team members present to juries. Additional team members may participate virtually in the Division Presentation Q&A.
- Faculty Advisors may not participate in the team's presentation or Q&A.

4 Design Challenge Contests

Teams submitting projects to the Design Challenge demonstrate competency by applying principles of building science and best-practice solutions. Teams are assessed on their submissions, including design and technical documentation, project plans, reports on required analyses, and the quality and content of their presentations. These submissions should demonstrate the team's ability to design, analyze, and plan for the construction of quality, high-performance buildings.

The jurors evaluate how well teams meet or exceed each Contest criterion and complete the requirements of the project submission.

This competition values innovation and creative approaches in design areas, including: scaled adoption of prefabricated design, energy efficiency, energy production, grid integration, building operations, and overall functionality and appeal.

Effective designs incorporate innovations that are likely to be embraced by the construction industry and consumers on a large scale. Enabling the construction and building design industries to adopt modern technology, manufacturing techniques, automation, or mass customization may allow innovation to have a greater impact on building energy consumption. Teams are encouraged to find solutions that make use of new or existing technologies as well as other creative features to improve building operations and desirability.

The project submissions are evaluated by jurors according to the 10 Contests in Table 3. All Contests are equally weighted. More details on each Contest are provided in the following sections (Sections 4.1 through 4.10).

Table 3. Contests

Contests
1. Architecture
2. Engineering
3. Market Analysis
4. Durability and Resilience
5. Embodied Environmental Impact
6. Integrated Performance
7. Occupant Experience
8. Comfort and Environmental Quality
9. Energy Performance
10. Presentation

4.1 Architecture

Contest Intent

This Contest evaluates the building's architecture for creativity, overall integration of systems, and ability to deliver outstanding aesthetics and functionality.

Architecture marries aesthetics with sound building science, energy efficiency, natural ventilation, energy production, and resilience. Cutting-edge energy-efficient buildings are better positioned to achieve meaningful market acceptance if integrated into architectural designs that creatively meet or exceed aesthetic and functional expectations of both industry and consumers.

Design Challenge Criteria

The jury evaluates teams on each of the following:

- A strong conceptual strategy executed as a compelling, integrated design
- Potential to influence or inspire subsequent designs for the project type
- Integration of building form and function, including exterior and interior architecture with respect to the target market
- Quality of the design and project appearance, including floor plan and interior details for flow, furnishings, storage, linkages to outdoors, and efficient use of space
- Architectural design that integrates climatic considerations toward achieving zero energy ready goals
- Consideration of specified site, including views, drainage, regionally appropriate materials, and community connection.

4.2 Engineering

Contest Intent

This Contest evaluates the effective design of high-performance engineering systems, technologies, and techniques through the use of energy efficiency and renewable energy.

Effective designs for buildings systems incorporate careful considerations of structural performance, occupant comfort, environmental conditions, and regulatory constraints. Heating, cooling, water, and ventilation system types and design should reflect different technology and integration options, including analysis of implications for energy and environmental performance, up-front and long-term costs, and reliability. Opportunities for water efficiency should be reflected in smart engineering solutions for domestic hot water delivery and landscaping irrigation as well as plumbing fixtures and landscaping choices. Energy consumption and production is evaluated against specific site constraints and designed accordingly.

Design Challenge Criteria

The jury evaluates teams on each of the following:

- Overall approach to solving engineering challenges and integrating solutions in design

- Sound selection and design of all building components (foundation, wall systems, roof) to address building science control layers
- Lighting system selection and design for energy-efficient ambient, task, and mood lighting fully integrated with natural light
- Plumbing system layout for efficient hot water delivery to minimize wait time, losses, and wasted water
- Selection of water conservation fixtures, estimated loads, supply piping, rainwater or gray water systems, and landscaping systems for minimizing water use.

4.3 Market Analysis

Contest Intent

This Contest evaluates the building's appeal, affordability, and attainability to its stated target market; this includes the likelihood of adoption by intended occupants and the construction industry for impactful, cost-effective design.

To ensure uptake in the market and drive both demand and supply, effective energy-efficient designs take into account the interests of intended building occupants and owners as well as the construction industry. On the consumer side, designs should reflect how occupants can best use and enjoy the built environment and accommodate potentially changing preferences of occupants over time. On the supply side, a successful design will consider how to reduce construction cycle time, ensure outstanding quality, and improve productivity of building industries. A successful design should also include high-quality construction documentation.

Financial analysis should include estimated costs of construction, monthly utilities, and maintenance to determine an overall cost of ownership and provide a basis for comparison to the financial capabilities of the target market and overall affordability. The cost of construction, as well as the extent to which the design would cost more than a code-compliant building, should be carefully considered and justified.

Design Challenge Criteria

The jury evaluates teams on each of the following:

- Execution of market analysis, including affordability and the integration of key findings in the design
- Use of design solutions that meet current market expectations for owner experience
- Application of market-ready construction materials and their cost-effectiveness in the design
- Life cycle cost comparison between a minimally code-compliant building and the proposed design
- Financial feasibility analysis in the target market as presented to the consumer
- Operational and maintenance cost estimate.

4.4 Durability and Resilience

Contest Intent

This Contest evaluates the building's long-term ability to endure local environmental conditions and anticipate, withstand, respond to, and recover from disruptions.

Durability reflects the ability of the building envelope to maintain long-term performance despite routine environmental conditions. Resilient design enables the building to maintain critical operations during disruptions and quickly restore normal operations. The benefits of investing in highly efficient buildings are compounded by also investing in resilient design. Teams must demonstrate how their buildings effectively address all of these challenges.

Design Challenge Criteria

The jury evaluates teams on each of the following:

- Building enclosure integration of all four building science control layers (e.g., thermal, air, bulk moisture, and moisture vapor), including foundation, walls, roof, and openings
- Analysis of the prevailing resilience risks associated with weather, natural or man-made events, and grid disruptions
- Identification of building design and construction strategies to withstand and recover from identified resilience risks
- Integration of these resilience strategies for mitigating location-specific risks in the building's design, including design details and construction practices
- Recovery plan to sustain critical operations after a disaster event or supply outage.

4.5 Embodied Environmental Impact

Contest Intent

This Contest evaluates the full life cycle of a building, from cradle to grave.

"Circular economy" for a building refers to an economic system in which buildings are designed with a focus on minimizing environmental impact from material extraction and manufacturing to transportation, construction, and use, while also considering "Re-X"—reclamation, refurbishment, repair, reuse, recycle, etc.—of materials throughout the building's life cycle. Within the sphere of a circular economy, various measurements and calculations are used to quantify the environmental impacts that are embodied in the building at each life cycle stage. As buildings become more resource efficient during occupancy, the environmental impact during this stage decreases. Consequently, the other life cycle stages—such as material production, manufacturing, construction processes, and end of life—become larger contributors to a building's total environmental impact and, therefore, become more important to address. The building industry must go beyond the occupancy stage to address these impacts in all life cycle stages.

Design Challenge Criteria

The jury evaluates teams on each of the following:

- Life cycle assessment of the building's embodied environmental impacts, showing assumptions (e.g., intended service life, functional requirements) for the assessment of each life cycle stage
- Design decisions and material selections with regard to circularity and embodied environmental impacts
- Discussion of trade-offs between up-front/embodied environmental impacts (e.g., energy, greenhouse gas emissions) and operational environmental impacts.

4.6 Integrated Performance

Contest Intent

This Contest evaluates how effectively the whole building performance is optimized through passive and active strategies across multiple building disciplines.

An integrated design utilizes architectural and engineering elements that complement each other to help the building achieve optimal performance. For example, a building that is properly oriented will more effectively capture passive heating, cooling, ventilation, and lighting. Without one design element (e.g., building orientation), additional energy-consuming systems are required to provide the dependent design element for interior conditions (e.g., mechanical HVAC). In a truly integrated design, when any element is altered or removed from the building, energy consumption of the overall building could increase.

Design Challenge Criteria

The jury evaluates teams on each of the following:

- Systems approach to integrating architecture and engineering relative to the building envelope and climate
- Effective use of passive design strategies to meet heating, cooling, ventilation, and lighting needs
- Integrated, interdisciplinary solutions that enhance synergies among building subsystems
- Space-conditioning system integration within the building's structural system
- Optimized installation of renewable energy systems to ensure technical feasibility of the application
- Discussion of lighting system effectiveness, including daylighting and electric lighting to provide ambient, task, and mood lighting.

4.7 Occupant Experience

Contest Intent

This Contest evaluates how the building optimizes occupants' quality of life while also meeting the energy performance goals of the design.

Technologies and appliances should be thoughtfully selected and integrated into the overall design. This includes strategies for efficiency, comfort, health, and safety that address operational expectations of consumers.

Design Challenge Criteria

The jury evaluates teams on each of the following:

- Design's functionality, attractiveness, and enhancement of the occupants' quality of life, health, and well-being
- Advanced building control technologies for appliances, equipment, security, and lighting systems that provide comfort, convenience, and safety
- Appliance selection (e.g., kitchen, hot water, laundry, lighting) and design integration for optimum efficiency and convenience
- Strategies for minimizing occupant maintenance.

4.8 Comfort and Environmental Quality

Contest Intent

This Contest evaluates the building's capability to deliver intended comfort and indoor environmental quality.

Well-designed buildings provide both a comfortable and healthy indoor environment. For occupants to be comfortable, the building must be able to control temperature and relative humidity levels, as well as reduce exterior noise infiltration. To provide a healthy indoor environment, the design must include a comprehensive approach to indoor air quality that incorporates ventilation, filtration, dilution, and material selection strategies.

Design Challenge Criteria

The jury evaluates teams on each of the following:

- Complete indoor environmental quality strategy, including HVAC system design, load calculations, equipment sizing, and duct sizing
- Comprehensive source control (e.g., chemicals, dust, pollen, biologicals, radon, and moisture) through material selection, details, and construction practices
- Whole-building ventilation and strategies for spot ventilation (e.g., controlling moisture in bathrooms as well as moisture and particles from cooking in kitchens) and filtration (e.g., high-capture filters)
- Acoustical design strategies for controlling unwanted interior and exterior noise.

4.9 Energy Performance

Contest Intent

This Contest evaluates reduction of whole-building energy consumption, ability to generate clean energy that is needed on-site, and interaction with local grid operations.

Effective whole-building energy analysis and decision-making is the foundation for energy performance. Energy performance incorporates energy consumption, clean energy generation, and the capability of the building to provide grid services.

Evaluation Criteria

The jury evaluates teams on each of the following:

- Comprehensive energy analysis showing energy performance targets will be achieved (i.e., HERS and/or EUI), including calculations with and without renewable energy
- Strategy for reducing plug loads and appliance loads
- Grid-interaction capabilities to include responsiveness of building systems to electric grid conditions to avert system stress and enhance grid reliability
- Strategies for effectively integrating sufficient renewable energy generation (on-site or off-site) to achieve zero annual energy use and offset nonrenewable energy sources.

4.10 Presentation

Contest Intent

Successful evaluation of each Contest depends on the team's ability to accurately and effectively convey its design and approach to energy performance to relevant audiences.

In order to inspire future professionals, incumbent industry leaders, and the public at-large to pursue energy efficiency and renewable energy opportunities, the value proposition must be clearly conveyed, both verbally and visually.

A smart design on its own is insufficient. Presentation quality can dramatically affect consumer perception and the likelihood of innovation being adopted. As such, each jury evaluates not just the criteria of the individual Contest but also the team's presentation of the design solution.

Design Challenge Criteria

The jury evaluates teams on each of the following:

- Completion, quality, and timeliness of submissions
- Quality of presentation package, spoken remarks, and any visual aids (if applicable)
- Ability to prioritize and convey key points about designing a zero energy ready building with enough detail that the project will achieve its goals
- Completeness and professionalism of presentation within the time limit
- Command of the design solution through effective response to juror questions.

5 Design Challenge Evaluation Process

The evaluation process of the competition is multifaceted and includes several submissions.

5.1 Optional Project Pitch

The optional Project Pitch is an opportunity to submit preliminary information about your project and receive early competition feedback. The organizers provide feedback on the following:

- Compliance with Division definition
- Submission formatting compliance.

It is understood that the Project Pitch might be considerations, aspirations, or otherwise tentative and subject to change in future submissions. The organizers will not provide feedback on the quality of the design itself.

5.2 Project Proposal to Select Finalist Teams

Based on the deliverables submitted for the Project Proposal, 10 Finalist Teams from each Division are selected to participate in the Competition Event. These Finalist Teams are selected based on the following:

- One panel of reviewers (each with 1–3 industry experts) convenes for each Division. Each reviewer evaluates all Project Proposals within their assigned Division.
- The reviewers assess the team's preliminary designs.
    - Reviewer feedback represents their professional guidance. This feedback is based on the unique expertise and opinion of the reviewer and should not be used as a justification for a final design to conflict with the Rules.
- Organizers individually evaluate the Project Proposals according to the following criteria:
    - Effectiveness of Project Summary in conveying the salient points of the project
    - Description of target market and building occupant characteristics
    - Discussion of how target market impacts the design constraints
    - Description of local climate
    - Discussion of the building science issues in the selected climate that impact the design
    - Discussion of building code constraints or standards that impact the design
    - Discussion of design goals
    - Quality of team's plan for completing the design and submitting the final Design Portfolio
    - Compliance with Division definitions
    - Compliance with submission formatting

    - Other factors, such as geographic locations and technology choices, that help optimize competition diversity and fairness.
- Up to 10 Finalist Teams are selected by organizers in each Division based on reviewer evaluation.
- Reviewers develop written feedback that is shared with the teams via the Project Site within two weeks of Project Proposal deadline.

5.3 Design Portfolio to Select Winners

The Design Portfolio provides sufficient design information for the jurors to score each team and select winners. The process is as follows:

- Division Juries (each with 3–5 industry experts) assess the team designs.
- One jury convenes for each of the Divisions. Each juror reviews all Design Portfolios within their assigned Division.
- Division Jurors individually determine preliminary evaluation results based on the Design Portfolio.
- Preliminary team evaluation results are modified by the jurors based on the live Division Presentations and associated question-and-answer period during the Competition Event.
- Division Juror panels select first-place, second-place, and third-place award winners in each Division based on the extent to which the design demonstrates the following attributes:
    - Understanding and application of building science
    - Excellence in design intent of the competition
    - Excellence in the Contest criteria subject areas.
- Each first-place team delivers a live presentation at the Awards Ceremony for evaluation by the Grand Jury, which chooses a Commercial Grand Winner and Residential Grand Winner according to the process described in Section 5.5.
- Division Jurors develop written feedback for the teams that is shared with the teams via the Project Site within two weeks of the Competition Event's conclusion.

5.4 Evaluation Rating Scale

The following scale is used to evaluate the submissions:

Table 4. Evaluation Scale

Design Challenge Scale for Evaluation	
1	MISSES EXPECTATIONS: Missing all items; no explanation of how the design addresses the criteria
2	APPROACHES EXPECTATIONS: Missing some items; minimal explanation of how the design addresses the criteria
3	MEETS EXPECTATIONS: All minimum requirements met; basic explanation of how the design addresses the criteria
4	EXCEEDS EXPECTATIONS: All minimum requirements met; detailed demonstration of applying the design solution to address the criteria
5	ECLIPSES EXPECTATIONS: All minimum requirements met; distinguished excellence in the explanations describing how the design exceeds the criteria

5.5 Grand Jury Award

The Grand Jury selects two Grand Winners from among the first-place teams based on the presentations given at the Awards Ceremony. One Grand Winner is selected from the residential Divisions, including SSF, USF, and AH; the other is selected from the commercial Divisions, including MM, ES, OB, and RT.

The Grand Jury enters the review process with the understanding that all the first-place winners have demonstrated a design that represents the quality expected for zero energy ready buildings.

The Grand Jury is tasked with evaluating which projects are most inspiring. The 8-minute summary presentations of the design are evaluated against the following:

- Level of inspiration
- Appeal to the target market, community, and occupants
- Architectural design aesthetics and functionality
- Responsiveness of design to building science factors
- Financial feasibility
- Constructability
- Innovation
- Presentation quality within specified time limit.

The Grand Jury evaluates each of these criteria on the scale shown in Table 4 to facilitate its selection of the Grand Winners.

5.6 Bonus Awards for Creativity

Bonus awards are given to teams in addition to the Grand Winner awards and the Division awards. These awards are intended to recognize excellence, professionalism, hard work, and enthusiasm that teams provide beyond the required deliverables. These awards may recognize:

- Terrific Team Spirit
- Spectacular Team Virtual Background
- Impressive First-Time Team
- Superb Social Media Engagement
- Fantastic Team Photo
- Outstanding Team Showcase Award
- Excellence in Industry Engagement
- Notable Engagement at Competition Event
- First Complete Design Narrative Submitted
- Unique Team Name
- Director's Award
- Fantastic Film Submission.

6 Design Challenge Deliverables

Throughout the Design Challenge, teams must submit deliverables necessary for evaluating their progress and design. The deliverables, file naming conventions, and due dates are below.

Table 5. Summary of Deliverables, File Naming Conventions, and Due Dates

Deliverable	Required Content	File Name	Due Date	Submit To
Project Pitch (optional)				
Project Summary	Single, bookmarked PDF	DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_SUMMARY_[SUBMISSION DATE (YYYY-MM-DD)].pdf	Dec. 1, 2020, 5 p.m. EST	Project Site
Project Proposal				
Updated Project Summary	Single, bookmarked PDF	DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_SUMMARY_[SUBMISSION DATE (YYYY-MM-DD)].pdf	Feb. 16, 2021, 5 p.m. EST	Project Site
Design Concept	Single, bookmarked PDF	DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_CONCEPT_[SUBMISSION DATE (YYYY-MM-DD)].pdf	Feb. 16, 2021, 5 p.m. EST	Project Site
Design Portfolio				
Updated Project Summary	Single, bookmarked PDF	DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_SUMMARY_[SUBMISSION DATE (YYYY-MM-DD)].pdf	March 30, 2021, 5 p.m. EDT	Project Site
Design Narrative	Single, bookmarked PDF	DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_NARRATIVE_[SUBMISSION DATE (YYYY-MM-DD)].pdf	March 30, 2021, 5 p.m. EDT	Project Site
Supplemental Documentation (optional)	Single, bookmarked PDF	DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_SUP_[SUBMISSION DATE (YYYY-MM-DD)].pdf	March 30, 2021, 5 p.m. EDT	Project Site
Project Images	Three images as files, such as .jpg, .tiff, or .png	PHOTO1, PHOTO2, TEAMPHOTO e.g.: DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_PHOTO1_[SUBMISSION DATE (YYYY-MM-DD)].[EXTENSION]	March 30, 2021, 5 p.m. EDT	Project Site
Presentation Recording	.mov, mp4 or PPTX	DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_RECORDING_[SUBMISSION DATE (YYYY-MM-DD)].[EXTENSION]	April 6, 2021, 5 p.m. EDT	Box
Presentation Slides	PDF and/or PPTX	DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_ PRESDIV_[SUBMISSION DATE (YYYY-MM-DD)].[EXTENSION]	April 13, 2021, 5 p.m. EDT	Box
Additional Submissions				

Deliverable	Required Content	File Name	Due Date	Submit To
Short Film (optional)	.mov or mp4	DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_FILM_[SUBMISSION DATE (YYYY-MM-DD)].[EXTENSION]	April 13, 2021, 5 p.m. EDT	Box
Faculty Report	Single, bookmarked PDF	DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_FACULTY_[SUBMISSION DATE (YYYY-MM-DD)].pdf	May 18, 2021, 5 p.m. EDT	SDdesign@nrel.gov

Note that a "bookmarked" PDF means the file has each major header bookmarked for easy viewing. This makes it easier for the jurors and reviewers to move around within lengthy and technical deliverables. For an example of what that looks like, view the bookmarks for this Rules document PDF. Guidance for creating a bookmarked PDF is provided on the Project Site.

See the following Sections 6.1 through 6.7 for the requirements for each Design Challenge deliverable, as well as submission instructions.

6.1 Project Pitch Submission Instructions (Optional)

The optional Project Pitch communicates the initial plan of the design project to the organizers, and it is submitted via the Project Site.

The Project Pitch is an opportunity for each team to submit a preliminary Project Summary, which will be revised for subsequent submissions. The Project Summary is one piece of the Project Pitch submission, with the other major piece being the information completed in the Project Site form. The Project Summary provides a high-level description of the project with key takeaways, and introduces the team and collegiate institution. Teams submit the Project Summary as a stand-alone document, developed via the Project Summary template. Past Project Summaries can be viewed on the history web page, and an example is provided on the Project Site. Teams are highly recommended to submit a Project Pitch—to practice submitting deliverables through the Project Site as well as for early feedback from the organizers—although this submission is not required.

It is understood that for the Project Pitch, the details might be considerations, aspirations, or otherwise tentative and subject to change in future submissions. This submission will not impact future evaluation of the team's project.

Project Summary Format Requirements

☐	Paper size: Standard 8.5 inches (in.) × 11 in. (216 millimeters [mm] × 279 mm), ANSI A
☐	Formatting: Single-spaced, 11-point font for body text (diagrams may have smaller fonts)
☐	Borders: 0.5-in. (12.7-mm) minimum, except for tables, figures, and images
☐	Maximum page length: 2
☐	File type: Single, bookmarked PDF
☐	File size: Less than 10 MB
☐	File name: DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_SUMMARY_[SUBMISSION DATE in format of YYYY-MM-DD].pdf

Project Summary Content Requirements

Project Summary
☐ List the project name, team name, Division, and collegiate institution(s) in the header.
☐ Replace the logo in the upper right with the team or collegiate institution's logo.
☐ Replace the building image with one or two graphics that best represent the project.
☐ Provide a concise description of the project, including a brief identification of the target market.
☐ Describe the relevance of the project to the goals of the competition.
☐ Summarize the design strategy and relevant key points.
☐ List the relevant project data, including cost estimates.
☐ Provide technical specifications for the project.
☐ Provide project highlights. Briefly explain how the design meets or exceeds the criteria in each Contest: 1. Architecture 2. Engineering 3. Market Analysis 4. Durability and Resilience 5. Embodied Environmental Impact 6. Integrated Performance 7. Occupant Experience 8. Comfort and Environmental Quality 9. Energy Performance 10. Presentation.

6.2 Project Proposal Submission Instructions

The Project Proposal comprises an updated Project Summary and a 5-page Design Concept document. These deliverables provide an interim submission to demonstrate the team's progress and likelihood of a complete design and submission of the Design Portfolio. If a team conducts an internal competition and creates multiple projects, only one Project Proposal per team can be submitted and reviewed for acceptance as a Finalist Team. Teams submit the Project Proposal via the Project Site.

Note that teams also submit a further refined Design Concept as part of the Design Portfolio.

Project Summary and Design Concept Format Requirements

☐	Paper size: Standard 8.5 in. × 11 in. (216 mm × 279 mm), ANSI A
☐	Formatting: Single-spaced, 11-point font for body text (diagrams may have smaller fonts); add page numbers for reviewer convenience
☐	Borders: 0.5-in. (12.7-mm) minimum, except for tables, figures, and images
☐	Maximum page length: • Project Summary: 2 pages • Design Concept: No more than 5 pages; the cover, back pages, and table of contents are not included in this count.
☐	File type: Single, bookmarked PDF
☐	File name: • Project Summary: DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_SUMMARY_[SUBMISSION DATE in format of YYYY-MM-DD].pdf • Design Concept: DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_CONCEPT_[SUBMISSION DATE in format of YYYY-MM-DD].pdf

Project Summary Content Requirements

Project Summary
☐ List the project name, team name, Division, and collegiate institution(s) in the header.
☐ Replace the logo in the upper right with the team or collegiate institution's logo.
☐ Replace the building image with one or two graphics that best represent the project.
☐ Provide a concise description of the project, including a brief identification of the target market.
☐ Describe the relevance of the project to the goals of the competition.
☐ Summarize the design strategy and relevant key points.
☐ List the relevant project data, including cost estimates.
☐ Provide technical specifications for the project.
☐ Provide project highlights. Briefly explain how the design meets or exceeds the criteria in each Contest: 1. Architecture 2. Engineering 3. Market Analysis 4. Durability and Resilience 5. Embodied Environmental Impact 6. Integrated Performance 7. Occupant Experience 8. Comfort and Environmental Quality 9. Energy Performance 10. Presentation.

Design Concept Content Requirements

Front Matter (Not included in page count)
☐ Cover (list collegiate institution, team name, and Division name)
☐ Table of Contents
☐ List of Tables and/or List of Figures (as applicable)
Target Market and Design Constraints Description (1–3 pages)
☐ Describe the neighborhood and/or community setting, including density, access to, and reliance on various transportation modes
☐ Summarize the lot location, size, shape, orientation, and relationship to road(s)
☐ Summarize the intended occupants and their characteristics
☐ Describe how the building's community setting, lot location, and occupant characteristics impact the design constraints
☐ Describe the local climate

☐	Summarize the building science considerations—as influenced by the local climate—that impact the building envelope construction to ensure building durability
☐	Describe how existing codes, standards, and programs influence the building's design and achieve competition goals
Design Goals (1 page)	
☐	Summarize the goals the team considered when creating and developing the design.
☐	Summarize the building systems anticipated for the design.
Plans for Completing Design Portfolio (1 page)	
☐	Provide a timeline of team's next steps for completion of competition deliverables.

6.3 Design Portfolio Submission Instructions

The Design Portfolio demonstrates the culmination of all the team's design work, and provides the final materials needed to evaluate the project. The Design Portfolio must include:

1. Project Summary (updated)
2. Design Narrative
3. Three Project Images
4. Presentation Recording (20 minutes)
5. Slides for the live presentation.

In addition, teams have the option to submit Supplemental Documentation. The Design Narrative and Presentation Recording will be reviewed by jurors and used to determine preliminary scores prior to the Competition Event. The submission instructions for the Design Portfolio deliverables are as follows.

6.3.1 Project Summary

Teams must submit the Project Summary via the Project Site. The Project Summary should be updated as needed to reflect the final parameters of the design. It must follow the requirements below:

Project Summary Format Requirements

☐	Paper size: Standard 8.5 inches (in.) × 11 in. (216 millimeters [mm] × 279 mm), ANSI A
☐	Formatting: Single-spaced, 11-point font for body text (diagrams may have smaller fonts)
☐	Borders: 0.5-in. (12.7-mm) minimum, except for tables, figures, and images
☐	Maximum page length: 2
☐	File type: Single, bookmarked PDF
☐	File size: Less than 10 MB
☐	File name: DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_SUMMARY_[SUBMISSION DATE in format of YYYY-MM-DD].pdf

Project Summary Content Requirements

Project Summary	
☐	List the project name, team name, Division, and collegiate institution(s) in the header.
☐	Replace the logo in the upper right with the team or collegiate institution's logo.
☐	Replace the building image with one or two graphics that best represent the project.
☐	Provide a concise description of the project, including a brief identification of the target market.
☐	Describe the relevance of the project to the goals of the competition.
☐	Summarize the design strategy and relevant key points.
☐	List the relevant project data, including cost estimates.

☐	Provide technical specifications for the project.
☐	Provide project highlights. Briefly explain how the design meets or exceeds the criteria in each Contest: 1. Architecture 2. Engineering 3. Market Analysis 4. Durability and Resilience 5. Embodied Environmental Impact 6. Integrated Performance 7. Occupant Experience 8. Comfort and Environmental Quality 9. Energy Performance 10. Presentation.

6.3.2 Design Narrative

Teams must submit the Design Narrative via the Project Site. This deliverable comprises an updated Design Concept as well as construction details and Contest narratives. The Design Narrative is limited to 60 pages, including appendices, and must contain all the information the team deems essential to effectively communicate its competition solution to the jury. A summary and discussion of analytical results should be provided in the Design Narrative. Supporting information—such as detailed calculations or equipment data sheets—should be relegated to Supplemental Documentation. Citations may be in the team's chosen format, but they should be consistent throughout the submission.

Design Narrative Format Requirements

☐	Paper size: Standard 8.5 in. × 11 in. (216 mm × 279 mm), ANSI A
☐	Formatting: Single-spaced, 11-point font for body text (diagrams may have smaller fonts)
☐	Borders: 0.5-in. (12.7-mm) minimum, except for tables, figures, and images
☐	File type: Single, bookmarked PDF
☐	Limit content to no more than 60 pages; the cover, back page, and table of contents are not included in this count
☐	Number pages; front-matter page numbers can use Roman numerals (e.g., i, ii, iii, etc.)
☐	Construction drawings: 11 in. x 17 in. (279 mm x 432 mm), ANSI B
☐	File Name: DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_NARRATIVE_[SUBMISSION DATE in format of YYYY-MM-DD].pdf

Design Narrative Content Requirements

Front Matter	
☐	Cover (list collegiate institution, team name, and Division name)
☐	Table of Contents
☐	List of Tables and/or List of Figures (as applicable)
Section 1: Design Constraints and Goals (up to 4 pages)	
☐	Design Constraints Description, including timeline, budget, community setting, climate, building science considerations, codes, occupant characteristics, etc. (1–3 pages)
☐	Design Goals, including rating systems, energy targets, occupant experience, operational cost, etc. (1 page)
Section 2: Contest narratives, including relevant images and figures (up to 27 pages)	
☐	1. Architecture
☐	2. Engineering
☐	3. Market Analysis
☐	4. Durability and Resilience
☐	5. Embodied Environmental Impact
☐	6. Integrated Performance
☐	7. Occupant Experience
☐	8. Comfort and Environmental Quality
☐	9. Energy Performance.

Appendices	
☐	A. Design renderings **(up to 5 pages)**
☐	B. Construction documentation highlights **(up to 20 pages)**
☐	a. Site plan
☐	b. Representative floor plan(s) with dimensions
☐	c. Building elevations
☐	d. Building sections, including building science control layers
☐	e. Interior details, including a rendered floor plan showing typical furniture layout and option details on finishes, cabinetry, and other fixtures
☐	f. Wall, window, door, floor, and roof details, including building science control layers, schedule, and specifications
☐	g. Mechanical plans and schedules,[9] indicating equipment locations and specifications as well as heating and cooling system capacity diagrams (Btu/hr·ft^2, tons/ft^2, or kilowatt/m^2)
☐	h. Plumbing plans and schedules,[9] including fixture locations, piping system layout and design, and equipment location and specifications

[9] Teams should indicate system type, size, and quantity; however, full system layout and specifications are not required.

☐	i. Electrical and lighting plans and schedules,[10] including installed lighting (watt/ft^2 or watt/m^2) levels, control systems, and renewable systems
☐	C. Energy performance (HERS Index rating and/or EUI target) **(up to 4 pages)**
☐	HERS Index Rating Documentation Summary
☐	1. Include the house size adjustment factor calculations as required for homes exceeding the area specified in the size adjustment factor table.
☐	2. Perform a HERS Index analysis to include the home with and without the renewable energy system.
☐	EUI Target Documentation Summary
☐	1. Summarize major inputs for the energy model, including envelope characteristics, lighting power densities, plug load densities, HVAC sizing capacities, HVAC system efficiencies, and overview equipment schedules.
☐	2. Demonstrate compliance with the Division definition. EUI should be provided in both site and source metrics. Show summary calculations of the potential for on-site or off-site renewable energy to offset the annual energy consumption of the building on a source basis.

6.3.3 Supplemental Documentation

Teams submit Supplemental Documentation via the Project Site. Supplemental Documentation is optional and may not be more than 100 pages. This document includes additional documentation to support the team's design goals and submission, such as energy analysis reports, financial analysis details, equipment specifications, quantity takeoffs, supplemental construction details, or supporting design calculations. Jurors have a limited amount of time to review the entire submission. They might not read the Supplemental Documentation in detail or at all, and they are not expected to open any hyperlinks contained within.

Supplemental Documentation Format Requirements

☐	Paper size: Standard 8.5 in. × 11 in. (216 mm × 279 mm), ANSI A
☐	Formatting: Single-spaced, 11-point font for body text (diagrams may have smaller fonts)
☐	Borders: 0.5-in. (12.7-mm) minimum, except for tables, figures, and images
☐	File type: Single, bookmarked PDF
☐	Limit content to no more than 100 pages
☐	Number pages
☐	File name: DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_SUP_[SUBMISSION DATE in format of YYYY-MM-DD].pdf

[10] Teams should indicate system type, size, and quantity; however, full system layout and specifications are not required.

6.3.4 Presentation Recording

Each team must submit a Presentation Recording summarizing their Design Portfolio via a Box link provided on the Project Site. The recording may be a maximum of 20 minutes. The base expectation is for teams to present slides with an audio narration; however, teams may be creative in how they chose to develop their Presentation Recording.

The jurors will review these recordings prior to the Competition Event. The recordings provide an opportunity to highlight design aspects that the team does not have time to discuss during the shorter presentation given live during the Competition Event. The Presentation Recordings from the winning teams will be shared via the Solar Decathlon YouTube following the Competition Event.

Presentation Recording Format Requirements

☐	Length: 20 minutes or less
☐	File type: .pptx, .mov, or .mp4
☐	File name: DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_RECORDING_[SUBMISSION DATE in format of YYYY-MM-DD].[EXTENSION]

Presentation Recording Content Requirements

☐	Cover Slide (list collegiate institution, team name, and Division name)
☐	Design Constraints and Goals
☐	Contest Narratives
☐	Energy Analysis
☐	Design Renderings

6.3.5 Project Images

Each team must submit three project images: two (2) images that best represent the project, such as renderings, drawings, photographs of scale models, or other team-generated content, and one (1) image of your team. These images must be submitted via the Project Site. Organizers use images to recognize individual team performance, to integrate into event materials, or for outreach, as appropriate.

Project Images Format Requirements

☐	Ensure all images have a minimum resolution of 1920 x 1080 pixels.
☐	Ensure the images have an aspect ratio of 16:9.
☐	Submit the images as files such as .jpg, .tiff, or .png.
☐	File names: • DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_PHOTO1_[SUBMISSION DATE in format of YYYY-MM-DD].[EXTENSION] • DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_PHOTO2_[SUBMISSION DATE in format of YYYY-MM-DD].[EXTENSION] • DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_TEAMPHOTO_[SUBMISSION DATE in format of YYYY-MM-DD].[EXTENSION]

6.3.6 Presentation Slides Submission Instructions

Each team develops one presentation for the competition event. The Presentation Slides are submitted via a Box link provided on the Project Site.

Presentation Slides Format Requirements

☐	File type: PDF and/or PPTX (Ensure that presentation slides have an aspect ratio of 16:9.)
☐	To ensure that all electronically submitted materials work with the organizers' presentation computers, teams should embed all videos in the team submission.
☐	Maximum file size: • 100 MB.
☐	File name: • DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_PRESDIV_[SUBMISSION DATE in format of YYYY-MM-DD].[EXTENSION]

6.4 Project Media Materials (Optional)

Each team may develop additional optional materials that showcase their design and response to Contest criteria. A session during the Competition Event will display the materials to teams, industry partners, and sponsors. Materials do not need to be submitted prior to the session.

6.5 Film Submission Instructions (Optional)

Teams can submit an optional short film, 3 minutes or less, to highlight how their design impacts the target market and/or talk about the team's experience with the Solar Decathlon. All content in the films, including graphics, must be original and may not include any copyrighted material.

By submitting the video, the team grants the U.S. Department of Energy and the Solar Decathlon organizers the right to edit the video in alignment with Solar Decathlon branding and post to Solar Decathlon YouTube, including amplification through social media and other channels. Films are submitted via a Box link provided on the Project Site.

Film Format Requirements

☐	Length: 3 minutes or less
☐	File type: .mov or .mp4
☐	File name: DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_FILM_[SUBMISSION DATE in format of YYYY-MM-DD].[EXTENSION]

Film Content Requirements

☐	Describe the team's experience with the Solar Decathlon Design Challenge, lessons learned, and impact on stakeholders.

6.6 Faculty Report Submission Instructions

The Faculty Report should reflect the results of the team's Design Challenge project. It will be used by the organizers to improve future events and identify lessons-learned opportunities. Faculty Reports should be submitted via email to SDdesign@nrel.gov.

Faculty Report Format Requirements

☐	File type: Single, bookmarked PDF
☐	Length: Up to 20 pages
☐	File name: DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_FACULTY_[SUBMISSION DATE in format of YYYY-MM-DD].pdf

Faculty Report Content Requirements

☐	Summarize degree program(s) of the participating students.
☐	Summarize how the Design Challenge was integrated into coursework.
☐	Summarize the team perspective on the effectiveness of the organizers' communications efforts with both the teams and the public.
☐	Describe next steps for the team project, if applicable.
☐	Provide a short description of team members' future plans for employment, continued study, or other endeavors.
☐	Include suggested competition improvements.
☐	Include any other information that would be helpful to the organizers or future teams.
☐	Include a contact list of all team members who worked on the project, including permanent (noncollegiate institution) email addresses.

Glossary

Challenge
Each of two avenues of participation for Solar Decathlon Competition teams: the Design Challenge and the Build Challenge

Competition
All aspects of the Solar Decathlon related to the Challenges, the 10 Contests, and the scoring of those Contests within each Challenge

Competition Event
The period when teams are presenting to juries and related activities

Contest
Like the Olympic decathlon, the Contests evaluate the building for creativity, overall integration of systems, and ability to deliver outstanding aesthetics, efficiency, and functionality

Design Challenge
A Challenge of the Solar Decathlon competition that tasks teams to design and present complete building designs

Design Concept
A 5-page maximum Design Challenge deliverable as part of the Project Proposal; this is an interim submission that demonstrates a team's progress toward completing the Design Portfolio

Design Challenge Manager
The head Rules Official responsible for writing and enforcing the Rules and conducting the Design Challenge

Design Narrative
A 56-page maximum Design Challenge deliverable that is part of the 60-page Design Portfolio; the Design Narrative provides a complete submission to be reviewed by jurors in advance of the competition

Design Partner
A client partner to the collegiate institution that presents a design challenge and customer for the team and their building

Director
The organizer representing the U.S. Department of Energy who has final decision-making authority regarding all aspects of the Solar Decathlon

Division Jury
A group of jurors evaluating a Division of the Build Challenge or a Division of the Design Challenge

Dwelling unit
A dwelling unit is a single unit that provides complete independent living facilities for one or more people, including permanent provisions for living, sleeping, eating, cooking, and sanitation. For more information, see the 2018 International Energy Conservation Code.

Elementary School
A complete educational facility for students in kindergarten through fifth grade that includes permanent provisions for a cafeteria; gym; offices; classrooms; and other support functions, such as mechanical spaces, circulation, and restrooms

Faculty Advisor
A team member who is a faculty member and representative of a participating collegiate institution in the project

Faculty Lead
A Faculty Advisor who serves as a primary contact for the team and is responsible for communicating competition details from the organizers to the team members, overseeing and closely engaging with the team

Faculty Report
A 20-page maximum Design Challenge deliverable that reflects the results of a team's Design Challenge project

Finalist Teams
Teams selected to present their final design to Division Jurors at the Competition Event

Floor Area
The floor area of the building is the sum of the floor areas of the spaces within the building, including basements.[11] The floor area is measured from the exterior faces of the exterior walls or from the centerline of walls separating buildings. For more information see ANSI Z765-2003 and ASHRAE 90.1-2019.

Finished area
The sum of the finished and conditioned areas measured at the floor level to the exterior finished surface of the outside walls

Grand Jury
A group of jurors evaluating the first-place Division Winners of the Design Challenge

Industry Partner
Industry professionals who offer expertise and experience to the project

Juror
An organizer selected by the appropriate Challenge Manager to participate as a member of a specific Division Jury

[11] Floor area is sometimes referred to as the finished floor area or gross floor area.

Mixed-Use Multifamily
A blend of residential and commercial building area

Multidisciplinary team
An educationally diverse team that includes students from more than one field of study, including, but not limited to, engineering, architecture, graphic design, construction, interior design, and more

Office Building
A complete commercial facility with full fit and finish for a defined client(s), including support functions such as mechanical and electrical spaces, circulation, vertical transportation, and restrooms

Organizer
A DOE or NREL employee, subcontractor, juror, or observer working on the project

Participant Team
A team that is not selected to present to Division Jurors, but allowed to participate in the Competition Event to present Project Media

Project Pitch
An optional deliverable that communicates the salient points of the projects to all competition participants

Project Media
An optional deliverable that showcases a team's design and response to Contest criteria

Project Site
An online site that includes official communications suitable for viewing by all teams and organizers

Project Summary
A 2-page, high-level description of the project with key takeaways and introductions of the team and collegiate institution; a preliminary Project Summary can be submitted through the optional Project Proposal, and updated in later deliverables

Resilience
The ability to anticipate, withstand, respond to, and recover from disruptions

Rules
All principles or regulations governing conduct, action, procedure, arrangement, etc., for the duration of the project; this document is the "Rules document"

Rules Official
An organizer authorized to interpret the Rules and officiate one or more of the Contests

Sponsor
A business or organization that provides funds for the competition

Staff
An individual working for the organizers whose role is not described elsewhere in these definitions

Team
The combination of team members representing a single entry to a Challenge of the competition

Team member
An enrolled student, faculty member, or other person who is affiliated with one of the participating collegiate institutions and is integrally involved with a team's project activities

U.S. Department of Energy Solar Decathlon
A collegiate competition, comprising 10 Contests, that challenges student teams to design and build highly efficient and innovative buildings powered by renewable energy

Appendix A: Resources

High-Level Resources

Professional Organization Websites

1. Air Conditioning Contractors of America (ACCA)

   ACCA is a nonprofit association that works to promote professional contracting, energy efficiency, and healthy, comfortable indoor environments.

2. The American Institute of Architects (AIA)

   AIA is a member organization that advocates for the value of architecture. Their website has information on project awards, courses on trending topics, events, and various topics including building science and technology.

   - Resources include:
     - AIA Committee on the Environment Top Ten Awards

       The Committee on the Environment (COTE) works to advance, disseminate, and advocate—to the profession, the building industry, the academy, and the public—design practices that integrate built and natural systems and enhance both the design quality and environmental performance of the built environment. The AIA's COTE oversees the annual Top Ten and Top Ten+ Project Awards. Go to 2018 and 2017 to view the winners.

     - AIA Construction Documentation Drawings (publication)

       13th edition, published in 2000 by Ernest L. Grigsby, AIA. Register to download the full document.

3. The American Institute of Architecture Students (AIAS)

   AIAS aims to promote excellence in architectural education, training, and practice; to foster an appreciation of architecture and related disciplines; to enrich communities in a spirit of collaboration; and to organize students and combine their efforts to advance the art and science of architecture.

4. ASHRAE

   ASHRAE is a diverse organization dedicated to advancing the arts and sciences of heating, ventilation, air conditioning, and refrigeration to serve humanity and promote a sustainable world.

- Resources include:
    - ASHRAE Advanced and Zero Energy Design Guides (publication)

      Free downloads (PDF). The Guides offer designers and contractors the tools needed for achieving significant energy savings compared to buildings that meet the minimum requirements of Standard 90.1-2004.
    - ASHRAE Education & Certification Fundamentals of Air System Design

      This is an online, self-directed course to develop an understanding of the basics of air movement; the components of air distribution systems; considerations of human comfort; load and occupancy demand; duct system design; sound and vibration; and how codes and standards affect the design of air systems. Course pricing is available for members and nonmembers.
    - Advanced Energy Design Guide – Achieving Zero Energy series (publication)

      This is an ASHRAE publication for small to medium office buildings as well as K–12 school buildings, and applies to all sizes and classifications (elementary, middle, high). This Guide establishes a set of energy performance goals for achieving zero energy. The goals are provided for all ASHRAE climate zones, in both site and source energy. Strategies on how to achieve these energy targets are provided throughout the guide.
    - ASHRAE GreenGuide (publication)

      This is the complete 5th edition of the *Green Building Guidance from Planning to Operation*, available for purchase.
    - ASHRAE Handbook—Fundamentals (Edition 2017) (publication)

      The ASHRAE Handbook is published in a series of four volumes, one of which is revised each year, ensuring that no volume is older than four years. Document is available for purchase or can be viewed online by subscribers.
    - ASHRAE 10 Tips for Home Indoor Air Quality (publication)

      Downloadable PDF of tips that engineers have identified regarding ways to move air in and out of homes to minimize the factors that lead to indoor air quality problems.
    - ASHRAE Standard 55—Thermal Environmental Conditions for Human Occupancy (document)

      Standard 55 specifies conditions for acceptable thermal environments and is intended for use in design, operation, and commissioning of buildings and other occupied spaces. Document is available for purchase.

- ASHRAE Standard 62.1-2016—Ventilation for Acceptable Indoor Air Quality and 62.2-2016—Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings (document)

  ANSI/ASHRAE Standards 62.1 and 62.2 are the recognized standards for ventilation system design and acceptable indoor air quality. Documents are available for purchase.

- ASHRAE Standard 90.1-2016—Energy Standard for Buildings Except Low-Rise Residential Buildings (document)

  Standard 90.1 has been a benchmark for commercial building energy codes in the United States and a key basis for codes and standards around the world for more than 35 years. Document is available for purchase.

- ASHRAE Standard 105-2014 (publication)

  This is the *Expressing, and Comparing Building Energy Performance and Greenhouse Gas Emissions* publication, available for purchase.

- ASHRAE Standard 189.1—Standard for the Design of High-Performance Green Buildings (document)

  Standard 189.1 provides total building sustainability guidance for designing, building, and operating high-performance green buildings. From site location to energy use to recycling, this standard sets the foundation for green buildings by addressing site sustainability, water use efficiency, energy efficiency, indoor environmental quality, and the building's impact on the atmosphere, materials, and resources. Document is available for purchase.

5. Association of Energy Engineers

AEE operates in the dynamic fields of energy engineering, energy management, renewables, power generation, energy services and sustainability. Website has membership information, as well as information on certification programs, and events.

6. Indoor Air Quality Association (IAQA)

IAQA is dedicated to bringing practitioners together to prevent and solve indoor environmental problems for the benefit of consumers and the public. Their website has membership information along with resources and access to training.

7. National Association of Homebuilders (NAHB)

NAHB is a professional association for home builders and remodelers that helps its members build communities. Create a login to sign in.

8. National Association of Realtors (NAR)

NAR is America's largest trade association, representing 1.3 million members, including NAR's institutes, societies, and councils. NAR is involved in all aspects of the residential and commercial real estate industries. Their website includes a link to the Homeownership Opportunities and Market Experience (HOME) Survey.

9. Urban Land Institute (ULI)

ULI is the oldest and largest network of cross-disciplinary real estate and land use experts in the world. Through its members' dedication to the mission and their shared expertise, ULI has been able to set standards of excellence in development practice.

U.S. Department of Energy

1. U.S. Department of Energy

The mission of the Energy Department is to ensure America's security and prosperity by addressing its energy, environmental, and nuclear challenges through transformative science and technology solutions.

- Resources include:
    - Advanced Strategy Guideline: Air Distribution Basics and Duct Design (publication)

      This is a Building Technologies Program 2011 publication (PDF).
    - Achieving 50% Energy Savings in New Schools (document)

      This is a 2014 fact sheet (PDF) that summarizes recommendations for designing elementary, middle, and high school buildings that will result in 50% less energy use than conventional new schools built to minimum code requirements. The recommendations are drawn from the Advanced Energy Design Guide for K-12 School Buildings, an ASHRAE publication that provides comprehensive recommendations for designing low-energy-use school buildings.
    - Building America: Bringing Building Innovations to Market

      The Building America Program has been a source of innovations in residential building energy performance, durability, quality, affordability, and comfort for 20 years. This world-class research program partners with industry (including many of the top U.S. home builders) to bring cutting-edge innovations and resources to market.
    - Building America Strategy Guideline: Advanced Construction Documentation Recommendations for High Performance Homes (publication)

      This is a 2011 publication from the Building Technologies Program by A. Lukachko, C. Gates, and J. Straube.
    - Building America Top Innovations Profile: Model Simulating Real Domestic Hot Water Use (document)

      This is a 2014 document from the Building Technologies Program.

- Building America Top Innovations

  New Top Innovations are awarded annually for outstanding Building America research achievements. Each year, Building America selects cutting-edge Top Innovations that demonstrate the value of investing in high-performance research and development and guide the industry toward more energy-efficient, healthier, and longer lasting homes.

- Building America Solution Center

  The Building America Solution Center provides access to expert information on hundreds of high-performance construction topics, including air sealing and insulation, HVAC components, windows, indoor air quality, and more.

- Buildings Catalog

  These are helpful case studies of high-performance buildings.

- Building Science Education

  The Building America Program recognizes that the education of future design/construction industry professionals in solid building science principles is critical to widespread development of high-performance homes that are energy efficient, healthy, and durable. Website has a link to the 2013 Building Science Roadmap PDF.

- Commercial Buildings Resource Database

  Resources include:

  Reducing Data Center Loads for a Large-Scale, Net Zero Energy Office Building

  Technical Support Document: Development of the Advanced Energy Design Guide for Medium to Big Box Retail Buildings for 50% Energy Savings

  Advanced Energy Retrofit Guide for K-12 Schools

  A Common Definition for Zero Energy Buildings

  Refrigeration Commissioning Guide for Commercial and Industrial Systems.

- Excellence in Building Science Education

  This Joint Committee on Building Science Education webpage provides information on programs/task groups and resources.

- Guidelines for Participating in the DOE Zero Energy Ready Home

  DOE Zero Energy Ready Homes are verified by a qualified third-party and are at least 40%–50% more energy efficient than a typical new home. This generally corresponds to a Home Energy Rating System (HERS) Index Score in the low- to mid-50s, depending on the size of the home and region in which it is built.

  Also see the DOE Zero Energy Ready Home (virtual tour of Zero Energy Ready Homes across the Country and map of builders) and DOE Zero Energy Ready Home Recommended Quality Management Provisions (PDF document from April 2014) websites.

- Housing Innovation Awards

  Since 2013, the Housing Innovation Awards have recognized the very best in innovation on the path to zero energy ready homes. These awards recognize forward-thinking builders for delivering American homebuyers with the home of the future, today. More information on these award-winning homes is available on the Tour of Zero.

- Teach and Learn

  This website includes links to lesson plans, energy basics, videos, and other downloads for K–12 teachers, collegiate administrators, or students interested in building a clean energy career.

- Technical Feasibility Study for Zero Energy K-12 Schools (technical report)

  This study includes energy use intensity targets for all climate zones, a pathway for how to achieve these EUIs by climate zone, and case studies of actual K–12 school applications.

- Technical Support Document: Development of the Advanced Energy Design Guide for K-12 School Buildings for 50% Energy Savings (document)

  This document describes the process and methodology for the development of the Advanced Energy Design Guide for K–12 School Buildings: Achieving 50% Energy Savings Toward a Net Zero Energy Building (AEDG-K12) (ASHRAE et al. 2011a).

- Toolkit: K-12 Solutions for Building Energy Excellence

  This toolkit highlights Better Buildings Challenge projects.

- U.S. Department of Education Green Ribbon Schools

  This program inspires schools, districts, and institutions of higher education to strive for 21st-century excellence by highlighting promising practices and resources that all can employ. This website includes information on student loans, grants, laws, and data.

- Zero Energy Buildings Resource Hub

  This website includes information and resources for zero energy ready buildings.

- Zero Energy Ready Home National Program Requirements (Rev. 07) (document)

  This document includes requirements for Zero Energy Ready Homes, to be verified and field-tested in accordance with HERS Standards.

U.S. Department of Energy Student Building Competitions

- The U.S. Department of Energy Race to Zero (now Solar Decathlon Design Challenge)

The Race to Zero history website provides links pages that provide the winners of each competition, including their presentation files and project summaries. These documents can provide important context and examples of successful past entries.

- The U.S. Department of Energy Solar Decathlon 2017
- The U.S. Department of Energy Solar Decathlon 2015
- The U.S. Department of Energy Solar Decathlon 2013
- The U.S. Department of Energy Solar Decathlon 2011
- The U.S. Department of Energy Solar Decathlon 2009
- The U.S. Department of Energy Solar Decathlon 2007
- The U.S. Department of Energy Solar Decathlon 2005
- The U.S. Department of Energy Solar Decathlon 2002

Each individual team page on the Solar Decathlon website includes links to download a range of the following: the complete set of Construction Drawings, Construction Specification, Jury Narratives, and other deliverables. These documents can provide important context and examples of successful past entries.

Other Organizations

1. Center for Sustainable Energy Webinars

The CSE Webinar Series provides information and tools to help accelerate the transition to a sustainable world powered by clean energy. Each webinar features insights from subject matter experts and/or industry experts and all are free to attend.

2. New Buildings Institute (NBI): Zero Net Energy

NBI is a nonprofit organization driving better energy performance in commercial buildings by working collaboratively with industry market players—governments, utilities, energy efficiency advocates and building professionals—to promote advanced design practices, innovative technologies, public policies, and programs that improve energy efficiency. NBI also develops and offers guidance and tools to support the design and construction of energy-efficient buildings.

3. New York State Energy Research and Development Authority (NYSERDA)

NYSERDA is a state organization that promotes energy efficiency and renewable energy to reduce greenhouse gas emissions, accelerate economic growth, and reduce energy bills. NYSERDA works with stakeholders throughout New York, including through training courses on topics such as Passive House.

4. WoodWorks

WoodWorks is a nonprofit that provides education and free technical support related to the design, engineering, and construction of commercial and multifamily wood buildings in the United States.

- Structural Design of Mass Timber Framing Systems

  Mass timber structural framing systems have high strength-to-weight ratios, are dimensionally stable, and are quickly becoming systems of choice for sustainably minded designers. This presentation provides a detailed look at the structural design processes associated with a variety of mass timber products, including glulam, cross-laminated timber, and nail-laminated timber. For more information, see the recorded seminar (Vimeo) and presentation slides.

- Mass Timber Building Systems: Understanding the Options

  Mass timber represents a rapidly advancing technology that can be utilized as an alternative to steel and concrete to frame a variety of mid- and high-rise building types. This presentation provides an overview of available mass timber systems, with an emphasis on their advantages and unique design considerations. Recorded Seminar (Vimeo).

- Exploring Efficient Design for a Mass Timber Office: The Nail Laminated Timber Solution

  With ground broken on a new seven-story example in Minneapolis, cost-effectiveness can be added to the potential benefits achieved with a mass timber structural solution. This presentation explores the aesthetic potential and efficiency of nail laminated timber

systems, while touching on relevant engineering, manufacturing and erection techniques used in other timber projects. Recorded Seminar (Vimeo).

- University of Arkansas Mass Timber Residence Halls: Design and Construction Insights

  At over 202,000 square feet, Stadium Drive at the University of Arkansas is the nation's first large-scale mass timber residence hall project. Presented by the project manager, this webinar will provide insights gained from the design and construction of this project, including building official review and code approval, interdisciplinary coordination, shop drawings, construction sequencing and field modifications. Recorded Seminar (Vimeo).

Resources by Contest

Architecture

- Architecture 2030

Architecture 2030 is a nonprofit organization whose mission is to rapidly transform the global built environment away from being the major contributor of greenhouse gas emissions.

- Efficient Windows Collaborative

This site provides unbiased information on the benefits of energy-efficient windows, descriptions of how they work, and recommendations for their selection and use.

- ENERGY STAR® Certified New Homes

ENERGY STAR is the government-backed symbol for energy efficiency, providing simple, credible, and unbiased information that consumers and businesses rely on to make well-informed decisions. Thousands of industrial, commercial, utility, state, and local organizations—including more than 40% of the Fortune 500®—rely on their partnership with the U.S. Environmental Protection Agency to deliver cost-saving energy efficiency solutions. Ninety percent of American households recognize the ENERGY STAR, making it one of the most widely recognized consumer symbols in the nation. Together, since 1992, ENERGY STAR and its partners have helped save American families and businesses more than $450 billion and over 3.5 trillion kilowatt-hours of electricity while also achieving broad emissions reductions—all through voluntary action.

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

This 2013 document provides building professionals with practical guidance to control moisture in buildings during design, construction, and maintenance. The guidance includes audience specific moisture control guidance related to site drainage, foundations, walls, roof and ceiling assemblies, plumbing systems, and HVAC systems as well as methods for verifying the appropriate implementation of the discussed moisture control recommendations. The Appendix A in this document, the Pen Test, is particularly helpful.

- High Performance Enclosures (publication)

This is a 2012 publication for purchase that provides guidance for architects and building enclosure engineers working to meet the growing need for buildings that have significantly lower operational energy consumption.

- Leadership in Energy and Environmental Design (LEED) V4

This is the website to view LEED credit descriptions and values for various project aspects such as innovation, energy and atmosphere, and regional priority. A downloadable scorecard is also available.

- New Building Institute Five Steps to Net Zero Energy (document)

This 2017 introduction guide includes information on how architects and engineers can help clients upgrade their existing buildings to be zero net energy through a Deep Energy Retrofit combined with renewable energy sources.

- National Institute of Building Sciences—Whole Building Design Guide

Gateway to up-to-date information on integrated whole building design techniques and technologies.

- Oak Ridge National Laboratory—Foundation Design Handbook

The purpose of the 2014 handbook is to provide information that will enable designers, builders, and homeowners to understand foundation design problems and solutions.

- Pacific Northwest National Laboratory—Building Science Publications

This is a searchable database of Pacific Northwest National Laboratory publications.

- WELL Building Standard

The WELL Building Standard, by the International WELL Building Institute, is a cutting-edge standard that focuses exclusively on the ways that buildings, and everything in them, can improve comfort, drive better choices, and generally enhance, not compromise, health and wellness.

- WUFI

WUFI is a menu-driven PC program that allows realistic calculation of the transient coupled one-dimensional heat and moisture transport in multilayer building components exposed to natural weather. Software download is available for purchase.

Engineering

- Building Science Corporation Measure Guideline—Deep Energy Enclosure Retrofit for Interior Insulation of Masonry Walls (publication)

This 2015 Measure Guideline describes a deep energy enclosure retrofit (DEER) solution for insulating mass masonry buildings from the interior. It describes the retrofit assembly, technical details, and installation sequence for retrofitting masonry walls.
Interior insulation of masonry retrofits has the potential to adversely affect the durability of the wall; this document includes a review of decision criteria pertinent to retrofitting masonry walls from the interior and the possible risk of freeze-thaw damage.

- Connecticut Zero Energy Challenge

The CT Zero Energy Challenge is a design and build competition for single and multifamily homes built in Connecticut that awards cash prizes to its winners, while educating and demonstrating how to build super high-efficiency homes.

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

This 2013 document provides building professionals with practical guidance to control moisture in buildings during design, construction, and maintenance. The guidance includes audience specific moisture control guidance related to site drainage, foundations, walls, roof and ceiling assemblies, plumbing systems, and HVAC systems as well as methods for verifying the appropriate implementation of the discussed moisture control recommendations.

- Oak Ridge National Laboratory Building Foundations Handbook—Basement Construction Details (publication)

This is Chapter 2 in the 2014 Foundation Design Handbook. The purpose of the handbook is to provide information that will enable designers, builders, and homeowners to understand foundation design problems and solutions.

Market Analysis

- Database of State Incentives for Renewables & Efficiency® (DSIRE)

DSIRE is the most comprehensive source of information on incentives and policies that support renewables and energy efficiency in the United States.

- NREL National Residential Efficiency Measures Database

This database is a publicly available, centralized resource of residential building retrofit measures and costs for the U.S. building industry.

- NREL BEopt™

The BEopt 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 net energy. BEopt can be used to analyze both new construction and existing home retrofits, as well as single-family detached and multifamily buildings, through evaluation of single building designs, parametric sweeps, and cost-based optimizations.

- OpenEI Database

OpenEI is a trusted source of energy data, specifically for renewable energy and energy efficiency. Users can view, edit, add data, and download data for free.

- RSMeans

RSMeans® is a supplier of construction cost information, providing accurate and up-to-date cost information that helps owners, developers, architects, engineers, contractors, and others to carefully and precisely project and control the cost of both new building construction and renovation projects.

- Green Building: Principles and Practices in Residential Construction (Go Green with Renewable Energy Resources).

This is a downloadable book, published in 2012, that is a guide to green building residential construction.

- LEED Guide to Certification: Homes

This is a step-by-step guide to obtain LEED certification for your project (downloadable PDF available).

- Sustainable Residential Interiors, 2nd edition

This book, published in 2014, is available for purchase as an ebook or hardcover. It addresses cutting-edge processes, strategies, and principles for sustainable residential interiors.

Durability and Resilience

- DisasterSafety.org

This website is a resource regarding how disasters affect homes and business and the solutions to mitigate against the impacts from events. It also includes information on the different risks found in each state.

- FORTIFIED Home

FORTIFIED Home™ is a set of engineering and building standards designed to help strengthen new and existing homes through system-specific building upgrades to minimum building code requirements that will reduce damage from specific natural hazards.

- FORTIFIED Commercial

FORTIFIED Commercial™ is a voluntary, superior construction standard and designation program designed by the Insurance Institute for Business and Home Safety to make new commercial buildings stronger against severe weather, including hurricanes and high winds/high winds and hail.

- Federal Emergency Management Agency (FEMA) Risk Management: Building Science

The U.S. Federal Emergency Management Agency (FEMA) offers resources for risk management through building science to address resiliency in the face of natural hazards. Resources include publications on the effects of wildfires, earthquakes, hurricanes, and other natural hazards on building infrastructure and guidance for mitigating the associated risks.

Embodied Environmental Impact

- Design for the Circular Economy: Cradle to Cradle Certification

This website provides information on Cradle to Cradle Certification as well as resources for Circular Design, including material selection guidance, videos, podcasts, and case studies.

- Material Flow Tracking system

This research presents a model of materials present in the Swiss residential building stock and predicts future flow of materials on an individual building basis. Capturing this information supports strategies for reducing environmental impact of buildings based on informed material choice.

- Katerra LCA study for Modular

The Carbon Leadership Forum provides a report on their life cycle assessment of cross laminated timber in the Katerra Catalyst Building. The report outlines opportunities for reducing environmental impact and enhancing efficiency in mass timber construction of mid-rise structures.

- Using Life Cycle Assessment Methods To Guide Architectural Decision-Making For Sustainable Prefabricated Modular Buildings

This research provides a case-study of using life cycle assessment modeling to inform sustainable design decisions for prefabricated modular buildings. Findings emphasize the importance of minimizing operational energy impacts.

Integrated Performance

- Whole Building Design Guide

The Whole Building Design Guide (WBDG) presents the philosophy of the integrated design approach and design objectives for whole building design. WBDG also includes guides for building envelope design.

- Integration at its Finest: Success in High-Performance Building Design and Project Delivery in the Federal Sector

This research report by Renee Cheng, AIA, Professor at the University of Minnesota School of Architecture, highlights the successes the integrated design approach for high-performance building design in the Federal Sector.

Occupant Experience

- ENERGY STAR® Energy-Efficient New Homes

This website describes the features and benefits of an ENERGY STAR certified home, along with benefits for homeowners and information on how integrated systems and features (such as a complete thermal enclosure system; efficient lighting and appliances; and high-efficiency heating and cooling) make a difference.

- ENERGY STAR Renewable Energy Ready Homes (RERH)

The U.S. Environmental Protection Agency (EPA) developed the RERH specifications to educate builders on how to assess and equip new homes with a set of features that make it easier and less expensive for homeowners to install solar energy systems after the home is constructed. The website includes links to the Solar Photovoltaic (PV) Specification, Checklist, and Guide; RERH Solar PV Checklist; and RERH Solar Site Assessment Tool.

- ENERGY STAR Efficient Lighting and Appliances

This website includes a fact sheet (PDF) for energy-efficient lighting and appliances.

- Green Globes

Green Globes is an online assessment protocol, rating system, and guide for green building design, operation, and management. It is interactive, flexible, and affordable, and it provides market recognition of a building's environmental attributes through third-party assessment. A free 30-day trial is available.

- Grid-Interactive Efficient Buildings Factsheet

The U.S. Department of Energy's Building Technologies Office envisions a future in which buildings operate dynamically with the grid to make electricity more affordable and integrate distributed energy resources while meeting the needs of building occupants.

- Lighting Design Lab

The Lighting Design Lab focuses on the commercial and industrial markets and offers lighting technology services and resources to electric utilities, energy efficiency organizations, and trade professionals. Resources available on the website include lighting guides, energy codes, incentive programs and workshops.

- Lighting Design Lab Footcandle Light Guide

Footcandles are the most common unit of measure used by lighting professionals to calculate light levels in businesses and outdoor spaces. This website has a guideline for common areas to assist in achieving appropriate light levels with the greatest energy efficiency.

- Lighting Research Center Energy Efficient Residential Lighting

This site provides information on quality, energy-efficient lighting for residences for an audience that includes homeowners, contractors, retailers, architects, and lighting design students. This website includes the Builders Guide to Home Lighting and an Economic Worksheet.

- Residential Energy Services Network (RESNET): Lighting, Appliance and Miscellaneous Energy Usage Profile Amendments

The RESNET website is a one-stop solution to learn about the energy audit and rating processes.

Comfort and Environmental Quality

- Air Conditioning Contractors of America (ACCA)

ACCA is a nonprofit association with a membership that includes more than 60,000 professionals and 4,000 businesses in the indoor environment and energy services community. ACCA works together to promote professional contracting, energy efficiency, and healthy, comfortable indoor environments.

- ACCA Spreadsheets, Technical Manuals, Standards & Codes

ACCA develops the industry standards for heating, ventilation, air conditioning, and building performance. Under the auspices of the American National Standards Institute (ANSI), the ACCA works across the industry in a consensus-based process to create meaningful standards that raise the bar for contracting. Resources are available for members.

- Design Master—Duct and Diffuser Layout

Design Master HVAC makes it easier for a designer or engineer to lay out their ductwork in AutoCAD. The website offers a free demonstration and a 30-day trial.

- Elite Software Ductsize—HVAC Duct Sizing and Analysis

Ductsize allows creation of a complete duct system from start to finish and gives control over every aspect of the design. The program can size all the ducts (using three different sizing methods), enter sizes to analyze an existing design, or any combination of the two, where you specify the duct sizes through tight areas where there is little room for ductwork, and let the program calculate the sizes everywhere else. A demo is available, though pricing depends on the program.

- ENERGY STAR® Heat and Cool Efficiently, Maintenance Checklist

This is a checklist for maintaining heating and cooling equipment.

- Energy Savings Plus Health: Indoor Air Quality Guidelines for School Building Upgrades

This 2014 guide (PDF) is written primarily for school facility managers, energy managers, risk managers, building operators and school administrators to help them collaboratively manage the relationships between energy efficiency upgrade activities and indoor air quality in schools.

- EPA Indoor airPLUS Program

Indoor airPLUS is a voluntary partnership and labeling program that helps new home builders improve the quality of indoor air by requiring construction practices and product specifications that minimize exposure to airborne pollutants and contaminants. Resources available on the website include publications and resources along with podcasts and webinars.

- Indoor Air Quality Association (IAQA)

IAQA is dedicated to bringing practitioners together to prevent and solve indoor environmental problems for the benefit of consumers and the public. Their website has membership information along with resources and access to training.

- Lawrence Berkeley National Laboratory—Indoor Air Quality Scientific Findings Resource Bank

The Indoor Air Quality (IAQ) Scientific Findings Resource Bank (IAQ-SFRB) serves as a resource for public health professionals, building professionals, and others who seek scientific information about the effects of IAQ on people's health or work performance.

- Protecting IAQ During School Energy Efficiency Retrofit Projects with Energy Savings Plus Health Guidelines

This is an EPA website with links to various documents, resources, and training related to reducing energy costs in schools.

- Trane® VariTrane™ Duct Designer (software)

VariTrane Duct Designer streamlines duct design and improves calculation precision, helping optimize designs while obtaining a minimum pressure system. VariTrane Duct Designer enables organization of the layout structure of a duct system and provides detailed engineering information on a section-by-section basis making revisions and updates easier.

The software is based on engineering data and procedures outlined in the ASHRAE Fundamentals Handbook. It includes tested data from ASHRAE Fitting database and from United McGill to provide the most accurate modeling possible. A free 30-day trial is available.

- Ventilation Guide (publication)

This 2011 publication by Armin Rudd is available for purchase. It presents a variety of recommendations for improving indoor air quality in residential buildings through controlled mechanical ventilation. These recommendations are intended to illustrate principles of best practice.

- Wrightsoft®, HVAC Design and Sales Software

This is a comprehensive start-to-finish HVAC tool available for desktop or mobile solutions. Permanent and subscription packages are available for purchase.

Energy Performance

- ENERGY STAR® Energy Efficient New Homes

This website describes features and benefits of an ENERGY STAR certified home, along with benefits for homeowners, and information on how integrated systems and features (such as complete thermal enclosure system; efficient lighting and appliances, and high-efficiency heating and cooling) make a difference.

- ENERGY STAR Renewable Energy Ready Homes (RERH)

The RERH Specifications were developed by the U.S. Environmental Protection Agency to educate builders on how to assess and equip new homes with a set of features that make it easier and less expensive for homeowners to install solar energy systems after the home is constructed. Website includes links to Solar Photovoltaic RERH Specifications, PV RERH Checklist, and the RERH Solar Site Assessment Tool.

- EnergyGauge Energy and Economic Analysis Software (software tool)

This software tool was developed by the University of Central Florida's Florida Solar Energy Center. Software licenses are available for purchase for Residential and Commercial Buildings.

- Green Globes

Green Globes is an online assessment protocol, rating system, and guidance for green building design, operation, and management. It is interactive, flexible, and affordable, and provides market recognition of a building's environmental attributes through third-party assessment. A free 30-day trial is available.

- GridOptimal Initiative

The New Buildings Institute and the U.S. Green Building Council are launching a multiyear comprehensive grid edge initiative that will refine and disseminate a new building rating system called GridOptimal.

- The International Association of Plumbing and Mechanical Officials (IAPMO)

The IAPMO Group is a complete service organization, providing code development assistance, industry-leading education, plumbing and mechanical product testing and certification, building product evaluation and a manufacturer-preferred quality assurance program. Website resources includes product listing directory and access to list of IAPMO Codes.

- Lawrence Berkeley National Laboratory—Hot Water Draw Patterns in Single-Family Houses (publication)

This 2011 report describes data regarding hot water draw patterns that Lawrence Berkeley National Laboratory obtained from 10 studies.

- National Institute of Building Sciences, Whole Building Design Guide (WBDG)

WBDG is a gateway to up-to-date information on integrated whole building design techniques and technologies. The goal of whole building design is to create a successful high-performance building by applying an integrated design and team approach to the project during the planning and programming phases.

- National Renewable Energy Laboratory (NREL) Building Energy Optimization (BEopt™) (software tool)

The BEopt 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 net energy.

BEopt can be used to analyze both new construction and existing home retrofits, as well as single-family detached and multifamily buildings, through evaluation of single building designs, parametric sweeps, and cost-based optimizations.

Version 28.0.0 is available for download after registering for an account. The program is currently available for Windows operating system but can be used on other operating systems via virtual machines (e.g., Parallels) or via dual booting.

- OpenStudio® (software tools)

This is a cross-platform (Windows, Mac, and Linux) collection of software tools to support whole building energy modeling using EnergyPlus and advanced daylight analysis using Radiance. OpenStudio is an open source (LGPL) project to facilitate community development, extension, and private sector adoption. OpenStudio includes graphical interfaces along with a Software Development Kit (SDK). Refer to the Software Document on the Project Site for full instructions.

OpenStudio is developed in collaboration by NREL, ANL, LBNL, ORNL, and PNNL.

- Ripple (software tool)

Ripple is a web-based tool developed by Slipstream that allows for basic energy modeling for commercial building types. Some large residential building types, such as multifamily residential, are also included. The platform provides a user-friendly introduction to whole-building energy modeling that is suitable for all level of users. The tool provides the opportunity to model how various improvement measures can impact overall energy performance and cost compared to a baseline. Refer to the Software Document on the Project Site for full instructions on how to access Ripple.

- NREL Tool for Generating Realistic Residential Hot Water Event Schedules (publication)

This 2010 paper describes the development of an advanced spreadsheet tool that can generate a series of year-long hot water event schedules consistent with realistic probability distributions of start time, duration and flow rate variability, clustering, fixture assignment, vacation periods, and seasonality.

- NREL PVWatts (online tool)

This tool estimates the energy production and cost of energy of grid-connected photovoltaic (PV) energy systems throughout the world. It allows homeowners, small building owners, installers, and manufacturers to easily develop estimates of the performance of potential PV installations.

- NORESCO REM/Rate (software tool)

REM/Rate™ and REM/Design™ desktop applications have been the industry standard for HERS® Ratings and home energy analysis/weatherization. Both programs are used within residential energy efficiency rebate programs. They provide valuable information about energy performance to electric and gas utility companies as well as their program implementers and evaluators who want to predict and assess new and existing single-family homes. IECC code compliance is also supported by REM software. A free 90-day trial is available.

- Technical Feasibility Study for Zero Energy K-12 Schools (publication)

This study includes energy use intensity targets for all climate zones, a pathway for how to achieve these EUIs by climate zone, and case studies of actual K–12 school applications.

- U.S. Environmental Protection Agency (EPA) Technical Reference: Source Energy (document)

This is a downloadable PDF of an ENERGY STAR document for commercial buildings (ENERGY STAR is a U.S. EPA partner).

- EPA WaterSense

This website includes links to various WaterSense-labeled products for homes, yards, and businesses.

Presentation

- Solar Decathlon 2020 Design Challenge (Team Presentations)
- Solar Decathlon 2019 Design Challenge (Team Presentations)

View the presentations (PDFs) of the 2019 winning team presentations and 2019 results

- Race to Zero Student Design Competition (Team Presentations)

View the presentations (PDFs) of the 2018, 2017, and 2016 winning team presentations and 2018, 2017, and 2016 results.

- DOE-Hosted Presentations

This YouTube channel includes video presentations on various topics.

- Ignite® Presentations

Ignite Talks are 5-minute video presentations on various topics. Ignite's mission is "Everyone Speaks," and the group believes that public speaking builds confidence in individuals and that events like Ignite build community. Their goal is to make it possible for anyone, anywhere, to learn to present their ideas and their stories.

- PG&E Zero Net Energy Program

Pacific Gas and Electric's (PG&E) ZNE outreach activities include workshops and educational series. Workshops help design professionals learn about creating ZNE buildings and are offered through PG&E's Training Centers. PG&E also holds speaker forums and presentations on key ZNE topics for building professionals and residential customers.

- TED Talks

This website includes video presentations on various topics. TED is a nonprofit devoted to spreading ideas, usually in the form of short, powerful talks (18 minutes or less).

- National Energy Educational Development Project (NEED)

Since its founding, NEED has kept its Kids Teaching Kids philosophy as a fundamental principle of NEED programming—encouraging students to explore, experiment, and engage, and encouraging teachers to embrace student leadership in the classroom. NEED trains and assists teachers in harnessing the energy of the classroom—the energy of students. Course catalog and workshop calendar are available.

- National Institute of Building Sciences Innovation Conference Proceedings

Speaker presentations are available for download from 2015. Sign-in is required.

- U.S. Department of Housing and Urban Development—The Diffusion of Innovation in the Residential Building Industry (publication)

This 2004 publication is a report in direct support of ongoing efforts to understand the home building industry's means and methods.

Additional Resources

Passive House

- PHIUS+

PHIUS is a non-profit organization dedicated to making high-performance passive buildings the mainstream standard. PHIUS provides training and certification programs for building professionals, conducts high-performance building research, and certifies passive buildings. PHIUS offers software and resources to assist building designers in incorporating passive design strategies, including the WUFI® Passive energy modeling software available for download at no charge.

- International Passive House Association (iPHA)

iPHA is a global network of Passive House stakeholders including architects, planners, scientists, suppliers, manufacturers, contractors, and property developers. It works to promote the Passive House Standard and foster a greater public understanding of its significance. IPHA provides Passive House Guidelines and contributes to additional passive design resources, including Passipedia: The Passive House Resource.

- Passipedia: The Passive House Resource

Passipedia is a web-based collection of resources related to the passive house design concepts curated by the Passive House Institute (PHI). Resources cover a range of topics for both residential and non-residential passive design strategies, including building envelope, mechanical systems, and applying passive strategies in different climates.

Design for Disassembly/Deconstruction

- Design for Disassembly – Themes and Principles

The disassembly of buildings to recover materials and components for future reuse is not widely practiced in the modern construction industry. This guide covers a range of themes and offers a set of principles, or guidelines, for design for disassembly that can be applied to a project in order to facilitate and encourage greater rates of reuse and recycling in the future.

See more of Dr. Philip Crowther's works for additional resources on design for disassembly and deconstruction.

- EPA Study on Methods and Success Stories for Designing for Disassembly and Deconstruction

This series of fact sheets developed by EPA highlights innovative approaches, results, and environmental and economic benefits emerging from innovative pilot projects that test ideas and strategies for improved environmental and public health results. Specifically, fact sheets cover topics on design for disassembly in the built environment; deconstruction for urban revitalization; and design for reuse.

Industrialized Construction

- Modular Construction—Process to Product

This research by McKinsey & Company quantifies benefits and challenges of modular construction and its potential for widespread and sustainable impact. Specifically, it covers cost-saving benefits, market impacts, and various approaches to modular construction.

- Modular Advantage by Modular Building Institute

This edition of Modular Advantage includes highlighted success stories and case studies of modular and offsite construction in industry. Topics include the future of offsite construction, construction savings and advantages, relocatable buildings, and innovative instances of modular design.

- Mass MODX

This resource by the Northeastern School of Architecture includes clear discussions with graphics and insights on a variety of topics concerning modular design, including modular ecologies, the modular factory and method of production, urban instances of modular design, modular dimensions, modular coalitions, and other indicators and initiatives.

- Off-site School in UK

Offsite Hub is an online information center for offsite construction based in the UK. The project gallery contains numerous case studies on offsite construction projects for both residential and commercial, including schools and retail, sectors.

- Design for Modular Construction by AIA

This materials practice guide by the American Institute of Architects is an introduction for architects entering the realm of modular construction design. It outlines the modular approach in detail, highlighting both benefits and barriers of modular construction. The guide also includes additional resources for prefab and modular architecture.

Advanced Manufacturing Tools for Buildings

Subtractive Manufacturing for Buildings

- Integrated Design and Manufacturing [IDM] Framework for the Modular Construction Industry

This research by Virginia Tech investigates the connection between design and manufacturing design phases for modular single-family homes. It also proposes strategies for improving this relationship through an integrated design and manufacturing (IDM) framework.

- WikiHouse

WikiHouse is a digitally-manufactured building system that aims to simplify design, manufacturing, and assembly of high-performance homes. CNC-fabrication of modular WikiHouse components can be performed on site, eliminating the cost for a prefabrication facility. Simple assembly of components further enhances the speed and practicality of the WikiHouse process. The WikiHouse Guide outlines the technology and process in full.

- Blueprint Robotics

Blueprint Robotics utilizes an integrated engineering approach and robotics to manufacture custom wall, floor, and roof elements for building projects. Designs are sent to the Blueprint Robotics facility, where robotics are used to quickly construct building elements, that are shipped to and assembled on the building site.

- Swedish Production Line for Construction

Lindbäcks Bygg, a Swedish modular timber-frame home manufacturer, is highlighted for its revolutionary assembly line approach to successful production. Training workers and streamlining processes through worker feedback are two ways in which Lindbäcks is able to maximize efficiency without sacrificing quality.

- Fabricating the Modern Dwelling

A prefab house designed and built by MIT architect Larry Sass uses mass-customized and standardized components that require no nails, screws, or glue for assembly. The structure is assembled with entirely friction-fit components.

- Digital Fabrication

The Design Fabrication Group MIT highlights a digital fabrication project in which planar modeling is used to break a building design into components that connect with interlocking joints. This method increases affordability by reducing on-site construction costs, making it a possible solution for affordable housing construction.

Additive Manufacturing for Buildings

- Hypes and Limitations of 3D printing in construction

This article provides an overview of the 3D-printing with concrete in the building sector and the progress of this technology. Benefits and limitations are highlighted, including examples of successful implementation of 3D-printed concrete structures.

- Contour Crafting

Contour Crafting Corp uses robotics to construct detached houses to multi-story and -unit structures through 3D-printing with concrete.

Process Optimization

- Digital Twin for construction

A digital twin is digital representation of the real-world object. In the case of construction, a digital twin can be used to monitor construction and make changes real-time, document progress, and streamline production methods. It also provides opportunities for automated process and safety monitoring, resource planning and logistics, quality assessment, and optimization of equipment usage.

- Solar Home Factory: Industry Best Practices

The Solar Village in Geneva, NY, is a fully solar-powered community designed by the Solar Home Factory. Their design includes prefabricated off-grid homes, community buildings, electrical vehicle checkout system, community gardens, and a 1.5-megawatt Solar Farm with battery back-up.

U.S. DEPARTMENT OF ENERGY
SOLAR DECATHLON

Build Challenge Rules
2020

June 2020

List of Acronyms

ADA	Americans with Disabilities Act
ANSI	American National Standards Institute
cfm	cubic feet per minute
CO_2	carbon dioxide
dB	decibel
dBa	A-weighted decibels
DOE	U.S. Department of Energy
EHS	Environmental, Health, and Safety
HERS	Home Energy Rating System
HVAC	heating, ventilating, and air conditioning
ISO	International Organization for Standardization
kWh	kilowatt-hours
Leq	level equivalents
lx	lux
NREL	National Renewable Energy Laboratory
OSHA	Occupational Safety and Health Administration
PPM	parts per million
PV	photovoltaic
Wh	watt-hours

Summary of Changes Since the January 2020 Release

The following is a summary of changes and updates included in this Rules document since its January 2020 release:

- Removed all references to the Smithsonian Folklife Festival
- Updated dates to align with event conclusion in April 2021
- Added Deliverable 6.5 “Public Exhibit and Community Exhibition Strategy” due November 3, 2020
- Clarified accessibility and inspection requirements for all teams building locally in their own communities
- Removed references to safety oversight and stop-work orders no longer relevant, as the Solar Decathlon organizers will not have oversight of any team’s construction activities
- Removed requirement for structural engineer stamp, team insurance, and other National Mall-specific requirements
- Updated expectations for student presentations to juries to reflect activities occurring at the Solar Decathlon Competition Event.

Foreword—Why Solar Decathlon Build Challenge?

High-performance building design includes comprehensive building science, energy efficiency, optimized mechanical systems, indoor air quality, resilience, and water conservation. These attributes will ultimately determine whether buildings succeed or fail in terms of the human experience: affordability, comfort, health, durability, safety, and adequate resources. Yet, professional curricula across the United States and around the globe do not consistently provide students the skills needed to effectively integrate high-performance measures into their design, engineering, and construction management careers moving forward. Moreover, emerging crises related to affordability, health, disaster risks, and water shortages are making these skills an imperative at the same time that degree programs are working to effectively integrate them into their curricula. Enter the U.S. Department of Energy (DOE) Solar Decathlon® Build Challenge.

Starting in 2002, the focus was on two critical goals. First, to integrate high-performance design and construction education into degree programs; and second, to inspire the public and industry through innovations implemented by student teams. The Solar Decathlon has grown to encompass an international footprint with events occurring around the globe and tens of thousands of alumni worldwide. The Solar Decathlon Build Challenge is helping to create the next generation of workforce with the skills and passion to build or retrofit future-ready buildings.

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Solar Decathlon Build Challenge Competition Rules Authors: NREL's Joe Simon, Alicen Kandt, Michael Young, Stacey Rothgeb, Chris Colgan, and Rachel Romero.

Solar Decathlon Build Challenge Rules

The Solar Decathlon is a collegiate competition, comprising 10 Contests, that challenges student teams to design and build highly efficient and innovative buildings powered by renewable energy. For more information on the competition as a whole, read the Solar Decathlon Competition Guide.

The Build Challenge encourages student participation during a 2-year period to prepare creative solutions for real-world issues in the building industry. Qualifying teams design and build complete, functional houses that are displayed locally in their communities.

During the Solar Decathlon Competition Event, all competing Build Challenge teams present to the public and exhibit their solutions before panels of expert jurors. Build Challenge teams also have the opportunity to meet with event organizers, learn from presentations by thought leaders and collegiate peers, and compare team projects and engage with buildings-related organizations to learn about energy careers.

Through local building exhibitions and national presentations, teams are recognized publicly, and the winning houses are published on the Solar Decathlon website. The competition and winners are promoted through a variety of media outreach efforts, which provide participants and their collegiate institutions an opportunity for national exposure. Collegiate institutions that participate in the Build Challenge are recognized as leaders in cultivating career-ready, young professionals with cutting-edge skills. Industry partners that collaborate with teams gain national and local recognition and have the opportunity to interact with knowledgeable future design and construction professionals.

1 Summary of Important Dates

Please note the following key milestones for the 2020 Build Challenge:

- **August 2018:** The initial 2020 Build Challenge Rules are released; the team application is available on the Solar Decathlon website.
    - After a team completes its application, the team is provided access to Build Challenge communications and resources, including building science training, topical webinars, and energy modeling software. The Groups.io Project Site is an online forum for participating students to receive timely information from organizers and access necessary resources.
- **December 10, 2018, 5 p.m. Eastern Standard Time (EST):** This is the deadline by which all teams must submit their team application online, including indicating which Division the team wants to enter and submitting a Build Challenge Proposal.
    - DOE accepts up to six teams for each Division, 12 in total for the Build Challenge. Dependent on funding availability and quality of applications, more or fewer teams may be accepted into either or both Divisions.
    - The application site can be accessed from the Solar Decathlon website.
    - In addition to providing the required information in the application, teams are required to submit a Build Challenge Proposal. The requirements for the Build Challenge Proposal are available on the Solar Decathlon website. Teams are provided feedback on their Build Challenge Proposal regarding their project compliance and design.
    - Each team pays a nonrefundable $100 fee, identifies a faculty lead or student team lead, and submits a preliminary roster of student team members.
        - Within 21 days, entries are evaluated against criteria indicated in the Build Challenge Proposal attachment. Based on the Build Challenge Proposal evaluation, up to six teams per Division category are invited to participate in the competition.
    - If a team is not accepted into its desired Division, the organizers may optionally offer a spot in the other Build Challenge Division based on the quality of the team's Proposal and other team Proposals received.
    - If a team is not accepted into either Build Challenge Divisions, the team is provided an opportunity to still participate in the Design Challenge by informing the organizers of its intent to continue and its intended Design Challenge Division within 14 days of notification of nonacceptance. A school may only have one team per Division in the Design Challenge, so if the school already has one or more teams participating in the Design Challenge, the nonselected Build Challenge team must choose an available Division or merge with an existing team. An additional $100 registration fee will not be collected for this transference of team application to the Design Challenge.

- **January 31, 2019:** Updated Solar Decathlon Competition Guide is released. Minimal revisions expected, primarily focused on clarifying intent or adding definition to dates or schedules.
- **February 19, 2019, 5 p.m. EST:** This is the deadline by which all teams must complete the Project Introduction.
    - The Project Introduction, as detailed in Section 6.1, must be submitted via the file submission link posted to the Groups.io Project Site.
- **March 26, 2019, 5 p.m. Eastern Daylight Time (EDT):** Teams must submit the Design Development deliverable by this deadline.
    - The Design Development deliverable, as detailed in Section 6.2, must be submitted via the file submission link posted to the Groups.io Project Site.
- **April 9, 2019, 5 p.m. EDT:** This is the deadline by which teams must submit their Design Presentation deliverable, including presentation files and optional posters, as detailed in Section 6.3. Presentations will not be accepted after this date.
- **April 12–14, 2019: Solar Decathlon Design Challenge Weekend:** Participating teams come to the National Renewable Energy Laboratory (NREL) main campus in Golden, Colorado, and present to industry leaders who evaluate each team's Design Development Documentation deliverable and Design Presentation deliverable to determine which teams will receive an Approval to Proceed to the next phase and receive the first distribution of prize funding. The funding distribution and process for evaluation of team progress for determining an Approval to Proceed is documented in the Approval-to-Proceed Procedures, which are available on the Solar Decathlon website.
    - At least one student team member, but no more than five students total, from each team must attend in person. One faculty lead is recommended to attend; up to two are allowed to attend for each team. A maximum of seven team members may attend.
- **July 31, 2019:** An updated 2020 Build Challenge Rules document, complemented by the overall Solar Decathlon Competition Guide, is released. Minimal revisions expected, primarily focused on clarifying intent or adding definition to dates or schedules.
- **November 5, 2019, 5 p.m. EST:** This is the deadline by which teams must submit their Construction Documentation deliverable, including complete construction drawings, Public Project Renderings, and an interim project report, as detailed in Section 6.4, and must indicate where they would like their house measurements collected.
    - The Construction Documentation deliverable, as detailed in Section 6.4, must be submitted via the file submission link posted to the Groups.io Project Site.
    - Teams are provided feedback on their Construction Documentation deliverable regarding their project code and rules compliance. The requirements for the Construction Documentation deliverable are detailed in Section 6.4.
    - Within 21 days, entries are evaluated by industry leaders to determine which teams will receive Approval to Proceed to the next phase and receive the second distribution of prize funding. The funding distribution and process for evaluation

of team progress for determining an Approval to Proceed is documented in the Approval-to-Proceed Procedures, which are available on the Solar Decathlon website.

- **January 31, 2020:** An updated 2020 Solar Decathlon Competition Guide is released. Minimal revisions expected, primarily focused on clarifying intent or adding definition to dates or schedules.
- **February 18, 2020, 5 p.m. EST:** This is the deadline by which teams must complete the As-Built Documentation deliverable, including their updated Public Project Renderings, 100% Construction Documentation, Construction Progress Photos, and Team Roster.
    - The As-Built Documentation deliverable, as detailed in Section 6.5, must be submitted via the file submission link posted to the Groups.io Project Site.
- **April 22, 2020, 5 p.m. EDT:** This is the deadline by which teams must submit their Project Summary deliverable, including their final project report, Public Project Summary, and Team Roster. This is also the deadline by which all teams must indicate which team members have completed the building science training online or have received an equivalency waiver from their faculty lead.
    - The Project Summary, as detailed in Section 6.6, must be submitted via the file submission link posted to the Groups.io Project Site.
- **November 3, 2020, 5 p.m. EDT: Public Exhibit and Community Exhibition Strategy**
    - This is the deadline by which teams must submit their Public Exhibit and Community Exhibition strategy deliverable.
- **Fall 2020 and Spring 2021: Solar Decathlon Build Challenge Community Exhibition Period:** This is the period during which all competing teams exhibit their as-built houses to their local communities, offering tours of the house and hosting educational activities. The organizers will complete verifying functionality as part of the measured contest activities during this time. To ensure equal testing and demonstration without dependency on local utility interconnections, all teams must be able to be operated off-grid for the required contest activities.
- **March 2, 2021, 5 p.m. EST:** This is the deadline by which teams must have received a Certificate of Occupancy from their local Authority Having Jurisdiction, installed all Organizer Instrumentation Equipment, and demonstrated an accessible tour route through their house locally to organizers. This is also the deadline by which teams must submit their Jury Documentation deliverables, including their narratives to each jury, architectural photography of their as-built house, photographs of the as-built house, and Public Construction Documentation.
    - The Jury Documentation deliverable, as detailed in Section 6.7, must be submitted via the file submission link posted to the Groups.io Project Site.

- **April 16–18, 2021: Solar Decathlon Competition Event**: Participating teams come to the National Renewable Energy Laboratory (NREL) main campus in Golden, Colorado, and present to jurors who evaluate each to determine scores.
- **May 18, 2021, 5 p.m. EDT: Final Report:** Deadline by which teams must submit their Final Report deliverable, including a summary of successes and challenges, to the organizers.
    - The Final Report deliverable, as detailed in Section 6.8, must be submitted via the file submission link posted to the Groups.io Project Site.

2 Build Challenge Description

2.1 Task Overview

- Read this Build Challenge Rules document and form a team.
- Review the past team entries on the Solar Decathlon website to inform efforts.
- Submit a team application with a Team Roster and Build Challenge Proposal using the instructions in the team application site.
- Receive notification of acceptance as a participant in the Build Challenge, or an invitation to join the Design Challenge.
- Ensure all team members have access to the Groups.io Project Site, where competition updates are posted regularly. Within the Groups.io Project Site, there is a subgroup specifically for the Build Challenge.
- Ensure all student team members complete the building science training course online or receive a confirmation from the team's faculty lead that equivalent training is provided as part of the student's curriculum.
    - The building science training coursework from world-renowned experts is provided at no cost to every team member.
    - Access instructions are available on the Groups.io Project Site.
    - The curriculum includes topics such as enclosure fundamentals; rain control; airflow control; heat flow control; vapor and condensation control; roofs; ventilation and air pressure management; windows; durable, healthy, efficient housing; unique solutions (optional); and multifamily/multiunit housing (optional).
- Identify areas in which industry partnership is needed or wanted.
- Study the resources provided in the Resources document on the Groups.io Project Site.
- Consult the Solar Decathlon website and Groups.io Project Site for updates and announcements.
- Attend optional webinars as advertised on the Groups.io Project Site for technical, design, and competition guidance. These webinars will also be available as recordings posted to the Groups.io Project Site if attendance is not possible as scheduled.

- Attend monthly all-team conference calls for project updates and important information from the organizers about Build Challenge requirements, as outlined in Section 3.
- Design and document a project compliant with the requirements listed in the latest version of the Build Challenge Rules.
- Build a house compliant with the requirements listed in the latest version of the Build Challenge Rules.
- Exhibit the project locally, compliant with the requirements listed in the latest version of the Build Challenge Rules.
- Exhibit the project, compliant with the requirements listed in the latest version of the Build Challenge Rules, to public and professional visitors.
- Submit all materials by the deadlines. Note that all deadlines are 5 p.m. Eastern Time (EDT from March to November each year, and EST from November to March).
- Submit questions to SDbuild@nrel.gov.

2.2 Developing a Team

Each team must be associated with a collegiate institution and include a faculty lead. The competition is open to all collegiate and degree-issuing institutions, including community colleges. International institutions are welcome to participate. Each team must have at least four students, with one student designated as the student team lead and others filling in team officer roles, as outlined in Table 1. Teams are encouraged to be multidisciplinary. Multiple collegiate institutions may combine to form a team. A collegiate institution may submit only one team application to the Build Challenge (see Section 3, Project Requirements). A team may choose to have several internal groups of students complete designs and then submit only one design when the submission deadlines occur. The team application costs $100 per team and is nonrefundable. If a school has multiple teams competing in the Solar Decathlon, across the Design and Build Challenges, each team must have distinct designs and must have unique team leads and team members. A faculty advisor may advise multiple teams.

If a team member who is not a U.S. citizen wants to participate in person at the Competition Event held at the NREL campus, each affected person must submit a Foreign National Data Card. Additional information and requirements are provided in the online team application site and the Groups.io Project Site.

2.3 Student Decathlete 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 fields such as architecture, engineering, building science, construction management, interior design, marketing, management, and landscape architecture. Often, students who receive some benefit for team participation—whether course credit, internship hours, a stipend, or a scholarship—are able to achieve greater success. Each student must be pursuing a degree and enrolled in at least one class at a participating collegiate institution or have graduated within 12 months of April 1, 2020.

2.4 Faculty Lead Role

The faculty lead, along with student team leads, is responsible for communicating competition details from the organizers to the team members. A team may have more than one faculty advisor; however, one faculty lead must be designated to serve as a primary contact and oversee the team. Among other responsibilities, the faculty lead will maintain responsibility for verifying that participating students complete the building science training or equivalent curriculum, ensure safety for all people participating in construction, and help guide participation in the Competition Event, participation in Divisions, and overall project budgets. The faculty lead is encouraged to closely engage with the students on the project. The faculty lead provides support in many areas, including the following:

- Ensure familiarity with the Competition Guide and Challenge-specific guidance, as appropriate.
- Make sure 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.
- Guarantee the necessary information is provided to team members who will be on-site at the competition events. The faculty lead is expected to attend the competition in person.
- Ensure the team successfully builds the house as designed and exhibits successfully to the public.

2.5 Build Challenge Divisions

The Solar Decathlon Build Challenge comprises two Divisions: National Showcase Division and Local Build Division. Each collegiate institution applies to only one Division. Collegiate institutions may choose to have multiple internal groups of students complete designs, but only one design project may be submitted. The organizers accept up to six teams per Division, based on the review criteria described in the Approval-to-Proceed Procedures, which are available on the Solar Decathlon website.

Each team selects and defines a specific location, building lot or site, and neighborhood characteristics as context for the building design and its relationship to surrounding structures and the community. All teams must have a specific target site and location for consideration by the juries, though the team will retain the option to locate the house elsewhere after the Challenge.

A dwelling unit, as defined by the 2018 International Energy Conservation Code, is a single unit that provides complete independent living facilities for one or more people, including permanent provisions for living, sleeping, eating, cooking, and sanitation. Total area compliance should be verified using Square Footage—Method for Calculating: ANSI Z765-2003 (R2013), which states that the finished area is the sum of the finished and conditioned areas measured at the floor level to the exterior finished surface of the outside walls.

The Solar Decathlon Build Challenge is meant to provide flexibility to collegiate institutions to compete in a way that resonates with their goals and fits within their cost, schedule, and technical constraints. The Contests and Rules apply equally to all teams, regardless of Division, unless noted otherwise. The same jurors judge each Division.

Maximizing energy performance of the designed house is critical to the success of the Solar Decathlon Build Challenge. Energy efficiency decisions significantly impact virtually all design decisions and submissions associated with the project.

Renewable energy must be evaluated and integrated into the project and built house. All houses, in both Build Challenge Divisions, must be designed and built to be able to be operated off-grid for competition evaluation purposes, including appropriate energy storage and safety systems for operation.

National Showcase Division

Teams shall design and build an energy-positive house that can be effectively transported long distances and rapidly installed. The design should respond to a unique, team-specified target market that would benefit from collegiate institution innovation and engagement. Teams will need to build a transportable design that can be set up in three days or less. For example, target markets for the National Showcase Division could include, but are not limited to, disaster response, indigenous-focus, rural solutions, urban accessory dwelling units, multifamily urban infill housing, or many other possible choices where a single-module design would be attractive and appropriate. Additionally, teams may develop and demonstrate possible sites where the design is installed as part of a multifamily building. The National Showcase house built must be a complete dwelling unit for part of its exhibition, defined as a single unit providing complete, independent living facilities for one or more people, including permanent provisions for living, sleeping, eating, cooking, and sanitation. The team's house cannot depend on future expansion to be fully functional.

Teams are expected to exhibit and operate their house in their region. The exhibit must be designed for effective transportation and rapid setup, shipping entirely constructed with limited work to do on-site to prepare the house for operation and touring.

The National Showcase house module is limited to maximum dimensions of 15 ft wide, 14 ft tall while in transportation mode, and 60 ft long. Each house module must have a minimum finished area of 400 square feet (ft^2), as measured according to ANSI Z765. Potential unfurling of elements such as panels, shading devices, or overhangs are evaluated on a case-by-case basis. The house must have separate entry and exit doors with an accessible route through the home for tour groups, further detailed in the Solar Decathlon Building Code. The remainder of the house does not need to be accessible.

> Note: for teams whose house may exceed the dimensions stated above while in transportation mode, or for any other reason, specific approval must be requested and received from Competition Management.

Local Build Division

Teams shall design and build an energy-positive house in their region that can be effectively exhibited and operated. The design should respond to a unique, team-specified target market that would benefit from collegiate institution innovation and engagement. For example, target

markets for the Local Showcase Division could include, but are not limited to, improved production housing, custom housing, housing for aging in place, low-income housing, existing-home renovation, attached housing, or disaster-resilient housing. Teams may build multifamily housing where the design is part of a townhome or row home development. However, the house presented must represent a complete dwelling unit, and only one dwelling unit will be evaluated as part of the contests.

Teams are required to exhibit and operate their house in their region. The Local Build house must be between 600 ft^2 and 3,000 ft^2. The house must have separate entry and exit doors with an accessible route through the house for tour groups. Not all levels must be accessible, but the visitor should have a comprehensive and compelling tour experience. The team must integrate into the design or otherwise provide ADA-accessible ramps to enable the public to tour the house while on exhibit. The organizers will have a third-party inspector verify the ADA tour route through each house prior to providing an approval to compete, though teams may use prize funding awarded to the team for this purpose, if desired.

2.6 Build Challenge Expectations

The Build Challenge provides a rich experience for students and on-site participants through networking opportunities, building a house, and attending other team and professional presentations. All students benefit from participation, regardless of event attended or role played. Students can benefit supporting design, project management, construction or presentation, whether they compete at 2019 Design Challenge Weekend or the Competition Event, which will occur at the National Renewable Energy Laboratory in April 2021. Often, teams partner with industry to guide and support both their design and construction.

The organizers do not plan to provide financial assistance for lodging or travel expenses.

Application and Proposal

Teams interested in participating in the Build Challenge are required to complete a team application, including a Build Challenge Proposal. After evaluating the Build Challenge Proposals, up to six teams are invited to compete in each Division, with up to 12 teams total.

Schematic and Design Development Activities

Following notification of acceptance into the Build Challenge as a finalist, each team is expected to promptly begin work on its design solution. Most schools will integrate the design and team formation process into a course (or more) in the spring semester or first quarter of 2019. During this phase, teams will refine their concept, recruit industry partners, confirm the location for the construction of the house, and prepare deliverables. The organizers expect each team to send at least one student, or up to five students total, to attend 2019 Design Challenge Weekend in-person, April 12–14, at NREL in Golden, Colorado, to present their design progress for determination of the first Approval to Proceed. One faculty lead is recommended to attend; up to two are allowed to attend for each team. In total, a team may have a maximum of seven team members present if they bring five students and two faculty leads.

Teams are expected to indicate when registering for 2019 Design Challenge Weekend if they are interested in bringing an architectural-scale model. The models may be on display during the

team's presentation and the Poster Session. These models are optional; all shipping and transportation costs are the responsibility of the teams.

As part of 2019 Design Challenge Weekend, team progress are evaluated by experts for an Approval to Proceed to the next phase and for receipt of a portion of prize funds, as outlined in the Approval-to-Proceed Procedures, which are available on the Solar Decathlon website.

These activities run from acceptance into the Build Challenge through April 2019.

Construction Documentation Activities

Following receipt of an Approval to Proceed in April 2019, teams are expected to complete their designs; Construction Documentation deliverable; and include all appropriate construction drawings, details, energy models, specifications, site plans, transportation logistics, and project plans per the schedule of deliverables outlined in Section 6. Teams will complete recruitment of industry partners/sponsors and fundraising and identify a final location for their as-built house. The Construction Documentation should be completed to such a level that a general contractor could build the house as the team intends with minimal additional questions or follow-up. The Construction Documentation will not be released publicly. It is expected that most teams will utilize some summer coursework or internship activities to make progress in the summer of 2019, and then integrate Construction Documentation, fundraising, and final project planning into the fall and winter of 2019.

Following the completion of each teams' Construction Documentation deliverable, team progress is evaluated by experts for Approval to Proceed in the Challenge, as outlined in the Approval-to-Proceed Procedures, which are available on the Solar Decathlon website.

These activities run from April 2019 through November 2019.

Build Activities

Following the successful completion of their Construction Documentation, teams begin the process of building their house. For Local Build teams, the house will likely be built on a permanent foundation. Teams will work with industry partners and sponsors to raise sufficient funds and receive sufficient materials to build the house as designed. Throughout the process, teams are expected to follow safe construction practices and document activities that may be relevant to the juries.

These activities run from November 2019 through the completion of the house.

Competition

Following the successful construction of the house, each team will compete in the Solar Decathlon 2020 Build Challenge. Organizers will work with each team to verify functionality and collect measurements necessary for scoring at a location to be coordinated with each team, and teams will present their solutions to juries. The teams will present to juries using photographs, videos, models, and/or other mediums to demonstrate their design and as-built house. All teams may optionally use photographs, videos, models, and or/other mediums to demonstrate aspects or elements of their design. The organizers will have each house

photographed and documented using interactive 3D photography with walkthroughs to provide to the juries for review in advance of deliberation. Simultaneous to the competition phase, teams are expected to exhibit their as-built houses to members of the general public, educating them about opportunities for energy efficiency and energy production in their own homes.

2.7 Industry Partners

Industry partnerships are encouraged to provide a market-ready perspective for proposed solutions and to help select and integrate building systems into the built house.

For the design and construction of their houses, teams are encouraged to engage with industry professionals such as builders, architects, city officials, contractors, developers, energy auditors, engineers, or tradespeople in areas such as site development, codes, construction, building materials, mechanical systems, lighting systems, financing, and sales. These partners can help inform the students' decision-making processes and review the project. It is expected that industry partners can provide support, donations, and guidance to students while the students remain responsible for design, detailing, documentation, construction, operation, and competition activities.

3 Build Challenge Project Requirements

A Solar Decathlon house is a high-performance building so energy efficient that a renewable energy system will offset all of the building's annual energy consumption, including electric vehicle charging. Along with achieving this level of performance, teams demonstrate the effective integration of building science principles and best-practice guidelines for the building envelope and mechanical systems into a compelling architectural design.

Homes are subject to local, state, and national codes or standards governing topics such as minimum bedroom size, fire protection requirements, resiliency, or other requirements. If there are conflicts between the Solar Decathlon Build Challenge Building Code and local regulations where both conditions cannot be met, teams must discuss the discrepancy with the Solar Decathlon Build Challenge Building Official. The Solar Decathlon Build Challenge Building Code applies to both the Local Build and National Showcase Divisions.

English units of measurement are preferred; however, a submission with metric units is acceptable. If metric units are used, state metric units first, followed by English equivalents in parentheses. For example, 38.1 meters (125 feet). For quick online conversions of English units of measurement to metric units, see the Digital Dutch Unit Converter or the French Investment Property Metric and Imperial Conversion Charts and Tables.

3.1 Authority

U.S. Department of Energy

DOE is the sponsoring organization, and the Solar Decathlon Build Challenge Director has the final decision-making authority in all aspects of the project.

Build Challenge Manager

The Build Challenge Manager is the only rules official authorized to write and modify these rules.

Rules Officials

The rules officials are the only organizers authorized to interpret the rules, revise the project schedule, change a team's score, or enforce the rules as required for the fair and efficient operation or safety of the competition.

a) The official version of the rules shall be the rules on the Groups.io Project Site. Other printed, electronic, and verbal communications covering the rules shall have the effect of the rules unless such communications are in conflict with the official version on the Groups.io Project Site. In the case of a conflict, the official version shall govern. If there is a dispute, DOE and the organizers shall resolve the dispute in accordance with the dispute procedures contained in the official version.

b) Printed, electronic, and verbal communications from the rules officials shall be considered part of, and shall have the same validity as, these rules.

3.2 Administration

Precedence

If there is a conflict between two or more versions of the rules, the version having the later date takes precedence. If a conflict exists between two or more rules in this document, the Build Challenge Manager will determine which rule has precedence and will inform all teams of the decision on the rules. If a conflict exists between the Competition Guide and the Build Challenge Rules document, the Build Challenge Rules document takes precedence.

Violations of Intent

A violation of a rule's intent is considered to be a violation of a rule itself. The organizers, in consultation with DOE, have the ultimate authority in interpretation of rules. All decisions made by DOE are final, and there is no process for appeal. Attempting to exploit a perceived loophole in the rules that incentivizes behavior that does not align with the goal of the competition will not be viewed favorably. DOE reserves the right to change the rules of the competition at any time.

Official Communications

It is each team's responsibility to stay current with official project communications. Official communications between the teams and the organizers occur through, but are not limited to, one or more of the following:

a) **Project Site:** Official communications suitable for viewing by all teams and organizers are posted on the Groups.io Project Site. The group will host messages and files for the teams. The Project Site is: https://solardecathlon.groups.io. Within the Project Site, there is a subgroup specifically for the Build Challenge.

b) **Organizer Email**: For confidential communications, teams may email the organizers. The content of communications sent to this email address remains confidential unless the team grants permission to the Build Challenge Manager to divulge the content of these communications to the other teams. If a question has general applicability to all teams, organizers—at their sole discretion—will post the answer to the Groups.io Project Site. The Build Challenge email address is SDbuild@nrel.gov. The overall Solar Decathlon Competition email is solardecathlon@nrel.gov. Should a team need to contact DOE's Solar Decathlon Director directly, the email is solar.decathlon@ee.doe.gov.

c) **Conference Calls**: At least one member from each team is expected to participate in regularly scheduled conference calls with the organizers. Invitations and instructions for participation in conference calls are provided via the Groups.io Project Site.

d) **Building Science Training**: All student team members are required to complete the free, organizer-provided building science training course or receive an equivalency waiver from their faculty adviser indicating that students receive equivalent training as part of their curriculum. Invitations and instructions for participation in training are provided via the Groups.io Project Site.

e) **Webinars**: Teams are expected to participate in regularly scheduled webinars intended to educate and prepare the teams for successful participation in the Challenge. Invitations and instructions for participation in webinars are provided via the Project Site.

f) **Meetings**: Before the Community Exhibitions, the teams and organizers may have one or more planning meetings. Notification of the date(s) and agenda(s) for these meetings is made via the Groups.io Project Site. Attendance is expected unless prior notice is given to the Build Challenge Manager.

g) **Individual Email**: For expediency and to protect design confidentiality amongst teams, teams and organizers may communicate directly via email. Organizer and team lead email addresses will be listed in the Groups.io Project Site. Organizers will not share team information discussed via email publicly unless appropriate for all teams or the public.

Prize Structure

To help increase the likelihood of success for Build Challenge teams, DOE will offer prize funding to successful teams. Teams are selected for prize funds via the process outlined in the Approval-to-Proceed Procedures, which are available on the Solar Decathlon website. Evaluators determining whether or not a team receives Approval to Proceed and a prize disbursement are separate from NREL staff, DOE staff, contest jurors, and the adjudication of these rules. The winner of the Build Challenge is the team that earns the most points at the end of the competition from the 10 Contests.

a) Depending on the Division chosen, teams that successfully complete their house and compete in the Challenge will earn a financial award based on their Division.

b) Prize disbursements are expected to be distributed in three phases, following the process outlined in the Approval-to-Proceed Procedures, which are available on the Solar Decathlon website.

c) Prizes are distributed by the organizers to a single entity and account, as directed by the team faculty advisor on official collegiate institution letterhead and signed by collegiate institution leadership. The official team faculty advisor must be identified prior to any award. Multiple recipients will not be accommodated.

d) For U.S. teams, it is the sole responsibility of the team to determine any taxes or associated payments required as a result of this award. Foreign teams are subject to nonresident alien withholding of 30% under Chapter 3 of the Internal Revenue Code (26 U.S.C. Chapter 3). Tax withholding requirements are determined by the W8BEN-E submitted by the foreign entity that was certified by their authorized signer. Any distribution beyond the initial recipient is the sole responsibility of the team.

e) Through participation in the competition, the team agrees to accept the decisions of the organizers. The results are final. No right to counsel is authorized.

Effective Date

The latest released version of the rules posted to the Groups.io Project Site represents the rules in effect.

Decisions on the Rules

The Groups.io Project Site will contain a Decisions on the Rules database that provides interpretations of the rules contained in this document. Should a rules official make a decision that may affect the strategies of all teams, the rules officials will add the decision to the Decisions on the Rules database and notify the teams of the addition.

Self-Reporting

Teams shall self-report obvious or suspected rules infractions that have occurred or may occur.

a) The rules are not expected to address every possible scenario that may arise during the competition. A team considering an action that is not explicitly permitted by the rules should ask the rules officials for a decision before proceeding with the action. If the team does not ask for an official decision, the team is putting itself at risk of incurring a penalty.

Penalties

Teams committing rules infractions are subject to one or more of the following penalties, depending on the severity of the infraction: (1) point penalty applied to one or more of the 10 Contests; (2) disqualification from part, or all, of one or more of the 10 Contests; or (3) disqualification from the competition.

a) The rules officials are authorized to apply point penalties and disqualify a team from part, or all, of one or more contests as a consequence of rules infractions.

b) The rules officials shall report to the director any significant rules infractions. The Build Challenge Manager determines whether a rules infraction is significant. The Build Challenge Director is solely authorized to disqualify a team from the competition. Disqualification from the competition requires prior notice to the team and an opportunity for the team to make an oral or written statement on its behalf.

c) The Build Challenge Manager shall notify all teams via the Groups.io Project Site and update the competition scoring when a penalty has been assessed against any team. The notification shall include the identity of the team receiving the penalty, an indication of the specific rule violated, a brief description of the infraction, and the penalty to be applied.

Protests

a) Official written protests may be filed by a team for any reason following the release of scores or decisions on the Rules. A filing fee of up to 10 points is assessed to the team if the protest is deemed by the Protest Resolution Committee to be frivolous.

b) Teams are expected to communicate with the rules officials to resolve issues and complaints before resorting to the protest process. Protests should be filed only if the team and the rules

officials are unable to resolve the dispute themselves, or if the team or the rules officials are too busy to engage in discussions that may result in resolution of the dispute without a protest.

c) Protests shall be submitted between 8 a.m. and 6 p.m. EST/EDT, and within 24 hours of the action being protested. The final opportunity to file a protest is 5 p.m. MDT on Saturday, April 17, 2021.

    Exception: The results of the contests are announced during the final awards ceremony. The results of contests announced during the final awards ceremony may not be protested.

d) The protest shall be submitted to a rules official in a sealed envelope or emailed to the Build Challenge Manager at SDbuild@nrel.gov. If submitted electronically, the protest shall be attached as a PDF to the email, and the email subject should include "Solar Decathlon 2020 Build Challenge Protest" and the name of the team submitting the protest. The protest shall include the name of a decathlete representing the team filing the protest, the date of the protest submission, an acknowledgment that a 10-point filing fee may be assessed, and a clear description of the protest.

e) Juried contests are inherently subjective, and the opinions of a jury cannot be protested. Only factual errors or mistakes may be protested.

f) The Protest Resolution Committee will consist of at least three individuals with relevant expertise and knowledge of the Solar Decathlon Build Challenge rules.

g) Following the receipt of a protest, the protest resolution procedure will occur as follows:

    - The Build Challenge Manager convenes the Protest Resolution Committee.
    - The Build Challenge Manager submits the team's protest to the committee. Unless the Build Challenge Manager is called by the committee to testify, the Build Challenge Manager is not permitted to read the protest until after the Protest Resolution Committee has submitted its written decision.
    - The committee reads the protest in private. No appearance by the Build Challenge Manager, rules officials, or team members is authorized during the committee's private deliberations. No right to counsel by organizers or team members is authorized.
    - The committee members shall individually call the decathlete who submitted the protest and the Build Challenge Manager for testimony to fully understand the protest. The committee may choose to call additional individuals for testimony.
    - The committee considers the protest and notifies the director and Build Challenge Manager of its recommendation in writing. The committee shall indicate the reason for the decision, any adjustment to a team's measurement or score, and how many points shall be assessed as a filing fee, if any.

- Following acceptance by DOE, if the recommendation involves changes to a team's measurement or score, the Build Challenge Manager will ensure that the appropriate changes are applied to the scoring server.

- The Build Challenge Manager posts a copy of the protest and decision on the Groups.io Project Site.

3.3 Participation

Contact Information

Each team shall provide contact information via the Groups.io Project Site for the team officers listed in Table 1 and shall keep the contact information current for the duration of the project. In addition, all team members are encouraged to join the official Solar Decathlon LinkedIn group to better enable future engagement and networking.

a) If a team's internal officer titles do not exactly match those listed in Table 1, each team shall still provide the contact information for the person fulfilling each of the areas of responsibility described in the second column.

b) Teams shall provide the contact information for only one person in each officer position.

c) Faculty members are only eligible to fill the faculty advisor team officer position. The collegiate institution health and safety officer position may only be filled by a member of the collegiate institution's Environmental, Health, and Safety (EHS) department. Decathletes must fill all other team officer positions.

For a period of time, extending 5 years from the end of the Solar Decathlon Build Challenge, each student and faculty member of a collegiate institution team is encouraged to participate in an evaluation of the downstream impacts of the Solar Decathlon. This evaluation is performed by a DOE-selected, third-party evaluation contractor. Participation in this evaluation will involve answering an annual survey of approximately 30 minutes or less in duration. The evaluator will use the collected survey information to assess the impact of the Solar Decathlon. The evaluator is authorized to use the collected information solely for the purpose of developing a DOE-sponsored and DOE-managed evaluation report that presents only results in aggregate. Information collected pertaining to individual students, alumni decathletes, or individual faculty will not be reported.

Table 1. Team Officers

Title	Responsibilities
Student team lead	The team lead is responsible for the overall success of the team's entry to the Challenge. This person ensures that official communications from the organizers are routed to the appropriate team member(s).
Construction officer	The construction officer is responsible for planning and executing the construction of the house, including providing the necessary oversight on construction activities.
Measured contest officer	The measured contest officer serves as the primary strategist and coordinator of measured contests. This person collaborates with the organizers' instrumentation team and the team's construction manager to accommodate the organizers' equipment.
Health and safety officer	The health and safety officer is responsible for developing the team's Health and Safety Plan, providing health and safety oversight to the project, and advising the project manager and construction manager, as necessary, on project health and safety issues. This person is also responsible for the team's safety, including the fire watch, public safety within the team's solar envelope, and evacuation procedures.
Faculty advisor	The faculty advisor serves as the lead faculty member and representative of a participating school in the project. This person also provides guidance to the team throughout the project.
Collegiate institution health and safety manager	The collegiate institution health and safety manager serves in an advisory role as an EHS mentor or consultant, not project oversight. To help ensure the safety of students building houses, it is required that each team engage a collegiate institution expert to help guide the team with regard to EHS activities.

In addition to these required roles, teams often assign student team leads for the following positions listed in Table 2.

Table 2. Team Leads (Optional)

Title	Responsibilities
Architectural project lead	The architectural project lead is responsible for the architectural design effort; no license is required.
Engineering project lead	The engineering project lead is responsible for the engineering design effort; no license is required.
Sponsorship lead	The sponsorship lead is responsible for recruiting team sponsors and for team compliance with the Rules for sponsor recognition.
Public relations lead	The public relations lead works in conjunction with DOE's Office of Public Affairs to coordinate the team's interactions with the media.

Safety

Each team is responsible for the safety of its operations.

a) Each team member and team crew member shall work in a safe manner at all times during the project in accordance with the requirements identified in the Rules and team Health and Safety Plan, see Section 6.4.

b) Each team shall supply all necessary personal protective equipment and safety equipment for all of the team's workers and visitors during the project.

c) Throughout activities, including any setup of exhibits or houses and regardless of Division, a minimum level of personal protective equipment shall be worn by each team member and team crew member:

    - Hard hat (ANSI Z89.1 or equivalent, Type I, Class G or better)
    - Safety glasses with side shields (ANSI Z87.1 or equivalent)
    - Shirt with sleeves at least 3 inches (7.6 centimeters) long
    - Long pants (the bottoms of the pant legs shall, at a minimum, touch the top of the boots when standing)
    - A Class 2 high-visibility reflective vest, shirt, or jacket
    - Safety boots (meeting Class 75 impact/crushing standards of ASTM F2413 or equivalent) with ankle support.

d) Additional personal protective equipment or safety equipment shall be used if required for the task being performed (e.g., shock/arc protection, hearing protection, face shields, dust mask, and so on).

e) Team members who are expecting to work on any electrical work during the project shall meet Occupational Safety and Health Administration (OSHA) 29 CFR Part 1910, Subpart S Electrical 1910.399 requirements, and in doing so will be considered a Qualified Electrical Worker.

f) Smoking is not permitted during Community Exhibitions or at the Competition Event at any time.

Conduct

Improper conduct, the use of alcohol or marijuana, and the use of illegal substances are not permitted at the Community Exhibition. Improper conduct may include, but is not limited to, improper language, unsportsmanlike conduct, unsafe behavior, distribution of inappropriate media, and cheating.

Use of Likeness, Content, and Images

Team members agree to the use of their names, likenesses, content, graphics, and photos in any communications materials issued by the organizers and event sponsors.

a) Content and images (graphics and photos), and any publications in which the content and images appear, may be viewable and made available to the general public via DOE's and the Solar Decathlon sponsors' websites with unrestricted use.

b) The organizers and event sponsors will make all reasonable efforts to credit the sources of content and images, although they may be published without credit.

Competition Withdrawals

Any team wishing to withdraw from the Challenge must notify the Solar Decathlon Director and Build Challenge Manager in writing. Teams considering withdrawal are encouraged to communicate early and frequently with the Build Challenge Manager. All written withdrawals signed by the listed faculty advisor are final.

Deliverables

Teams are required to submit all deliverables associated with the project. All deliverables are due by 5 p.m. EST/EDT on the dates indicated in this document. Late or incomplete submission of deliverables may be subject to penalty points. Following receipt, organizers will review the deliverables and provide comments to teams. Teams shall correct all issues noted to be eligible for participation in the competition. Eligibility for earning points in the competition is determined separately from evaluation for an Approval to Proceed, as outlined in the Approval-to-Proceed Procedures, which are available on the Solar Decathlon website.

Penalty points for late submissions still received on the due date are scaled linearly, based on the time received after 5 p.m. EST/EDT up until 11:59 p.m. EST/EDT on the due date. The maximum penalty associated with same-day late submission of each deliverable is two points; additional penalty points may be assigned for failure to meet submission requirements beyond the scenarios indicated in this document, including incomplete but on-time deliverables and deliverables received after the due date.

Refer to Table 7 for a summary listing deliverables and due dates.

3.4 Build Challenge House Restrictions

National Showcase Size Restrictions

Each team's maximum dimensions from 0 ft to 7 ft above grade shall be no more than 15 ft wide in the north-south direction and no more than 60 ft long in the east-west direction. The maximum height of the house module, while in transportation mode, shall be 14 ft including any height of the trailer used to move the house. The finished floor level of the tourable module should be 27" (68.58 cm) above grade or less when in the exhibited configuration. The finished and conditioned space of the National Showcase house shall be at least 400 ft^2 as measured according to ANSI Z765. The build area available to each team is 20 ft wide, 15 ft tall, and 80 ft long.

Teams may compete using one unit of a multifamily property, where additional dwelling units are placed adjacent to or otherwise surrounding the competition prototype. Teams may compete using a house that consists of more than one module; however, the module must meet the minimum size requirements of the National Showcase.

a) The official height of a site component or set of contiguous site components is the vertical distance from the point of highest grade along the outside perimeter of the site component(s) to the highest point of the site component(s).

b) Shading devices, solar panels, weather stations, antennas, air vents, and other similar components may be specifically exempted from the constraints listed above if all of the following conditions are met:

- The team makes a request to the Build Challenge Manager for an exemption prior to the start of setup.
- The element can be rapidly deployed, erected, or unfurled upon arrival. Construction of any element newly existing is not permissible.
- The Build Challenge Manager determines that the component is sufficiently unique in function to warrant an exemption.

c) Moveable or convertible house or site components extending beyond the dimensions stated previously shall not restrict pedestrians at any time during jury visits, public exhibit hours, or contests.

The finished square footage, as defined by Square Footage—Method for Calculating: ANSI Z765-2003 (R2013), shall be at least 400 ft^2 (55.742 square meters [m^2]). The maximum is limited only by the maximum dimensions listed previously.

a) If the building has convertible or moveable components, the maximum and minimum square footages observed during live demonstrations or shown in printed or electronic media presented by the team during jury visits, public exhibit hours, or contests count as the maximum and minimum square footages of record, respectively.

b) For the purposes of the Solar Decathlon, all finished square footage is included in the finished square footage calculation, regardless of whether or not the finished square footage is contiguous (i.e., attached to the main dwelling unit). Both maximum and minimum square footages must be within the limits set above.

Local Build Size Restrictions

The teams must meet their local Authority Having Jurisdiction requirements for residential construction. Renovation of an existing structure is permissible. Teams may compete using one unit of a multifamily duplex, row home, or townhouse development where units are placed side by side from each other.

The teams must provide accessible tour-route access to and from the house.

The finished square footage, as defined by Square Footage—Method for Calculating: ANSI Z765-2003 (R2013), shall be at least 600 ft^2 but shall not exceed 3,000 ft^2.

a) If the building has convertible or moveable components, the maximum and minimum square footages observed during live demonstrations or shown in printed or electronic media presented by the team during jury visits, public exhibit hours, or contests count as the maximum and minimum square footages of record, respectively.

b) For the purposes of the Solar Decathlon, all finished square footage is included in the finished square footage calculation, regardless of whether or not the finished square footage is contiguous (i.e., attached to the main dwelling unit). Both maximum and minimum square footages must be within the limits set above.

3.5 House Design Requirements

Structural Design Approval

Each team shall submit structural drawings and calculations that have been stamped by a qualified, licensed design professional for the complete house design and the exhibit. The professional must be registered in the state associated with the final target location of the house.

a) By stamping the structural drawings and calculations, the licensed professional certifies that the structural provisions of the Solar Decathlon Build Challenge Building Code have been met by the design and that house or exhibit is safe for the public to enter if it has been built as designed.

b) The licensed professional shall stamp the structural drawings and calculations of the house, exhibit, and all site components that might pose a threat to public safety if they fail.

Entrance and Exit Routes

Each house must have a distinct entrance and exit doorway, each of which shall be at least 36 inches (in.) wide.

a) The main house entrance may be placed on any side of the house. However, an accessible route leading from a public access point to the main entrance of the house shall be provided.

b) The house exit route shall be accessible to the public and lead from the main house exit to a publicly accessible street or path.

Competition Prototype Alternates

The juries may consider alternate installations of the competition prototype; however, each team must build a single complete dwelling unit for consideration by the juries. Additional dwelling units may be proposed to be adjacent to, or otherwise surrounding, the competition prototype, but additions to the dwelling unit itself is not allowed. Only the competition prototype house with its included components and functionality, as built, is evaluated by juries. It is permissible to show the competition prototype house in context in renderings, photographs, or other media. National Showcase teams may present a single module of a larger house, but the module must be presented as it would exist as part of the larger design.

a) Juries shall consider how the design addresses local building code provisions and site restrictions at the target client's site.

b) Public exhibit communications materials are not considered part of the competition prototype and do not need to be shown in renderings, drawings, or other materials.

3.6 Energy

Photovoltaic Technology Limitations

a) Bare photovoltaic (PV) cells and encapsulated PV modules must be commercially available by or approved by the organizers prior to the beginning of the Competition Event.

b) Substantial modification of the crystal structure, junction, or metallization constitutes the manufacture of a new cell and is not allowed unless approved by the organizers prior to the Competition Event.

Energy Monitoring

Teams shall install full branch-circuit level monitoring equipment within their competition prototype. Teams may be asked to provide the collected data at the conclusion of the competition, and the data may be shared among teams. For the benefit of teams and DOE, some energy monitoring equipment used for the competition may be left with each team following the completion of the competition for long-term research and monitoring.

Energy Sources

Teams are expected to design their house to operate as part of an established electric grid and utility but must design their house to be able to operate off-grid. However, approval to operate on an electric grid is *not* a requirement of participation in the Build Challenge, for either the National Showcase or Local Build Challenges. After a team has become grid-tied, the organizers will not require grid isolation for testing should the local utility not allow islanding.

To participate successfully in the Build Challenge, each house must have the capability of operating independently of an electric utility grid. After the conclusion of construction and until the conclusion of the Community Exhibition, global solar radiation incident on the lot is the only source of energy that may be consumed in the operation of the house without the requirement of subsequent energy offsets.

a) Fireplaces, firepits, candles, and other devices using nonsolar fuels are not permitted in the designs.

b) The use of batteries is permitted as detailed below in the Energy Storage and Inspections sections of these rules.

Energy Storage

Batteries include most commercially available energy storage devices, such as electrochemical batteries and capacitors. Additional energy storage may also be permissible, following discussion and approval by the Build Challenge Manager.

a) The use of energy storage as part of the competition prototype design is required to enable the off-grid operation previously discussed. The storage, such as batteries, and associated enclosure(s) must be compliant with the Solar Decathlon Build Challenge Building Code.

b) The use of primary (nonrechargeable) batteries (no larger than 9-volt) is limited to smoke detectors, remote controls, thermostats, alarm clock backups, and other small devices that typically use small primary batteries. These batteries do not need to end the competition with a full charge.

c) The use of the factory-installed battery within a team's electric vehicle is permitted. Vehicle-to-grid power flow capabilities within the competition prototype is only permitted if vehicle-to-grid power flow and associated equipment are approved by the vehicle's manufacturer.

d) Plug-in (nonhardwired) devices with small secondary (rechargeable) batteries that are designed to be recharged by the house's electrical system (e.g., a laptop computer) shall be connected, or plugged into, the house's electrical system whenever the devices are present at the competition house.

> **Exception:** If not used in the operation of the house at any time during the Community Exhibition, portable electronic devices used for mobile communications,

such as cell phones and tablets, are permitted within the solar envelope without having to be plugged into the house's electrical system.

e) Stand-alone, PV-powered devices with small secondary batteries are permitted, but the aggregate battery capacity of these devices may not exceed 100 watt-hours (Wh).

Desiccant Systems

If a desiccant system is used, it must be regenerative.

a) To ensure that the desiccant has been fully regenerated by the conclusion of the Energy Performance Contest, the desiccant material or device must be easily measurable.

b) In most cases, the material or device is measured prior to, and at the conclusion of, the Energy Performance Contest. In some cases, a measurement at the conclusion of the Energy Performance Contest may not be necessary.

c) At the conclusion of the Energy Balance Contest, the weight of the desiccant material or device shall be less than or equal to its initial weight.

d) Some desiccant systems with very low moisture storage capacities may be exempt from this requirement. Exemptions are granted on a case-by-case basis by the Build Challenge Manager.

Gray Water Reuse

A team may reuse gray water as permitted in the Solar Decathlon Build Challenge Building Code or approved by the Solar Decathlon Build Challenge Building Official on a case-by-case basis. Any gray water reuse must be approved by the Build Challenge Building Official before the start of construction.

Rainwater Collection

A team may collect rainwater that falls on its site and use it in, or as, any of the following as permitted by their local Authority Having Jurisdiction:

a) Irrigation source

b) Water feature

c) Heat sink or heat source

d) Other purposes as approved by the Solar Decathlon Building Official on a case-by-case basis.

Evaporation

Water may be used for evaporation purposes.

Thermal Mass

Teams may use liquids as thermal mass. The thermal storage containers shall be isolated, i.e., the contained liquid shall not circulate to other containers or systems.

Gray Water Heat Recovery

Heat may be recovered from gray water as it flows from the drain to the waste tank. "Batch"-type gray water heat recovery is prohibited.

3.6.1 Build Challenge Events

Build Challenge Events include Design Challenge Weekend occurring April 12–14, 2019, at NREL in Golden, Colorado; the Community Exhibition activities, which occur primarily in fall 2020 and spring 2021, and the Competition Event, which will occur in April 2021 at NREL.

Registration

All Solar Decathlon Build Challenge Event participants must register.

a) The following rules apply to **all participants:**
    - Each event participant must register individually. Group registrations are not allowed.
    - When registering, event participants must complete all required information and forms before access is allowed.

b) **Organizers, team members, and staff** should use the online registration site to submit completed forms, information, and Foreign National Data Cards prior to the Competition Event. Once all information, forms, and Foreign National Data Cards are received, the organizers will issue an event security ID that must be visible at all times while at the event.

c) **Visiting media** are not considered participants and will not be required to register but must check in at registration headquarters. For safety, site access for visiting media may be restricted.

Event Sponsor Recognition

All communications materials produced by the teams concerning or referring to the project (including team websites) shall refer prominently to the competition as the "U.S. Department of Energy Solar Decathlon" and the Challenge as the "2020 Build Challenge."

a) Teams are required to use the Solar Decathlon logo, the DOE word mark, and the NREL logo on all communication materials used at the Community Exhibition site. The Solar Decathlon logo must be at least three times the size of all other logos.

b) The Solar Decathlon logo, the DOE word mark, and the NREL logo are the only required graphic elements teams must use.

c) Team uniforms are exempt.

Team Sponsor Recognition

Team sponsors may be recognized with text, logos, or both, but the text and logos must appear in conjunction with the Solar Decathlon text and logo.

The information in the Team Insurance Requirements

a) Communications materials or other products that exist largely for the recognition of sponsors are limited to 20 ft^2 (1.858 m^2), at the Community Exhibition. "Other products" include, but are not limited to, signs, exhibits, posters, plaques, photos, wall art, and furnishings.

b) For multimedia or audio presentations a team chooses to play during the Community Exhibition, no more than 20% of the total time, 1 minute, or whichever is less may be dedicated to the recognition of team sponsors.

c) Off-the-shelf components that feature a built-in manufacturer's logo are acceptable and do not need to be accompanied by the Solar Decathlon text and logo.

d) Team uniforms are exempt.

Logistics at Build Challenge Events

a) Each team is responsible for the transport of any necessary team equipment or exhibits to their Community Exhibition and to the Competition Event. Each team is responsible for any damage to or loss of such items.

b) Each team is responsible for procuring all necessary equipment, tools, and supplies to build its house and to present at the Competition Event.

c) Each team is responsible for transportation, accommodations, lodging, food, and beverages.

d) Each team is responsible for making its own reservations and arrangements, and for covering all necessary costs.

Inspections

Each team entry is required to comply with the Solar Decathlon Build Challenge Rules and Building Code.

a) All teams must provide an inspection record from their local Authority Having Jurisdiction or an approved third-party inspector that demonstrates compliance with the Solar Decathlon Building Code and, as applicable, locally adopted codes. Inspections are expected to occur throughout the construction process and must be completed for a team to be eligible to compete in Build Challenge Events.

b) Each team shall be required to provide an ADA-compliant accessible tour-route through its house, inspected by a qualified professional prior to public exhibit. The entire home does not need to be accessible.

c) The Build Challenge Manager shall check each team's inspection status to determine which houses are eligible to participate in the contests. All final inspections shall be passed by the deadline indicated on the Groups.io Project Site. Failure to pass inspections by the required deadline may disqualify a team for participation in Competition Event and is considered a rules violation. A team must have passed inspections to be eligible to participate in the contests.

> **Exception:** Jury visits or presentations will proceed as scheduled regardless of a team's inspection status. However, jurors will be made aware of the team's inspection status and may consider it in their evaluations.

d) Because open, partially functioning houses and exhibits are preferable to closed, fully functioning houses, the organizers may direct the inspectors to require that an unsafe condition be corrected so public visits can occur—even if, as a consequence, the house is ineligible for participation in one or more contests.

3.7 Site Operations at the Community Exhibition Sites

For any construction done off-site, either in preparation for exhibition or as part of the Community Exhibition, teams are expected to follow local rules and regulations.

Damage Liability

Each team is financially responsible for any damage it causes.

3.8 Build Challenge Activities

House Occupancy

Under normal circumstances, no more than 50 people may be located in the finished square footage of the house at any one time for safety reasons. This applies to both the Local Build and National Showcase teams.

a) Occupancy will also be limited when temperature and humidity measurements are being taken, though this is expected to occur outside of public exhibit periods. See the Build Challenge calendar on the Groups.io Project Site for the temperature and humidity measurements schedule.

b) Jurors, Observers, official organizer-provided competition photographers, media, writers, visiting Observers, and others with authority to enter a house as an organizer are not counted toward the number of house occupants.

House Operators

Only student decathletes, as defined in Section 2.3, are permitted to operate the house and participate in the contests.

a) All competition-related communications during the Build Challenge Events shall be between the organizers and decathletes. Nondecathlete team members and crew, including faculty, are not permitted to participate in or listen to competition-related communications.

b) Nondecathlete team members are permitted to give tours to the public and be present on the exhibition site.

Late Design Changes

The final project assembled on the exhibition site shall be consistent with the design and specifications presented in the As-Built Documentation.

a) If there are known inconsistencies between the final project and the as-built drawings and the Project Manual, the team shall document these inconsistencies and submit the documentation to the Build Challenge Manager as soon as possible after the inconsistency is known. The Build Challenge Manager will review the changes against the team's final documentation to assess whether the changes warrant additional or different controls. The Build Challenge Manager will compile a summary of all known inconsistencies discovered during the inspections process and submit the summary to the respective juries.

Public Exhibit

a) Teams are required to provide an accessible route to all areas of the house or exhibit that are available to the public during exhibit hours.

b) Teams are permitted to produce and distribute up to one informational brochure or handout at the Community Exhibition.

c) Teams shall develop signage that complements public exhibit tours by informing visitors about the team project and engaging visitors waiting in line.

d) Signage on display at the Community Exhibition shall be compliant with branding guidelines.

e) Teams are prohibited from selling items to the general public at the Community Exhibition.

f) Teams are prohibited from providing food and beverages to the general public at the Community Exhibition.

Team Uniforms

a) During all Build Challenge Events and special events specified by the organizers, all team members present shall wear uniforms representing their team.

b) Team uniforms are exempt from the Event Sponsor Recognition section.

c) Team sponsor logos are approved to be visible only on the back of the team uniform (e.g., jacket, shirt, hat, or another wearable item).

d) The only information or graphics that are approved to be visible from the front of the team uniform (jacket, shirt, hat, or other wearable item) shall be the institution(s) and its logo(s), the team name and logo, and the Solar Decathlon logo.

4 Build Challenge Contests

Projects submitted to the Solar Decathlon Build Challenge demonstrate competency by applying principles of building science and best practice solutions to an as-built, functional house. The teams are assessed on a variety of deliverables, their as-built house and its measured performance, and the quality and content of their presentations to the public and to juries. These submissions should demonstrate the team's ability to design, analyze, plan, build, operate, exhibit, and showcase a complete house design.

The Solar Decathlon Build Challenge consists of 10 separately scored Contests, and some Contests contain one or more Subcontests, as outlined in Table 3. Each Contest is worth 100 points. The team with the highest total points at the end of the competition wins. Points are earned through jury evaluation and measured performance. Measured Contests are evaluated based on the criteria indicated in the Contest details. The scoring of the juried Contests is more subjective than the scoring of the measured Contests. However, for the sake of fairness, the jurors will use the evaluation method described in Section 5.

Table 3. Contests and Subcontests

Contest No.	Contest Name	Points	Subcontest Name	Subcontest Points
1	Energy Performance	100	Energy Efficiency (HERS Score w/o PV)	30
			Energy Production (producing power w/ PV)	20
			Net-Zero Plus Energy (estimated annual energy production – consumption)	20
			Demand Response (capability to shed at least 30% of peak load automatically)	10
			Off-Grid Functionality (ability to maintain critical loads)	20
2	Engineering	100	None	n/a
3	Financial Feasibility & Affordability	100	None	n/a
4	Resilience	100	None	n/a
5	Architecture	100	None	n/a
6	Operations	100	Kitchen Appliances	25
			Hot Water	25
			Laundry	5
			Electric Lighting	15
			Home Electronics	5
			House Occupancy	10
			Electric Vehicle Charging	15
7	Market Potential	100	None	n/a
8	Comfort & Environmental Quality	100	Temperature Control	30
			Humidity Control	20
			Indoor Air Quality	20
			Air Tightness	20
			Exterior Noise Infiltration	5
			Internally Generated Noise	5
9	Innovation	100	None	n/a
10	Presentation	100	None	n/a

4.1 Energy Performance

Contest Intent

This Contest evaluates the building's energy use and production, as well as its capability to provide energy services—whether connected to the electricity grid or operating with on-site and/or stored power.

Superior energy performance is at the heart of the Solar Decathlon. Energy modeling can help inform design choices as well as estimate a building's likely energy performance. Once built, energy performance is verified by measuring building loads as well as on-site generation. The capabilities of the building to interact with the grid, and potentially address the needs of a local electric utility, are also part of a building's overall energy performance. Finally, thoughtful selection and operation of lighting, plug loads, appliances, and other components are increasingly important as they commonly represent more than 50% of total energy consumption in high-performance buildings.

Energy Efficiency Subcontest

The residential building industry often uses the Home Energy Rating System (HERS) Index to indicate energy efficiency. A lower score signifies a more energy efficient home. To determine the score, homes are compared to a benchmark based on the 2006 International Energy Conservation Code. The HERS score can be calculated by using any accredited HERS software.

HERS rating software calculates heating, cooling, hot water, lighting, and appliance energy loads, consumption, and costs for new and existing single family and multifamily homes. One of the industry accredited programs, REM/*Rate*™, is provided to teams at no charge after completing the team application; however, using it is not required. The organizers will generate a HERS score of each house as part of measured contest scores following a consistent and to-be-distributed process provided to all teams.

All available points are earned for a HERS score of 35 or below, without any renewable energy being considered. The organizers will hire qualified HERS rater(s) to evaluate all team houses based on as-built features and construction documents.

a) Reduced points are earned for a HERS score between 35 and 60. Reduced points are scaled linearly. No points are earned for a HERS score above 60.

Energy Production Subcontest

All available points in this Subcontest are earned at the conclusion of the energy period by successfully generating at least 20 kilowatt-hours (kWh) in a 24-hour period, starting at a time agreed upon in advance between the team and the organizers. A positive energy production indicates successful solar installation and operability.

a) Reduced points are earned for an energy production value between 0 kWh and 20 kWh. Reduced points are scaled linearly. No points are earned for an energy production value of 0 kWh.

Net-Zero Plus Energy Subcontest

Each team's modeled energy production and estimated energy consumption will be evaluated by the organizers for the target site, as well as evaluated for whether or not the house will produce at least as much energy as it will consume over the course of 1 year, including the charging and operation of an electric vehicle estimated to be driven 20 miles per day.

a) Reduced points are earned for an annual net consumption between 0 kWh and 2,000 kWh. Reduced points are scaled linearly. No points are earned for an estimated annual net-energy consumption more than 2,000 kWh.

Demand Response Subcontest

Each house shall have the capability to respond to a conceptual utility-initiated load-shedding call. To earn full points in this Subcontest, the organizers will verify the house's capability to shed at least 30% of its load in response to a received request from the local utility.

a) Reduced points are earned for a load-shedding capability between 0% and 30% of its load. Reduced points are scaled linearly. If automated load-shedding is not possible, no points are earned.

Off-Grid Functionality Subcontest

To demonstrate resilience, each house shall have the capability of maintaining critical loads in the house for a period of at least three days (72 hours) within the schedule provided in the Build Challenge calendar, which is available on the Groups.io Project Site. Critical loads shall include, at a minimum, fire protection systems, a refrigerator, a freezer, sufficient lighting circuits to maintain 70 lux (lx) in the living room for at least 4 hours daily, one small appliance circuit, and two plug outlets for critical occupant personal devices. If the photovoltaic system allows operation in an islanded mode, PV generation will be estimated as the average daily production over annual analysis for each of the three days.

a) Reduced points are earned for an ability to maintain critical loads for between 24 and 72 hours. Reduced points are scaled linearly. No points are earned for an inability to maintain critical loads for at least 24 hours.

4.2 Engineering

Contest Intent

This Contest evaluates the effective integration of high-performance engineering systems in energy-efficient and energy-producing buildings.

Structural and engineering systems should be effectively integrated with natural heating and cooling opportunities, including solar orientation, thermal mass storage, solar shading, and convective cross-ventilation. Heating, cooling, water, and ventilating system types and design should reflect thoughtful consideration of different technology and integration options, including analysis of implications for energy and environmental performance, up-front and long-term costs, and reliability. The space-conditioning system must be designed to maintain comfort with extremely low load conditions via effective temperature control, humidity control, air mixing, and distribution systems. Opportunities for water efficiency should be reflected in smart

engineering solutions for domestic hot water delivery and landscaping irrigation, as well as selection of plumbing fixtures and landscaping.

Build Challenge Criteria

A jury of engineers shall assign an overall score for the house's engineering merit and implementation. The jury will consider the submitted deliverables and perform an extensive evaluation of the as-built house.

The jury shall consider the following specific criteria in its evaluation:

Approach

- Quality of the overall approach to solving engineering challenges and integrating solutions in design
- Extent to which the design demonstrates research, multidiscipline collaboration, market-leading technologies, and engineering integration.

Design

- How well will house systems and architectural details function together?
- Sound selection and design of all building envelope components (foundation, wall systems, roof) to address building science control layers
- Natural comfort design (a.k.a., passive solar design) integration including solutions such as solar orientation, effective solar shading, thermal mass storage, and cross-ventilation
- How well will the home's envelope and active comfort systems maintain occupant comfort in the permanent site location year-round, including but not limited to: air temperature, humidity, surface temperatures, temperature asymmetries and stratifications
- Lighting system selection and design for energy efficient ambient, task, and mood lighting fully integrated with natural light
- How appropriately are energy production systems sized for estimated annual performance of the competition prototype house at its target location?
- Plumbing system layout for efficient hot water delivery
- Landscaping system for minimizing water use for irrigation.

Efficiency and Performance

- To what extent is energy efficiency integrated into the house design?
- How complete is the space-conditioning system integration within the building's structural system?
- Extent of the quality of space-conditioning system design to ensure full air mixing in all rooms
- To what extent is water efficiency integrated into the house design?
- To what extent has the team considered maintenance in the design?

- How likely is it that a homeowner will be able to operate the house as the team intends?

Documentation

- How accurate, complete, and clear are the competition drawings and specifications?
- To what extent was the energy model created in a professional and accurate manner?
- How effectively did the reviewed deliverables reflect the constructed project and enable the jury to conduct a thorough evaluation of the design?

Engineering Innovation

In addition to and separate from the score assigned to each team for the Engineering Contest, the jury shall assign each team a score for innovation, which is scored as one-quarter of the Innovation Contest.

- To what extent did the team use engineering research processes to develop or decide on the solution implemented?
- To what extent does the design solution utilize new, unique, or atypical technologies or engineering solutions that improve on the status quo?

4.3 Financial Feasibility & Affordability

Contest Intent

This Contest evaluates the building's financial costs and ability to address growing affordability challenges in the housing industry.

The purpose of this Contest is to ensure the team's unique solution is affordable and cost-effective for occupants. Financial analysis should include up-front cost to the consumer, monthly utilities, and maintenance to determine an overall cost of ownership, and provide a basis for comparison to the financial capabilities of the target market. The cost of construction, and the extent to which the design would cost more than a minimally code-compliant building, should be carefully considered and justified.

Build Challenge Criteria

A jury of professional builders and cost estimators shall assign an overall score for the house's financial feasibility in the marketplace, including the up-front cost and costs of operation and maintenance. The jury will consider the submitted deliverables and perform an in-depth evaluation of the as-built house.

The jury shall consider the following specific criteria in its evaluation:

Affordability

- How likely is it that the house would be affordable to the team's target market, estimated up-front cost (i.e., cost to consumer), financing, insurance, taxes, monthly utilities, and maintenance?
- How do the energy-related and other innovative features enhance the home's market value?

- To what extent does the estimated competition prototype cost align with market needs and expectations?

Cost-Effectiveness[1]

- Does the house offer a good value to the target market, considering quality of design, construction, materials, equipment, and other related elements?
- To what extent is the cost-effectiveness supported by reasonable and complete market analysis?

Cost Estimate

- Quality of construction cost estimate based on built house.
- How successfully does the team construction cost estimate reflect the as-built competition house?
- The quality and magnitude of the team operational cost estimate for the as-built competition house, including forecasted utility, maintenance, insurance, and any monthly operations or subscription fees.

4.4 Resilience

Contest Intent

This Contest evaluates the building's ability to withstand and recover from prevailing disaster risks for its intended location, maintain critical operations during grid disruptions that commonly occur post-disasters, and ensure long-term durability in response to local climatic conditions.

Resilience is the ability to anticipate, withstand, respond to, and recover from disruptions. The benefits of investing in highly efficient buildings are protected by also investing in resilient design. Buildings must demonstrate how they effectively address all of these challenges.

Build Challenge Criteria

A jury of industry professionals shall assign an overall score for the house's durability and resilience. The jury will consider the submitted deliverables and perform an on-site evaluation of the as-built house.

The jury shall consider the following specific criteria in its evaluation:

Durability

- To what level do the building design details, materials selection, and construction practices ensure durability of all building science control layers (thermal, air, bulk moisture, and moisture vapor)?

[1] Although no points are directly assigned based on the estimated construction cost of the house, the jury will evaluate whether cost-effective decisions were made with respect to the client demographic and expected house performance. A professional cost estimator is included as part of the jury and will review the team-developed estimated construction cost in detail to determine its thoroughness, reasonableness, and accuracy. Teams may provide justification to have the cost of a particular innovative technology included at a cost equal to a market-ready equivalent.

- To what extent is the house, through both design and materials, durable and able to resist extreme environmental conditions?
- How well does the design optimize or address longevity of design, including maintenance, material performance, life cycle costs, and owner operation?

Performance

- To what extent does the building design approach for the specified location enable the building to withstand and recover from potential disasters because of risks posed by weather and other natural or man-made events?
- To what extent does the house provide occupants critical load capabilities, including the ability to operate during an extended power and water outage through energy efficiency designs, on-site generation, on-site storage with islanding capabilities, and critical load considerations?

Resource Management

- To what extent does the team holistically integrate passive strategies, materials selection, life cycle, and local strategies to maximize resilience?
- To what extent does the competition prototype enable the reclamation and reuse of water utilized by the house?
- To what extent is the competition prototype house expected to require less energy than a comparable minimally code-compliant building?

Resilience Innovation

In addition to and separate from the score assigned to each team for the Resilience Contest, the jury shall assign each team a score for innovation, which is scored as one-quarter of the Innovation Contest.

- To what extent did the team take unique or innovative approaches to building resilience and occupant safety throughout the design process and implementation?
- How well does the team use resilient design to improve house performance and occupant health?

4.5 Architecture

Contest Intent

This Contest evaluates the building architectural design for its creativity, overall integration of systems, and ability to deliver outstanding aesthetics and functionality along with energy-efficient performance.

Cutting-edge energy-efficient building performance is better positioned to achieve market acceptance if integrated into architectural designs that creatively meet or exceed aesthetic and functional expectations of both industry and consumers. Specifically, good design marries aesthetics with sound building science, energy efficiency, natural comfort (e.g., glare-free views, natural heating, natural fresh air, and natural lighting), energy production, and resilience.

Build Challenge Criteria

A jury of architects shall assign an overall score for the design's architectural conceptual coherence, merit, integration, and implementation. The jury will consider the submitted deliverables and perform an extensive evaluation of the as-built house.

The jury shall consider the following specific criteria in its evaluation:

Architectural Concept and Design Approach

- How well did the team utilize an overall clear concept, idea, or ideas to guide the development of the house?
- How well does the house demonstrate overall coherence among disciplines and systems?
- How well does the house address unique issues and challenges to respond to its target site?
- What is the design's overall ability to effectively enhance the life of intended occupants?
- How effectively does the overall architectural design offer a sense of inspiration and delight to occupants?
- To what extent does the design consider climatology, including plant palette and water conservation, in the landscaping and site design?
- How effectively does the design address unique issues and challenges given its target site?

Architectural Implementation

- What is the overall quality of the architectural design and project appearance?
- What is the design's effectiveness in integrating energy efficiency and building science principles?
- To what extent do the floor plan and interior details account for functionality, furnishings, storage, linkages to outdoors, and efficient use of space?

- How well does the house demonstrate quality design through materials, details, and implementation?[2]
- How effectively does the design use natural methods to meet heating, cooling, and lighting needs (also known as passive solar design)?
- How well does the team integrate both natural and electric lighting into the house?
- How well did the team integrate energy efficiency and energy production technologies into the architectural design?
- How optimal is the use and consideration of the specified site, including views, drainage, regionally appropriate materials, and community connection?

Documentation

- How effectively did the deliverables enable the jury to conduct a preliminary evaluation of the design?[3]
- How effectively does the team use digital technology, to represent its as-built competition prototype remotely?
- How accurate, complete, and clear are the competition drawings and specifications?

Architectural Innovation

In addition to and separate from the score assigned to each team for the Architecture Contest, the jury shall assign each team a score for innovation, which is scored as one-quarter of the Innovation Contest.

- How innovative was the team in its use of architectural elements including, but not limited to, scale and proportion, indoor/outdoor connections, composition, and linking of various house elements?
- How innovative was the team's approach to holistic and integrated design, inclusive of space, structure, and building envelope?

4.6 Operations

Contest Intent

This Contest evaluates how effectively and efficiently the building operates to carry out intended functions while also ensuring persistence of performance.

Building systems, appliances, and features should be thoughtfully selected and integrated into the overall design. Buildings should incorporate creative and technical solutions that work seamlessly with energy efficiency and energy production strategies. This includes strategies for persistence of performance (e.g., efficiency, comfort, health, safety, and durability) that address operation limitations of typical occupants.

[2] The jury should consider the design, detailing, and implementation from the perspective of a professionally constructed house. Student-built or installed elements should be evaluated as if they were professionally built and installed.

[3] Deliverables are required to accurately reflect the competition prototype as it appears in its final form.

For all Operations Subcontests, see the Build Challenge Event Schedule to be provided on the Groups.io Project Site for the agenda and number of available points per scored period, measurement, or task.

Kitchen Appliances Subcontest

All available points are earned for successfully operating each kitchen appliance according to the following constraints.

a) Refrigerator: All available points are earned for maintaining time-averaged interior temperature of a refrigerator between 34°F (1.111°C) and 40°F (4.444°C) during the scored periods.

- Reduced points are earned if the time-averaged interior refrigerator temperature is between 32°F (0°C) and 34°F (1.111°C) or between 40°F (4.444°C) and 42°F (5.556°C). Reduced point values are scaled linearly. No points are earned for a time-averaged interior refrigerator temperature below 32°F (0°C) or above 42°F (5.556°C).
- The refrigerator volume published in the manufacturer's specifications shall be a minimum of 4.5 cubic feet (ft^3) (0.127 cubic meters [m^3]).
- The refrigerator may only be used to store food and beverages.

b) Freezer: All available points are earned for maintaining a time-averaged interior temperature of a freezer between -20°F (-28.889°C) and 5°F (-15°C) during the scored periods.

- Reduced points are earned if the time-averaged interior freezer temperature is between -30°F (-34.444°C) and -20°F (-28.889°C) or between 5°F (-15°C) and 15°F (-9.444°C). Reduced point values are scaled linearly.
- The freezer volume published in the manufacturer's specifications shall be a minimum of 2 ft^3 (0.0566 m^3).
- The freezer may be used to store food and only enough ice to fill the freezer's ice bin (or equivalent).

c) Oven: All available points are earned for establishing an interior temperature of an oven between 400°F (204.444°C) and 450°F (232.222°C) during scored periods.

- Reduced points are earned if the time-averaged interior oven temperature is between 250°F (121.111°C) and 400°F (204.444°C) or between 450°F (232.222°C) and 550°F (287.778°C). Reduced point values are scaled linearly.
- The oven volume published in the manufacturer's specifications shall be a minimum of 2 ft^3 (0.0566 m^3).
- The oven may not contain any food or beverages during the measurement period.
- Teams are provided two attempts to meet this requirement, with each attempt separated by at least 8 hours of time.

d) Cooktop: All available points are earned for bringing at least 8 cups (1.892 L) of water in a pot to a rolling boil during a scored period.

- Reduced points are earned if the temperature of the water is between 50% and 100% of the boiling temperature of water for the location where measurements are collected. Reduced point values are scaled linearly.
- Teams are provided two attempts to meet this requirement, with each attempt separated by at least 8 hours of time.

Hot Water Subcontest

Significant water and energy are often wasted as occupants wait for hot water to emerge from their showerhead. All available points are earned for providing water of at least 105°F (40.556°C) before an average of 2 cups (0.473 L) of water has passed through each of the showerhead, lavatory, and kitchen sink faucets under normal operation. If more than one of each fixture exists in the house, the fixture likely to be most-commonly used shall be the one evaluated.

a) Reduced points are earned for an average draw between 2 (0.473 L) and 20 (4.73 L) cups. Reduced point values are scaled linearly. If more than 20 (4.73 L) cups of water, on average, is required to be drawn to reach a temperature of 105°F (40.556°C), no points are earned.

b) Teams are offered three attempts to meet this requirement, with each attempt separated by at least 8 hours of time. The team may not cycle water through their system in advance of this evaluation in a way intended to manipulate the evaluation results.

Laundry Subcontest

All available points are earned for washing laundry by running an automatic clothes washer containing six organizer-supplied bath towels through three complete, uninterrupted, "normal" (or equivalent) cycles on one of the specified days in the Build Challenge calendar, which is available on the Groups.io Project Site.

a) The clothes washer shall operate automatically and have at least one wash and rinse cycle.

b) Cycle "interruption" includes the adjustment of supply temperature or flow in a manner not anticipated by the manufacturer or addressed in its operation manual.

c) The organizers will consult the operation manual to identify appropriate cycle settings. "Normal" or "regular" settings shall be selected, if available. Otherwise, settings most closely resembling typical "normal" or "regular" settings shall be selected.

d) The evaluation begins when a team indicates it is ready for the organizers to evaluate. Multiple attempts per load are not allowed.

Electric Lighting Subcontest

All available points are earned at the conclusion of each scored period by achieving a time-averaged interior illumination level of 300 lx or greater when evaluated according to the Build Challenge Event schedule.

a) Reduced points are earned if the time-averaged interior illumination level is between 300 lx and 100 lx. Reduced point values are scaled linearly. No points are earned for a time-averaged interior illumination level below 100 lx.

b) The organizers will identify at least two zones in each house and measure the illumination level at the approximate center of each zone at an approximate height of 3 ft (0.914 meters [m]). Care will be taken to ensure that the measurement reflects the functional illumination of the room. The time-averaged interior illumination level deviating farthest from the target lighting level for a particular scored period is the illumination level of record.

Home Electronics Subcontest

All available points are earned for successfully operating smart home electronics, including a television, a computer, a smart outlet, and energy monitoring circuits. Teams may choose when to target earning points within the available times indicated in the Build Challenge calendar, which is available on the Groups.io Project Site. The available points are divided equally across the three elements listed below:

a) The television display shall be a minimum of 27 in. (68.58 cm), and the computer display shall be a minimum of 15 in. (38.1 cm), each as according to the manufacturer's stated display size. The television and computer displays shall be able to be operated simultaneously and controlled independently of each other. Points are earned for demonstrating that each can be powered and operated successfully.

b) Each home shall have at least one smart outlet or light that can be controlled remotely and set to a schedule. Points are earned for demonstrating successful operation of the outlet or light.

c) Each home shall have the ability for the homeowner to monitor circuit-level energy use. Points are earned for demonstrating complete and successful circuit-level energy monitoring to the organizers.

House Occupancy Subcontest

Each team shall host at least six members of its community for at least 2 hours as specified in the Build Challenge calendar, which is available on the Groups.io Project Site. The House Occupancy Subcontest will feature at least six individuals in addition to two decathletes operating the house. The goal of this Subcontest is to validate a fully functional house with visitors and to enable a successful evaluation of the house for the Comfort & Environmental Quality Contest. To earn full points for the House Occupancy Subcontest, teams shall:

a) Host at least six guests, including at least one organizer-invited Observer.

b) Serve a complete meal with an adequate amount of food for all guests at appropriate serving temperatures and in a timely manner.

c) Prepare and cook all food and beverages in the house during a scheduled period of time in accordance with the Build Challenge calendar, which is available on the Groups.io Project Site.

d) Serve and have guests eat the meal in the finished square footage.

e) Comply with the following safety requirements:

- Do not use any flames, including candle flames.
- Do not serve or use any alcoholic beverages.
- Use only drinking water purchased in sealed containers.

- Wash and rinse all dishes and cookware before use.
- Store all food and beverages properly.
- Do not use coolers to store food, beverages, or ice.

Electric Vehicle Charging Subcontest

All available points are earned for charging an electric vehicle from a battery state below 25% to "full" within a time period available in the Build Challenge calendar, which is available on the Groups.io Project Site. Teams may choose when to begin the charging, but each task must begin and end within the times indicated in the Build Challenge calendar and once a team has initiated the task, additional attempts are not permitted. Teams may drive the car before start of the Subcontest to reduce the battery charge state an appropriate starting level.

a) The vehicle must be entirely electric. Hybrid vehicles and nonelectric vehicles are not permitted.

b) The competition prototype house must include the infrastructure required to charge the vehicle.

c) Any vehicle used must be a model commercially available at the beginning of the Competition Event.

d) The vehicle must have four wheels and, at a minimum, seat two individuals side-by-side.

e) The charging of the vehicle must be witnessed by an organizer-approved Observer.

4.7 Market Potential

Contest Intent

This Contest evaluates the building's responsiveness to its stated target market, likely appeal to intended occupants and the construction industry, and ability to transform how energy is used in buildings given its approach and wide-scale desirability.

To ensure uptake in the market and drive both demand and supply, effective energy-efficient designs take into account the interests of intended building occupants and owners as well as the construction industry. On the consumer side, designs should reflect how occupants can best use and enjoy the built environment and accommodate potentially changing preferences of occupants over time. On the supply side, a successful design will consider how to reduce construction cycle time, ensure outstanding quality, and improve construction productivity. It will also include construction documentation that helps ensure best practices and quality workmanship.

Build Challenge Criteria

A jury of professionals from the home-building industry shall assign an overall score for the design's responsiveness to the characteristics and requirements of the team-defined target market and market impact potential. The Jury will consider the submitted deliverables and perform an extensive evaluation of the as-built house. The team must define a target client, with a minimum level of detail including household income, location, and requirements.

Teams shall define a target client with a minimum level of specificity as indicated in Table 4. The target market defined for the competition prototype must be for year-round occupancy. The

Jury will evaluate all construction details, style, and design details as demonstrated by the competition prototype as part of the Market Potential Contest.

Livability

- How well does the design reflect current market expectations for livability and convenience?
- How well does the house support a safe, functional, convenient, comfortable, and enjoyable place to live?
- How successfully do the design details of the competition prototype meet the unique needs and desires of the target client?
- How successful is the design of the house's lighting, entertainment, and other controls?
- How successfully does the design encourage a homeowner to use fewer resources than a typical homeowner?

Market Analysis

- How effective is the team market analysis, and how well does the design integrate key findings from the market analysis?
- How successfully do the house, material, equipment, and design details demonstrate appeal for the target client?
- How effectively does the team highlight the house's energy features and strategies to improve the marketability of the house to the target client?
- How effectively does the team demonstrate the market need for the competition prototype house and associated components?
- To what extent is the design able to leverage growing interest in off-site construction or other innovations to improve quality, cost, and productivity?
- To what extent will the innovations have immediate and/or long-term commercial impact in the marketplace (e.g., offer opportunities for more effective production and delivery of housing in the United States)?
- To what extent is there market potential for the design as built, including ability for trades to reproduce and/or scale it to other sites?
- To what extent could the design and integrated elements positively impact the U.S. residential energy efficiency and renewable energy industry?

Buildability

- How effective are drawings and documentation at demonstrating construction materials and practices conducive to housing industry adoption at scale?
- How successfully does the design support buildability, including thoroughness of the construction documentation?
- How challenging would the competition prototype be to construct successfully?

- How effectively could the house be adopted and built in the private sector?

Market Potential Innovation

In addition to and separate from the score assigned to each team for the Market Potential Contest, the jury shall assign each team a score for innovation, which is scored as one-quarter of the Innovation Contest.

- How innovative was the team in its approach to market potential, increasing the likelihood that the design will be adopted in the residential home market and impact national energy performance?
- How innovative was the team's approach to livability and buildability, inspiring the public to consider the opportunities for housing of the future?

Table 4. Examples of Target Client Definition

Characteristic or Requirement	Example 1	Example 2	Example 3
Location of permanent site	Minot, North Dakota	Folsom, California	Boston, Massachusetts
Client demographic	Working professionals	Recent graduate	Retired individual
Household income	$85,000	$180,000	$30,000

4.8 Comfort & Environmental Quality

Contest Intent

This Contest evaluates the building's capability to integrate comfort and indoor environmental quality with energy-efficient performance.

Well-designed buildings provide both a comfortable and healthy indoor environment. For occupants to be comfortable, the building must be able to control temperature and relative humidity levels, as well as reduce disturbances from interior and exterior sources of noise. To provide a healthy indoor environment, the design must include a comprehensive approach to indoor air quality that incorporates ventilation, filtration, dilution, and material selection strategies.

Sensors are to be in place for the duration of any measured Subcontest period at the location agreed upon between the team and the organizers to accurately represent house performance. The sensors do not need to be in place when a particular measured Subcontest is inactive, such as during public exhibit hours.

Temperature Control Subcontest

All available points are earned for achieving a time-averaged interior dry-bulb temperature between 68°F (20°C) and 74°F (23.333°C) during at least one of the scored periods.

a) Reduced points are earned if the time-averaged interior dry-bulb temperature is between 64°F (17.778°C) and 68°F (20°C) or between 74°F (23.333°C) and 78°F (25.556°C). Reduced point values are scaled linearly. No points are earned for a time-averaged interior dry-bulb temperature below 64°F (17.778°C) or above 78°F (25.556°C).

b) The organizers will identify at least two zones in each house and measure the temperature of each zone. The zone temperature deviating farthest from the target temperature range is the zone temperature of record.

Humidity Control Subcontest

All available points are earned at the conclusion of each scored period by achieving a time-averaged interior relative humidity between 35% and 50% during at least one of the scored periods.

a) Reduced points are earned if the time-averaged interior relative humidity is between 25% and 35% or between 50% and 70%. Reduced point values are scaled linearly. No points are earned for a time-averaged interior relative humidity below 25% or above 70%.

b) The organizers will identify at least two zones of each house and measure the humidity of each zone. The zone humidity deviating farthest from the target humidity range is the zone humidity of record.

Indoor Air Quality Subcontest

All available points are earned at the conclusion of each scored period by keeping the time-averaged interior carbon dioxide (CO_2) level below 1,000 parts per million (PPM) following occupancy of six individuals for 1 hour. The CO_2 levels are measured when the house is occupied as part of the House Occupancy Subcontest.

a) Reduced points are earned for time-averaged interior CO_2 levels between 1,000 PPM and 2,000 PPM. Reduced point values are scaled linearly. No points are earned for time-averaged interior CO_2 levels above 2,000 PPM.

b) The organizers will identify at least one zone in each house and measure the CO_2 level of each zone. If more than one measurement is collected, the CO_2 level deviating farthest from the target CO_2 level is the CO_2 level of record.

Air Tightness Subcontest

All available points are earned for a measured air tightness of less than or equal to 0.05 cubic feet per minute (cfm) 50/ft^2.

a) Reduced points are earned for measurements between 0.05 cfm 50/ft^2 and 0.25 cfm 50/ft^2. Reduced point values are scaled linearly. No points are earned for measurements above 0.25 cfm 50/ft^2.

b) Air tightness will be evaluated in advance of the competition at the team site by a qualified third-party provider hired by the team.

c) To calculate CFM50, the interior volume of each house is required to be known. Each team shall provide this value to the organizers.

Exterior Noise Infiltration Subcontest

The sound insulation decibel (dB) values for three of the 1/3 octave bands will be calculated between 100 hertz and 5 kilohertz—specifically, 200, 1,000 and 4,000 kilohertz. All available points are earned for a measured sound pressure level from outside noise intrusion less than or equal to 35 A-weighted decibels (dBa) based on an assumed peak hour sound level equivalents (Leq) of 90 dBa.[4]

a) Reduced points are earned for measurements between 35 dBa and 50 dBa. Reduced point values are scaled linearly. No points are earned for a measured exterior noise infiltration greater than 50 dBa.

b) The organizers will identify at least two zones of each house and measure the exterior noise infiltration at a pre-agreed-upon location in each zone. The zone exterior noise infiltration deviating farthest from the target range is the zone of record.

Internally Generated Noise Subcontest

Heating, ventilating, and air-conditioning (HVAC) systems, electronics, mechanical equipment and other noise-emitting office devices, as well as occupants themselves, can be sources of indoor noise. All available points are earned for a maximum background noise in the home, measured in home because of interior noise sources (HVAC systems, lighting, appliances, and other building services operating simultaneously), less than or equal to 40 dBA.[4]

a) Reduced points are earned for measurements between 40 dBa and 55 dBa. Reduced point values are scaled linearly. No points are earned for a measured maximum background noise in the home greater than 55 dBa.

b) The organizers will identify at least two zones of each house and measure the exterior noise infiltration at a pre-agreed-upon location in each zone. The zone exterior noise infiltration deviating farthest from the target range is the zone of record.

4.9 Innovation

Contest Intent

This Contest evaluates the design's success incorporating innovations and/or creative approaches that enhance energy efficiency, energy production, grid interaction, and building operations, as well as overall functionality and appeal.

Effective designs incorporate innovations that can be embraced by the construction industry and consumers on a large scale. Teams are encouraged to find solutions that use new or existing technologies, as well as other creative measures to improve building operations and desirability.

Build Challenge Criteria

In addition to contest-specific criteria identified previously, the Architecture, Engineering, Market Potential, and Resilience Juries shall consider the following specific criteria in their evaluation:

- What approach did the team take toward integrating innovations into the design?

[4] http://www.usgbc.org/node/4631859?return=/credits

- To what extent does the design use innovations or innovative approaches to satisfy an existing market need or desire?
- How successfully did the team use discovery, research, prototyping, analysis, and collaboration?
- What is the validation of the innovation potential through the as-built design and implementation?
- To what extent do the design and innovative features address the interests and needs of target buyers and users (e.g., not only in terms of providing a comfortable living environment but also one with attractive and desirable elements that meet the target users' needs)?
- To what extent does the team's approach to innovation relate to the team intent, mission, strategies, or goals?
- To what extent will the innovations endure relative to the anticipated life cycle of the house?
- To what extent do the innovations improve or maintain the safety of occupants of the house?

4.10 Presentation

Contest Intent

This Contest evaluates the team's ability to accurately and effectively convey its design and energy performance strategy to relevant audiences.

The value proposition of energy efficiency and renewable energy opportunities must be clearly conveyed to industry leaders and the public at large. A smart design on its own is insufficient. Presentation quality can dramatically affect market perception and the likelihood of innovation adoption.

Build Challenge Criteria

A jury of communication professionals shall assign an overall score for the success of each team's communication strategies, materials, and efforts to educate, inform, engage, and interest the public. Presentation quality includes complete and consistent documentation that clearly conveys the goals of the team and its design, tells a story that resonates, and engages the public effectively. The jury will consider the submitted deliverables, perform an extensive evaluation of the team's tour sequence for public visitors at the Community Exhibition, and evaluate the public outreach materials utilized by the team.

The jury will consider the following specific criteria in its evaluation:

Strategy

- How well did the team's communication materials and activities collectively convey a comprehensive, consistent, and integrated communications strategy?
- How clearly defined are the team's communication audiences and goals?

- How successful are the team's communication and outreach strategies?

Implementation

- What is the quality of all presentations to the jury and the public in the team's local market?
- How successfully did the team conduct outreach, education, and engagement in its local market?
- How successfully does the team incorporate online and digital communications strategies and products to engage audiences?
- How effective are the team's educational and outreach messages to intended audiences?
- How informative, interesting, engaging, and audience-appropriate is the team's public presentation and approach for providing tours?
- How effectively does the team use features, displays, models, or other materials to engage and educate the public?
- How extensively and successfully is the team's local outreach, education, and engagement?
- How effective is the team's strategy for accommodating large crowds and long lines?
- How well do the on-site communication materials educate and inform the visiting public?
- What is the quantity of visitors and quality of visitor experiences to each team's house or exhibit, including consideration of each location's climactic conditions for visitors?

5 Build Challenge Juried Contest Evaluation Process

The evaluation process is multifaceted and includes the following:

- Contest juror panels (each with three to five jurors) assess the team's projects.
- One jury convenes for each of the Architecture, Market Potential, Engineering, Resilience, Financial Feasibility & Affordability, and Presentation Contests.
- Each jury will review all teams. The jury will review the assigned deliverables associated with all competing teams and will evaluate the presentations from each Division. The juries will then assign a percentage integer value according to this process for every team, awarding a 1st through nth place for all teams in each Division.

A jury's evaluation of each team's project consists of the following three steps:

1. Step 1: Deliverables Review
2. Step 2: As-Built House Evaluation
    - The juries will witness a scheduled presentation from each of the teams accompanied by photographs, 3D walkthroughs, and video of the as-built house.
3. Step 3: Deliberation.

5.1 Step 1: Deliverables Review

Each juror will spend approximately 1–2 hours reviewing the submitted deliverables to explore the relevant details of each team's project. An outline of the reviews is listed in Table 5.

Table 5. Jury Reviews

Jury	Time Commitment for Phase 1 Deliverables Review	Relevant Deliverables for Review	Time Commitment for Phase 2 Team Presentation
Engineering	1–2 hours per team	Engineering Narrative Energy Model Analysis and Results Architectural Photography and 3D Tour As-Built Drawings As-Built Specifications Audiovisual Presentation, including video of house	30 minutes per team
Financial Feasibility & Affordability	1–2 hours per team	Financial Feasibility and Affordability Narrative Construction Cost Estimate Operational Cost Estimate Architectural Photography and 3D Photo Tour As-Built Drawings As-Built Specification Audiovisual Presentation, including video of house	30 minutes per team
Resilience	1–2 hours per team	Resilience Narrative Architectural Photography and 3D Photo Tour As-Built Drawings As-Built Specifications Audiovisual Presentation, including video of house	30 minutes per team
Architecture	1–2 hours per team	Architecture Narrative Architectural Photography and 3D Photo Tour As-Built Drawings As-Built Specifications Audiovisual Presentation, including video of house	30 minutes per team
Market Potential	1–2 hours per team	Market Potential Narrative Architectural Photography and 3D Photo Tour As-Built Drawings As-Built Specifications Audiovisual Presentation, including video of house	30 minutes per team
Presentation	1–2 hours per team	Presentation Narrative Local Attendance and Engagement Stats Team website and/or social media accounts Architectural Photography and 3D Photo Tour Public exhibit materials Audiovisual Presentation, including video of house	30 minutes per team

5.2 Step 2: As-Built House Evaluation

Each jury will complete an extensive evaluation of the house as-built by the competing team. Each house will be documented by professional architectural or real estate photographers, including extensive exterior and interior photography and an organizer-provided 3D photographic walk-through. The jury presentations offer the jurors an opportunity to ask the decathletes for clarification of questions that may arise during the deliverables review and evaluation of the as-built house.

5.3 Step 3: Deliberation

During the deliberation phase, which takes place after the in-depth evaluation of the as-built house, the jury is encouraged, but not required, to place each team into one of five classes (outlined in Table 6) based on each team's performance relative to the juror's expectations with regard to the Contest criteria.

Juries are not required to place a uniform number of teams in all classes or to place at least one team in every class. For example, if a jury determines that no teams are worthy of Class 1, there would be no teams with scores greater than 90%. After reviewing the teams in each class, the jury shall assign each team a percentage integer from 0% to 100%. Ties are not permitted.

After assigning each team a percentage integer from 0% to 100%, the jury shall submit its percentage integers to the Build Challenge Manager, who will convert them to a score based on the total number of available points for the contest being judged. The Build Challenge Manager will round off any noninteger percentage scores to the nearest integer. Prior to posting scores in the scoring server, the Build Challenge Manager will apply any applicable penalties that may have been incurred.

The highest scoring team(s) are announced during a scheduled announcement. Pending the jurors' availability, the organizers will invite one or more jurors to make the announcement. The scores for all of the teams are posted immediately following the announcement.

The jury must submit written or recorded scoring justifications for each team to the Build Challenge Manager. The jury's scoring justifications may be provided as feedback to each team so it might better understand the jury's evaluation. The justifications may be posted on the Solar Decathlon website.

5.4 Evaluation Rating Scale

The jury scores each parameter according to the following scale in Table 6.

Table 6. Evaluation Scale

Class 5	0%–20%	MISSES EXPECTATIONS: Missing all requirements; no explanation of how the design addresses the criteria
Class 4	20%–40%	APPROACHES EXPECTATIONS: Missing some requirements; minimal explanation of how the design addresses the criteria
Class 3	40%–60%	MEETS EXPECTATIONS: All requirements met; acceptable explanation of how the design addresses the criteria
Class 2	60%–90%	EXCEEDS EXPECTATIONS: All requirements met; full demonstration of how the solution addresses the criteria
Class 1	90%–100%	ECLIPSES EXPECTATIONS: All requirements met; distinguished excellence in the how the design exceeds the criteria

5.5 Team Guidelines

a) It is ultimately the team's responsibility to be ready for the juries at the times indicated in the jury presentation schedule provided on the Groups.io Project Site.

b) Up to six decathletes may be present during the presentations to the juries. No other team members may be present.

c) The jury presentations are held to a very strict schedule for each of the teams. The importance of following this schedule is twofold: (1) ensuring each team receives equal time with the juries and (2) deviating from the schedule will have an immediate effect on other scheduled activities. A small deviation in the defined schedule for the juries could result in a very difficult situation to resolve in another component of the competition. If a team is not ready for a jury to begin its evaluation at the scheduled time, then the total time the jury spends with that team will be reduced.

d) During jury presentations, the team will have up to 15 minutes to present their project to all juries and their peers. Additionally, each jury has 20 minutes to meet with team, followed by a 5-minute deliberation period. During the 20 minutes with each team, the entire time is allocated for team members to lead the jury through the contest-specific aspects of the design and answer any questions the jury may have. After 20 minutes, all team members shall leave the area so that the jury can hold a private 5-minute discussion about the team that has just presented. Following the discussion, each jury has 5 minutes to prepare for the next team presentation.

    - All teams will present to juries, including showing juries through their competition prototype house utilizing digital technologies or other means.
    - For the Presentation Contest jury, the team shall present its Public Outreach Activity to the jury. Each team is expected to spend up to 5 minutes presenting the personalized public outreach activity to the Presentation Contest Jury as it would be presented to the public. The version given to the Presentation Jury must represent the version presented to the public throughout the competition week. The team should briefly describe how it would modify the Public Outreach

Activity to accommodate large crowds or long lines. The remaining time shall be used to present the team communications strategy, including brand management and past activities for outreach locally, and to answer questions.

e) Presentation boards and other electronic or visual media are permitted to be on display during jury visits.

f) Teams may not record the jury visit or the private jury discussion period.

g) Areas of the house or exhibit excluded from the accessible exhibit route may be considered by the juries and considered in their evaluations.

h) The organizers will provide all juries with summaries of relevant rule and code violations for each team so they are aware of violations before giving credit for aspects of the project that are not in compliance.

5.6 Public Exhibit Requirements

The team shall prepare two versions of its public outreach.

Community Exhibition

- All teams are required to exhibit their house to their own community for at least two weekends, which is noted on the Groups.io Project Site.
- Each team shall prepare and offer a comprehensive tour of the house to all visitors. Any team members or associated individuals can offer tours of the house to the public.
- The tour shall educate the visitors about the Solar Decathlon, the team's target market and goals, the design solution itself, and how visitors could adopt technologies or practices in their own homes.
- Tours are expected to last between 5 and 30 minutes and can be guided or supported by team members at stations throughout the house.

Competition Event Exhibition

- Teams are expected to educate people about the Solar Decathlon, the team's target market and goals, the team's design solution, and ideas for how people could adopt technologies or energy-efficient practices in their own homes.

Common Requirements

- Both versions of each team's public outreach shall be informative, interesting, and accessible by people of all abilities.
- Teams are encouraged to employ effective and creative methods to control wait times and engage visitors waiting in line during public tour hours.
- Digital technologies (such as virtual reality, television screens, or apps), printed signage, and components (such as scale models, wall sections, or material samples) may be used to entice and educate the visiting public.

6 Build Challenge Deliverables

Throughout the project, the organizers will require teams to submit deliverables necessary for ensuring safety and for generating sufficient interest in the Solar Decathlon Build Challenge Events. These design deliverables (outlined in Table 7) serve the following important functions:

- In the **Project Introduction**, the team shall disclose to the organizers their initial design decisions, all nonstandard design features, communications strategies, site operations plans, and health and safety considerations that require further review prior to the continuation of the project into the design development phase. The team shall provide a project management plan for the next phases of the Challenge.
- At all stages, the **drawings and project manual** shall demonstrate compliance with the Solar Decathlon Build Challenge Building Code and Rules so the inspectors are able to grant final on-site approval by verifying that the constructed project was accurately represented by the approved drawings and project manual.
- At all stages, the **drawings and project manual** are expected to provide sufficient detail to enable a residential contractor to generate an accurate, detailed cost estimate and to efficiently construct the building as the design team intended it to be built.
- Because the juries have a very limited opportunity to evaluate the constructed projects, the **submitted Jury Documentation deliverables** are the only means for a team to provide a detailed presentation of its project to the juries.

Table 7. List of Deliverables

Deliverable Name	Required Content	Use of Submission	Due Date
D1: Project Introduction	Team short description Project management plan Design summary Initial design renderings	Feedback to team	Feb. 19, 2019
D2: Design Development Deliverable	50% complete construction drawings Initial project report	Evaluated as part of Approval to Proceed to Phase 2 and first prize disbursement	March 26, 2019
D3: Design Presentation Deliverable	20-minute presentation on design Optional poster	Evaluated as part of Approval to Proceed to Phase 2 and first prize disbursement	April 9, 2019
D4: Construction Documentation	Public project renderings 95% complete construction documentation (drawings and specifications) Interim project report	Evaluated as part of Approval to Proceed to construction and second prize disbursement	Nov. 5, 2019
D5: As-Built Documentation	Updated public project renderings 100% complete construction documentation (reflecting house under construction) Stamped structural drawings and calculations Construction progress photos Updated Health & Safety Plan Team roster	To be used by juries for scoring teams and by organizers for scoring measurement	Feb. 18, 2020
D6: Project Summary	Final project report Public project summary Public exhibit materials, including signage, uniform, and website Team roster	To be used for public outreach about the team, reviewed by juries	April 22, 2020
D7: Jury Deliverables	Jury narratives Architectural photography of as-built house 3D tour of house Final construction documentation Team roster	To be used by juries for scoring the team	March 2, 2021
D8: Final Report	Post event project report	To be used by organizers for lessons learned	May 18, 2021

6.1 D1: Project Introduction

The Project Introduction deliverable is reviewed by organizers, and feedback is provided to teams to help increase their likelihood of success in the remainder of the Challenge. It is not used as the basis of the Approval to Proceed and prize disbursement in accordance with the Approval-to-Proceed Procedures, which are available on the Solar Decathlon website.

The Project Introduction is not made publicly available until after the completion of the competition, with the exception of the team description, goals, and renderings, which may be shared on the Solar Decathlon website. The documentation is reviewed by the organizers.

The team shall provide information that outlines the team's structure, approach to the competition, general work schedule, course integration, and fundraising schedules. The project management plan is limited to 30 pages.

Format Requirements

☐	Packaged into a single PDF file (Renderings and/or audiovisuals may be submitted separately, if desired.)
☐	Up to 30 pages
☐	File name abbreviation: INTRO

Content Requirements

☐	Updated 100-word description of team and its goals for public release
☐	Strategy for winning the Challenge, including a contest-by-contest approach (3–5 pages)
☐	Team structure, including detailed descriptions of roles and responsibilities (2 pages)
☐	Description of the team's approach to successfully build the house, including a detailed project schedule, explanation of any coursework integration, and summary of any research positions offered to enable successful student commitment (4 pages)
☐	Summary of potential innovations and nonstandard elements being pursued (1–2 pages)
☐	Fundraising approach, schedule, and current progress, along with a current total estimated project budget and description of any current industry partnerships (2 pages)
☐	Schematic Project representation (renderings, graphic floor plan; section drawings; mechanical, electrical, and plumbing system drawings; photography of scale model; animation; and so on) of schematic design (8–10 images or drawings, minimum 1080 pixels in shortest dimension)
☐	Team photograph including as many members of the team as possible and associated file identifying the name of each individual shown and the photographer (1 image, minimum 1080 pixels in shortest dimension)
☐	Description of public exhibit, communications, and outreach strategy and coverage included to date, including a summary of team's current online presence, including social media accounts and website URLs (1–2 pages)
☐	Health and Safety Plan outline, including approach to meeting OSHA training requirement (1–2 pages)
☐	Identification of the licensed design professional expected to stamp structural documentation (1 page)

6.2 D2: Design Development Documentation Submission

The Design Development Documentation Submission shall represent 50% complete construction documentation. The documentation shall clearly indicate all design details, house systems, and methodologies expected to be present in the competition prototype. While details may not be fully complete or finalized, the Design Development Submission shall provide sufficient information for the organizers to conduct a thorough Solar Decathlon Build Challenge Rules and Building Code compliance review. The submission must address the team's approach to safety, including identifying team-specific concerns and constraints. All major decisions with regard to the project design are expected to be complete. The Design Development Documentation Submission will not be reviewed by any contest juries. However, it may be made publicly available following submission.

The Design Development Documentation is reviewed by organizers, and feedback is provided to teams to help increase their likelihood of success in the remainder of the Challenge. It is used as the basis of the Approval to Proceed and prize disbursement. It is also used as the basis for presentation at 2019 Design Challenge Weekend.

(Continued on next page)

Design Development Drawings

Format Requirements

☐	Packaged into a single bookmarked PDF document
☐	Up to 150 pages
☐	ANSI D (22 in. x 34 in. [55.88 cm x 86.36 cm]) sheet size
☐	File name abbreviation: DDDRAW

Content Requirements

☐ Design drawings, including at a minimum:

a) General, including accessible tour route and finished square footage

b) Site Plan

- For Community Exhibitions, the house location and site work necessary, with particular attention paid for public visitor tour access and routes

c) Landscape, including plantings, containers, and watering methodology

d) Structural, including building, decking, and associated structures

e) Architectural, including dimensioned floor plans, building sections, detailed sections, reflected ceiling plans, roof plans, elevations, window and door schedules, and exterior structures

f) Interiors, including finishes, furniture layout, and cabinetry

g) Fire protection, including sprinklers and required detection systems

h) Plumbing, including layout, schedules, diagrams, and solar thermal (if applicable)

i) Mechanical, including layout, schedules, diagrams, and installation requirements

j) Electrical, including AC and DC layout, one-line diagrams, three-line diagrams, and sizing calculations

k) Telecommunications, including instrumentation, wiring, and associated elements

Design Development Project Manual

Format Requirements

☐	Packaged into a single bookmarked PDF document
☐	File name abbreviation: DDPM

Content Requirements

☐	Project overview
☐	Detailed water budget
☐	Statement of grid islanding capability, including summary of any unlisted electrical components, storage strategy, and associated equipment
☐	Summary of reconfigurable features
☐	Health and safety approach
☐	Energy analysis and modeling
☐	Structural Professional Acknowledgement Letter signed by licensed professional indicating acceptance of the Construction Documentation deliverable deadline and support of team
☐	Structural calculations
☐	Construction specifications

Design Development Renderings (Design Development Digital Project Representation)

The teams shall submit renderings, photographs, graphics, and/or animations representing the competition prototype design and competition entry for use on the Solar Decathlon website and in outreach materials generated by the organizers. High-quality and varied submissions are expected to lead to greater visibility for the team. This submission can include renderings, photography of scale models or mockups, refined graphics, computer-generated walk-throughs, 360-degree virtual tours, or other representations as determined by the team. The organizers will select a subset of submitted documentation for public distribution.

Format Requirements

☐	Packaged into a single zipped file (for elements hosted online, a link shall be included in the submission.)
☐	Photographs shall be at least 1080 pixels in their shortest dimension and shall be accompanied by a file containing the name and affiliation of the photographer or graphic creator and identification of any individuals visible.
☐	Videos, if submitted, shall be wide-screen format and accompanied by a verbatim transcript of the audio narrative to meet DOE's Office of Energy Efficiency and Renewable Energy Section 508 compliance standards and identification of the creator and any individuals visible in the video. Closed-captioning does not need to be included within the video file. Permission must be provided for any copyrighted content or audio used as part of the video.
☐	File name abbreviation: DDRENDER

Content Requirements

☐	Teams should submit a minimum of five images, with at least one exterior, one interior, and one bird's-eye view
☐	Photographs shall be at least 1080 pixels in their shortest dimension and shall be accompanied by a file containing the name and affiliation of the photographer or graphic creator and identification of any individuals visible.
☐	Videos, if submitted, shall be wide-screen format and accompanied by a verbatim transcript of the audio narrative to meet Section 508 compliance standards and identification of the creator and any individuals visible in the video. Closed-captioning does not need to be included within the video file. Permission must be provided for any copyrighted content or audio used as part of the video.

6.3 D3: Design Presentation

Each team shall develop presentation files on its design, which are presented at the Competition Event. The presentations, together with D2: Design Development Documentation deliverable are used as the basis of the Approval to Proceed and prize disbursement.

Build Challenge Design Presentation

A 20-minute presentation on the project to be delivered in person during the Competition Event, with an additional 5 minutes for questions, for a total 25-minute team presentation.

Format Requirements

☐	Packaged into a single PDF and/or PPTX presentation
☐	Presentation slides with an aspect ratio of 16:9
☐	Teams are encouraged to embed all videos in the team submission and to notify the organizers before arriving at the competition to allow organizers to ensure that the appropriate software is available to play the video.
☐	File name abbreviation: BCPRES

Content Requirements

☐	Team structure and industry partnerships
☐	Target market description
☐	Design summary
☐	Approach to winning each contest

Build Challenge Poster (optional)

Each team may develop a Project Poster that showcases its design and response to Division parameters. A Poster Session during the Competition Event displays all team projects.

Teams should print their poster and bring it to the Competition Event.

Format Requirements

☐	Packaged into a single PDF file
☐	Shall be 3 ft wide x 2 ft tall (0.9 m wide x 0.6 m tall)
☐	File name abbreviation: BCPOSTER

Content Requirements

☐	Team structure and industry partnerships
☐	Target market description
☐	Design summary

6.4 D4: Construction Documentation Submission

The final Construction Documentation submission shall represent 95% complete construction documentation, with sufficient detail for a contractor to build the competition prototype house as it is expected to exist for the Build Challenge. The documentation shall include complete and final design details, house system specifications, and construction. While it is recognized that a few minor details may change during construction, the Construction Documentation submission shall provide sufficient information for the organizers to conduct a final Solar Decathlon Rules and Building Code compliance verification. The submission must address the team's approach to safety, including identification of team-specific concerns and constraints. The construction documentation submission will not be reviewed by any juries. However, it may be made publicly available following submission.

The Construction Documentation submission is used as the basis of the Approval to Proceed.

Construction Drawings

Format Requirements

☐	Packaged into a single bookmarked PDF document
☐	Up to 150 pages
☐	ANSI D (22 in. x 34 in. [55.88 cm x 86.36 cm]) sheet size
☐	File name abbreviation: CDDRAW

Content Requirements

☐ Complete construction drawings, including at a minimum:

a) General, including solar envelope compliance, accessible tour route, finished square footage, water delivery and removal compliance information, and constructed footprint calculations
b) Site Plan
    - For the Community Exhibition, the house location and site work necessary, with particular attention paid for public visitor tour access and routes
c) Landscape, including plantings, containers, and watering methodology
d) Structural, including building, decking, and associated structures
e) Architectural, including dimensioned floor plans, building sections, detailed sections, reflected ceiling plans, roof plans, elevations, window and door schedules, and exterior structures
f) Interiors, including finishes, furniture layout, and cabinetry
g) Fire protection, including sprinklers and required detection systems
h) Plumbing, including layout, schedules, diagrams, and solar thermal (if applicable)
i) Mechanical, including layout, schedules, diagrams, and installation requirements
j) Electrical, including AC and DC layout, one-line diagrams, three-line diagrams, and sizing calculations
k) Telecommunications, including instrumentation, wiring, and associated elements
l) Operations, including house or exhibit transportation, setup methodology, and staging.

Project Manual

Format Requirements

☐	Packaged into a single bookmarked PDF document
☐	File name abbreviation: CDPM
☐	Up to 150 pages

Content Requirements

☐	Project overview
☐	Statement of grid islanding capability, including summary of any unlisted electrical components, storage strategy, and associated equipment
☐	Summary of reconfigurable features
☐	Complete energy analysis and model
☐	Construction specifications
☐	Draft cost estimate

Stamped Structural Submission

The structural submission shall represent a complete structural design, including structural calculations and specifications. The entire submission shall be stamped by a licensed design professional, such as a structural engineer or architect, who is licensed to stamp residential structural drawings and calculations in the team's Authority Having Jurisdiction and with educational and professional qualifications comparable to those required for licensure in Washington, D.C.

Format Requirements

☐	Packaged into a single bookmarked PDF document
☐	File name abbreviation: CDSTRUCT

Content Requirements

☐	Stamped structural calculations and specifications demonstrating compliance with the Solar Decathlon Build Challenge Building Code

Health and Safety Plan

Format Requirements

☐	Packaged into a single bookmarked PDF document
☐	File name abbreviation: CDHEALTH

Content Requirements

☐	Health and Safety Plan meeting the requirements outlined in an attachment
☐	Proof of OSHA 30-hour training for the required team members outlined in an attachment

Public Project Renderings

The teams shall submit renderings, photographs, graphics, and/or animations representing the competition prototype design and competition entry for use on the Solar Decathlon website and in outreach materials generated by the organizers. High-quality and varied submissions are expected to lead to greater visibility for the team. This submission can include renderings, photography of scale models or mock-ups, refined graphics, computer-generated walk-throughs, 360-degree virtual tours, or other representations as determined by the team. The organizers will select a subset of submitted documentation for public distribution.

Format Requirements

☐	Packaged into a single, zipped file. If elements are hosted online, a link shall be included in the submission.
☐	Photographs shall be at least 1080 pixels in their shortest dimension and shall be accompanied by a file containing the name and affiliation of the photographer or graphic creator and identification of any individuals visible.
☐	Videos, if submitted, shall be wide-screen format and accompanied by a document including a verbatim transcript of the audio narrative to meet Section 508 compliance standards and identification of the creator and any individuals visible in the video. Closed-captioning does not need to be included within the video file. Permission must be provided for any copyrighted content or audio used as part of the video.
☐	File name abbreviation: CDRENDER

Content Requirements

☐	Teams shall submit a minimum of five images, with at least one exterior, one interior, and one bird's-eye view

6.5 D5: As-Built Documentation

The As-Built Documentation provides an opportunity for teams to update their presentations based on their construction progress. The As-Built Documentation deliverables are expected to provide a summary of each team's approach to meeting the contest requirements and to inform the organizer's scoring of measured contests. The organizers will provide feedback as necessary to ensure that the houses built are compliant with the Rules and safe for the public to enter.

As-Built Drawings

Format Requirements

☐	Packaged into a single bookmarked PDF document
☐	Up to 150 pages
☐	ANSI D (22 in. x 34 in. [55.88 cm x 86.36 cm]) sheet size
☐	File name abbreviation: ABDRAW

Content Requirements

☐	Complete construction drawings representing the as-built competition prototype house and with sufficient detail for a residential general contractor to build the house without additional input from the team.

As-Built Specifications

Format Requirements

☐	Packaged into a single bookmarked PDF document of sufficient detail for a residential general contractor to build the house without additional input from the team
☐	File name abbreviation: ABSPEC

Content Requirements

☐	Construction specifications

Public Project Renderings

The teams shall submit updated renderings, photographs, graphics, and/or animations representing the competition prototype design and competition entry for use on the Solar Decathlon website and in outreach materials generated by the organizers. High-quality and varied submissions are expected to lead to greater visibility for the team. This submission can include renderings, photography of scale models or mock-ups, refined graphics, computer-generated walk-throughs, 360-degree virtual tours, or other representations as determined by the team. The organizers will select a subset of submitted documentation for public distribution.

Format Requirements

☐	Packaged into a single, zipped file. If elements are hosted online, a link shall be included in the submission.
☐	Photographs shall be at least 1080 pixels in their shortest dimension and shall be accompanied by a file containing the name and affiliation of the photographer or graphic creator and identification of any individuals visible.
☐	Videos, if submitted, shall be wide-screen format and accompanied by a document including a verbatim transcript of the audio narrative to meet Section 508 compliance standards and identification of the creator and any individuals visible in the video. Closed-captioning does not need to be included within the video file. Permission must be provided for any copyrighted content or audio used as part of the video.
☐	File name abbreviation: ABRENDER

Content Requirements

☐	Teams shall submit a minimum of five images, with at least one exterior, one interior, and one bird's-eye view

Construction Photography

Format Requirements

☐	Photographs shall be at least 1080 pixels in their shortest dimension and shall be accompanied by a file containing the name and affiliation of the photographer(s) and identification of any individuals visible.
☐	File name abbreviation: ABPHOTOS

Content Requirements

☐	At least 10 photographs showing construction to date of the competition prototype

Team Roster

Format Requirements

☐	Packaged into a single Excel file
☐	File name abbreviation: Roster

Content Requirements

☐	The names of all team members expected to be present on-site, including students, faculty advisors, university staff, and any volunteers or industry members who will be directly supporting the team with on-site activities.
☐	The company name of all "vendors" of the team who will be present on-site, but with which the team has no more than a contractual relationship.

6.6 D6: Project Summary and Public Exhibit Materials

The team shall submit an updated description of the project team and design approach, renderings, graphic floor plans, logos, and other relevant information for use on the Solar Decathlon website and for organizer outreach about the Solar Decathlon Build Challenge Events. The team shall submit all public exhibit materials the team plans to employ at the Community Exhibition for organizer review of proper use of Solar Decathlon branding, sponsor recognition, content, and so on. Teams must receive a Certificate of Occupancy from their local Authority Having Jurisdiction no later than March 2, 2021.

Project Summary

Format Requirements

☐	Packaged into a single bookmarked PDF file
☐	10 pages maximum
☐	File name abbreviation: SUMMARY

Content Requirements

☐	A 100-word or less description of the team house. (1 paragraph)
☐	Design philosophy and house design, indicating goals, architectural style, target market, and so on. (1 page)
☐	Unique house features. What makes the house unlike any other? (1 page)
☐	Technological innovations incorporated into the house. (1–2 pages)
☐	Define the target client for the team house and how the design responds to this market's needs. (1 paragraph)
☐	Team organization, number of members, and permanent (noncollegiate institution) email addresses for all team members. (1 page, or attachment)
☐	Future plans for the house. Where will it go after the competition? (1 paragraph)
☐	Final details for the team's Community Exhibition (dates, times, location, parking, etc.).

Team Photograph

Format Requirements

☐	Photographs shall be at least 1080 pixels in their shortest dimension and shall be accompanied by a file containing the name and affiliation of the photographer or graphic creator and identification of any individuals visible
☐	File name abbreviation: TEAMPHOTO

Content Requirements

☐	Include all team members (if possible) and strive for creativity.

Team Logo

Format Requirements

☐	Vector or high-resolution format appropriate for print (EPS preferred)
☐	File name abbreviation: TEAMLOGO

Content Requirements

☐	Graphic logo
☐	Associated text file containing name, phone number, and email of person submitting logo

Team Roster

Format Requirements

☐	Packaged into a single Excel file
☐	File name abbreviation: Roster

Content Requirements

☐	The names of all team members expected to be present on-site, including students, faculty advisors, university staff, and any volunteers or industry members who will be directly supporting the team with on-site activities.
☐	The company name of all “vendors” of the team who will be present on-site, but with which the team has no more than a contractual relationship.

Digital Project Representation

The teams shall submit updated renderings, photographs, graphics, and/or animations representing the competition prototype design and competition entry for use on the Solar Decathlon website and in outreach materials generated by the organizers. High-quality and varied submissions are expected to lead to greater visibility for the team. This submission can include renderings, photography of scale models or mock-ups, refined graphics, computer-generated walk-throughs, 360-degree virtual tours, or other representations as determined by the team. The organizers will select a subset of submitted documentation for public distribution.

Format Requirements

☐	Packaged into a single, zipped file. If elements are hosted online, a link shall be included in the submission.
☐	Photographs shall be at least 1080 pixels in their shortest dimension and shall be accompanied by a file containing the name and affiliation of the photographer or graphic creator and identification of any individuals visible.
☐	Videos, if submitted, shall be wide-screen format and accompanied by a document including a verbatim transcript of the audio narrative to meet Section 508 compliance standards and identification of the creator and any individuals visible in the video. Closed-captioning does not need to be included within the video file. Permission must be provided for any copyrighted content or audio used as part of the video.
☐	File name abbreviation: RENDER

Content Requirements

☐	Teams shall submit a minimum of five images, with at least one exterior, one interior, and one bird's-eye view

Competition Prototype Graphic Floor Plan

The graphic floor plan is expected to be posted to the Solar Decathlon website and used in various communications materials to introduce the public to each competition prototype. The floor plan should be presented in a way to demonstrate the layout of the house, interior furnishings, and all site elements.

Format Requirements

☐	Natively generated vector PDF file
☐	File name abbreviation: FLOORPLAN

Content Requirements

☐	Complete floor plan showing all exterior elements, including landscaping, ramps, decks, and interior elements, including furniture and fixtures

Public Exhibit Materials

Format Requirements

☐	Packaged into a single bookmarked PDF file
☐	All public exhibit materials shall be represented at their full scale within the PDF; therefore, it is expected that the PDF may contain sheets at several different scales.
☐	File name abbreviation: EXHIBIT

Content Requirements

☐	Design of on-site signage, team handout, digital displays, or other products intended to convey information to the public
☐	Plan depicting location of all public exhibit materials
☐	Team uniform design
☐	Links to team website and/or social media properties

Team Roster

Format Requirements

☐	Packaged into a single Excel file
☐	File name abbreviation: Roster

Content Requirements

☐	The names of all team members expected to be present on-site, including students, faculty advisors, university staff, and any volunteers or industry members who will be directly supporting the team with on-site activities.
☐	The company name of all “vendors” of the team who will be present on-site, but with which the team has no more than a contractual relationship.

D6.5: Public Exhibit and Community Exhibition Strategy

The team shall submit an updated description of the project summary and submit all public exhibit materials the team plans to employ for organizer review of proper use of Solar Decathlon branding, sponsor recognition, content, and so on.

Updated Project Summary

Format Requirements

☐	Packaged into a single bookmarked PDF file
☐	10 pages maximum
☐	File name abbreviation: SUMMARY

Content Requirements

☐	An updated 100-word or less description of the team house. (1 paragraph)
☐	Design philosophy and house design, indicating goals, architectural style, target market, and so on. (1 page)
☐	Unique house features. What makes the house unlike any other? (1 page)
☐	Technological innovations incorporated into the house. (1–2 pages)
☐	Summary of public exhibit and community exhibition strategies planned and executed (1 page)
☐	Summary of all media coverage of the project and visitors to the home. (2 pages)
☐	Future plans for the house. Where will it go after the competition? (1 paragraph)
☐	Final details for the team's Community Exhibition (dates, times, location, parking, etc.) (1 paragraph)

Public Exhibit Materials

Format Requirements

☐	Packaged into a single bookmarked PDF file
☐	All public exhibit materials shall be represented at their full scale within the PDF; therefore, it is expected that the PDF may contain sheets at several different scales. If web content is created, create static versions for submission.
☐	File name abbreviation: EXHIBIT

Content Requirements

☐	Design of on-site signage, team handout, digital displays, or other products intended to convey information to the public
☐	Plan depicting location of all public exhibit materials
☐	Team uniform design
☐	Links to team website and/or social media properties

6.7 D7: Jury Documentation Deliverables

The Jury Documentation deliverables provide an opportunity for teams to present their projects to each jury. The jury deliverables are expected to provide a summary of each team's approach to meeting the contest requirements for each of the juried contests. The jury deliverables are reviewed by the respective jury prior to the competition. The narratives may include any combination of text and graphics. The narratives may link to multimedia hosted online, which are reviewed by jurors as time permits. The narratives will not be made public prior to the release of the respective contest results.

Jury Narratives

Format Requirements

☐	Packaged into a single bookmarked PDF file for each jury
☐	File name abbreviations: a) Architecture Jury: JURYARCH b) Engineering Jury: JURYENG c) Market Potential Jury: JURYMARKET d) Resilience Jury: JURYRESIL e) Financial Feasibility & Affordability Jury: JURYAFF f) Presentation Jury: JURYPRES

Content Requirements

☐	Architecture narrative, including architectural photography (10 pages maximum plus up to 10 photographs)
☐	Market Potential narrative (10 pages maximum)
☐	Resilience narrative (10 pages maximum)
☐	Engineering narrative, including energy analysis (10 pages maximum plus energy model, analysis and results) Note: energy model and analysis will also be used for calculating the team's score in the "Net-Zero Plus Energy" Subcontest
☐	Presentation narrative, including links to team website and/or social media accounts (10 pages maximum plus on-site public exhibit materials)
☐	Financial Feasibility and Affordability narrative (10 pages maximum plus cost estimate and appendices)

Final Drawings

Format Requirements

☐	Packaged into a single bookmarked PDF document
☐	Up to 150 pages
☐	ANSI D (22 in. x 34 in. [55.88 cm x 86.36 cm]) sheet size
☐	File name abbreviation: DRAWINGS

Content Requirements

☐	Complete construction drawings representing the as-built competition prototype house and with sufficient detail for a residential general contractor to build the house without additional input from the team.

Final Specifications

Format Requirements

☐	Packaged into a single bookmarked PDF document of sufficient detail for a residential general contractor to build the house without additional input from the team
☐	File name abbreviation: SPECS

Content Requirements

☐	Construction specifications

Audiovisual Presentation

Format Requirements

☐	Wide-screen, high-definition video file (such as .mov, .mp4, and so on)
☐	3-minute maximum length
☐	Accompanied by a document including a verbatim transcript of the audio narrative to meet Section 508 compliance standards and identification of the creator and any individuals visible in the video. Closed-captioning does not need to be included within the video file. Permission must be provided for any copyrighted content or audio used as part of the video.
☐	File name abbreviation: VIDEO

Content Requirements

☐	Must include video footage of the complete constructed house as built prior to the competition
☐	May contain still photos and graphics
☐	Gives the jurors a realistic preview of what they will experience during the on-site walk-throughs
☐	Includes an audio narrative that explains to viewers what they're seeing and describes the underlying philosophy behind the design and team approach to the competition

Team Roster

Format Requirements

☐	Packaged into a single Excel file
☐	File name abbreviation: Roster

Content Requirements

☐	The names of all team members expected to be present on-site, including students, faculty advisors, university staff, and any volunteers or industry members who will be directly supporting the team with on-site activities
☐	The company name of all "vendors" of the team who will be present on-site, but with which the team has no more than a contractual relationship.

6.8 D8: Final Report

The Final Report shall reflect the results of the team's Solar Decathlon project. It is used by the organizers to improve future events and provide lessons-learned opportunities.

Format Requirements

☐	Packaged into a single bookmarked PDF file
☐	20 pages maximum
☐	File name abbreviation: REPORT

Content Requirements

☐	Summary of fundraising activities—final project budget and lessons learned
☐	Results of media outreach activities, including statistics
☐	Results of on-site exhibition activities—estimates of the number of visitors, assessment of visitor experiences, and lessons learned (what went well, what didn't, and what you would do differently)
☐	Evaluation of the team's online presence, including statistics and lessons learned (what went well, what didn't, and what you would do differently)
☐	Team perspective on the effectiveness of the organizers' communications efforts with both the teams and the public
☐	Description of future plans for the house
☐	Short description of each team officer's future plans for employment, continued study, or other endeavors
☐	Suggested competition improvements
☐	Any other information you feel would be helpful to the organizers or future teams
☐	Contact list of all team members who worked on the project, including permanent (noncollegiate institution) email addresses

Glossary

Architecture Contest
A Contest that evaluates a building's architectural design for its creativity, overall integration of systems, and ability to deliver outstanding aesthetics and functionality along with energy-efficient performance

Build Area
The area containing the competition prototype for the Build Challenge

Build Challenge
A Challenge of the Solar Decathlon Competition that tasks teams to design, fund, build, operate, and present a complete house to the public

Build Challenge Manager
The head rules official responsible for writing and enforcing the rules and conducting the Build Challenge

Challenge
Each of two avenues of participation for Solar Decathlon Competition teams: the Design Challenge and the Build Challenge

Comfort & Environmental Quality Contest
A Contest that evaluates a building's capability to integrate comfort and indoor environmental quality with energy-efficient performance

Construction period
The period of time between the completion of the Construction Documentation activities and the beginning of the contests and local public exhibit period

Communications manager
The organizer responsible for the team's public outreach and communications activities

Communications materials
All printed or electronic publications designed to convey information to the public

Competition
All aspects of the Solar Decathlon related to the Challenges, the 10 Contests, and the scoring of those Contests within each Challenge

Competition prototype
The complete assembly of physical components installed within the solar envelope as part of the Build Challenge

Contest
The Solar Decathlon competition consists of 10 separately scored Contests

Decathlete
A team member who meets the decathlete eligibility rules, as defined in Section 2.3

Decision on the Solar Decathlon Rules
The Build Challenge Manager's interpretation or clarification of the Solar Decathlon Rules

Design Challenge
A Challenge of the Solar Decathlon Competition that tasks teams to design and present complete building designs

Director
The organizer representing the U.S. Department of Energy who has final decision-making authority regarding all aspects of the project

Dwelling unit
A single unit that provides complete independent living facilities for one or more people, including permanent provisions for living, sleeping, eating, cooking, and sanitation

Energy Performance Contest
A Contest that evaluates a building's energy use and production, as well as its capability to provide energy services—whether connected to the electricity grid or operating with on-site and/or stored power

Energy-positive house
A zero energy ready home that is so efficient it produces more energy than it consumes, leaving you with extra energy to use in other ways such as powering your mobile devices, power tools, or even your electric car

Engineering Contest
A Contest that evaluates the effective integration of high-performance engineering systems in energy-efficient and energy-producing buildings

Event production manager
The organizer responsible for the project's special events and volunteer activities associated with either the Competition Event or other Build Challenge Events

Event sponsor
An entity selected by Solar Decathlon organizers to help ensure the success of the project

Faculty advisor
A team member who is a faculty member and representative of a participating school in the project

Financial Feasibility & Affordability Contest
A Contest that evaluates a building's financial costs and ability to address growing affordability challenges in the housing industry

Finished area
The sum of the finished and conditioned areas measured at the floor level to the exterior finished surface of the outside walls

Groups.io Project Site
An online community forum that includes official communications suitable for viewing by all teams and organizers. The URL is https://solardecathlon.groups.io/g/2020BuildChallenge/topics

Industry partner
A business partner to the collegiate institution that offers expertise and experience to the project

Innovation Contest
A Contest that evaluates a design's success incorporating innovations and/or creative approaches that enhance energy efficiency, energy production, grid interaction, and building operations, as well as overall functionality and appeal

Juried contest
A contest with results based on a jury evaluation

Juror
An organizer selected by the appropriate Challenge Manager to participate as a member of a specific contest jury

Jury
A group of jurors evaluating a specific juried contest of the Build Challenge or a Division of the Design Challenge

Market Potential Contest
A Contest that evaluates a building's responsiveness to its stated target market, likely appeal to intended occupants and construction industry, and ability to transform how energy is used in buildings given its approach and wide-scale desirability

Measured Subcontest
A Subcontest with results based on task completion or monitored performance in the Build Challenge

Mixed-Use Multifamily
A blend of residential and commercial building area

Observer
An organizer, assigned by the Build Challenge Manager, to observe team performance and records the results of specific contest activities but does not provide interpretations of the Rules

Operations Contest
A Contest that evaluates how effectively and efficiently a building operates to carry out intended functions while also ensuring persistence of performance

Organizer
A DOE or NREL employee, subcontractor, juror, or observer working on the project

Personal protective equipment
Safety glasses, protective clothing, helmets, or other garments or equipment designed to protect the wearer's body from injury

Presentation Contest
A Contest that evaluates the team's ability to accurately and effectively convey its design and energy performance strategy to relevant audiences

Project
All activities related to the U.S. Department of Energy Solar Decathlon

Protest Resolution Committee
A group of three organizers selected by the Build Challenge Manager to resolve team protests in the Build Challenge

Public exhibit
Areas open to the public during designated hours as part of the Build Challenge

Qualified Electrical Worker
A team member who has the requirements for qualified electrical work on the build site

Resilience
The ability to anticipate, withstand, respond to, and recover from disruptions

Resilience Contest
A Contest that evaluates a building's ability to withstand and recover from prevailing disaster risks for its intended location, maintain critical operations during grid disruptions that commonly occur post-disasters, and ensure long-term durability in response to local climatic conditions

Rules
All principles or regulations governing conduct, action, procedure, arrangement, and so on, for the duration of the project, represented in aggregate by this Solar Decathlon Build Challenge Rules document (see separate Design Challenge Rules document as applicable)

Rules official
An organizer authorized to interpret the rules and officiate one or more of the contests

Scored period
Any 15-minute period beginning at 0, 15, 30, or 45 minutes after the hour

Scoring server
A server that collects data and calculates composite scores

Site operations manager
The organizer responsible for all event site operations

Solar Decathlon Building Code
A set of design and construction standards set forth for the protection of public health and safety

Solar Decathlon Building Official
The rules official responsible for writing, interpreting, and enforcing the Solar Decathlon Build Challenge Building Code

Sponsor
A business or organization that provides funds for the competition

Staff
An individual working for the organizers whose role is not described elsewhere in these definitions

Subcontest
An individually scored element within a contest

Team
The combination of team members representing a single entry to a Challenge of the competition

Team crew
A team member who is involved with a team's project who may be unaffiliated with a participating school

Team member
An enrolled student, recent graduate, faculty member, or other person who is affiliated with one of the participating schools and is integrally involved with a team's project activities; decathletes, faculty advisors, and team crew members are all considered team members

U.S. Department of Energy Solar Decathlon
A collegiate competition, comprising 10 Contests, that challenges student teams to design and build highly efficient and innovative buildings powered by renewable energy

Volunteer
An individual selected by the volunteer coordinator to support activities on the build site and whose role is not described elsewhere in these definitions

Volunteer coordinator
An organizer selected by the event production manager to manage volunteer activities on the build site

Prepared by the National Renewable Energy Laboratory (NREL)

NREL is a national laboratory of the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy

Operated by the Alliance for Sustainable Energy, LLC

For more information, visit: energy.gov/eere

DOE/GO-102021-5532 • February 2021