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 and jurors, and the building 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 developed and updated every year 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!
List of Acronyms

ADA  Americans with Disabilities Act
AH  Attached Housing
ANSI  American National Standards Institute
Btu  British thermal unit
cfm  cubic feet per minute
CO₂  carbon dioxide
dB  decibel
dBa  A-weighted decibels
DOE  U.S. Department of Energy
EHS  Environmental, Health, and Safety
ES  Elementary School
EUI  energy use intensity
HERS  Home Energy Rating System
HVAC  heating, ventilating, and air conditioning
Hz  hertz
ISO  International Organization for Standardization
kHz  kilohertz
kWh  kilowatt-hours
Leq  level equivalents
MM  Mixed-Use Multifamily
NAHB  National Association of Home Builders
NREL  National Renewable Energy Laboratory
OB  Office Building
OSHA  Occupational Safety and Health Administration
PPM  parts per million
PV  photovoltaic
RESNET  Residential Energy Services Network
SSF  Suburban Single-Family
USF  Urban Single-Family
Wh  watt-hours
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1 The New 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.

1.1 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 the DOE premier building competitions—Solar Decathlon and Race to Zero—during the past several years. This year, DOE is excited to merge these two successful collegiate design competitions into one Solar Decathlon.

This Solar Decathlon will offer 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 will be those teams that best blend architectural and engineering excellence with innovation, market potential, building efficiency, and smart energy production.

1.2 History

The award-winning Solar Decathlon began with a public event on the National Mall in Washington, D.C. in 2002. Since 2005, the Solar Decathlon has been held biennially in the United States for a total of eight competitions (through 2017), growing technology and workforce benefits with each event. The Solar Decathlon has also expanded internationally, including five international regions that have hosted their own events and have several more upcoming.

The Race to Zero competition began in 2014 and was held annually through 2018. The growth of this competition’s impact has been impressive, including an expansion to commercial buildings and more diverse residential building types, a rapid increase in the number of competing teams and participating students, and substantial integration of the program into collegiate institution curricula across the country.

1.3 Building Science to Ensure High-Performance Buildings

As with these past collegiate competitions, the new Solar Decathlon challenges students to fully integrate comprehensive building science with energy efficiency and renewable energy innovation. This will help 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 will have the opportunity to learn more about strategies for high performance, energy efficiency, and energy production than they would have otherwise gained in the classroom alone.

1.4 Two Challenges, Ten Contests

This Solar Decathlon, which spans 2019 and 2020, 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 six allowable building types to create their design. Teams entering the Build Challenge do not choose a building type (all teams build a residential building) but instead must choose to compete with a Local Build house or with a transportable National Showcase house. 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 these 10 Contests to be victorious. Figure 1 provides a graphic depiction of the various competition options.

![Solar Decathlon Competition Diagram](image)

**Figure 1. Structure of the Solar Decathlon**

1.5 Design Challenge (Annual)

Teams that compete in the annual Solar Decathlon Design Challenge must 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. The Design Challenge is similar to the previous Race to Zero Student Design Competition. Teams choose one of six 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 Section 2). A few key points are noted here:

- Design Challenge teams choose to compete in one of six Divisions:
  - Suburban Single-Family
• Teams may apply and begin projects as early as August of the preceding challenge year (for example, beginning in August 2018 for the 2019 Design Challenge). All teams that apply by the November deadline are accepted to participate through the following February. For the Design Challenge application, each team:
  - Identifies a faculty or student team lead with a preliminary roster of student team members
  - Selects the Division in which it intends to compete
  - Submits an optional five-page Project Introduction
  - Pays a nonrefundable $100 application fee.

• Participating teams are confirmed and announced by December.

• Participating teams each submit a Project Progress Report the following February for evaluation.
  - Up to 48 finalist teams, eight in each of six Divisions, are selected and invited to compete further with a final Project Report and Presentation of their design at the Design Challenge Weekend, held annually in April at the National Renewable Energy Laboratory (NREL) main campus in Golden, Colorado.

  - For this coming cycle, teams that apply in November 2018 and are selected to proceed after submitting their Project Progress Report in February 2019 will be invited to complete their project in March and then present at the Design Challenge Weekend at NREL in April 2019.

• Six winners—one from each Division—are determined by juried evaluation across all 10 Contests and awarded with trophies at the annual Design Challenge Weekend. A Design Challenge Grand Winner is also selected from the pool of six winners and provided with a special award.

1.6 Build Challenge (Biennial)

Teams that compete in the Solar Decathlon Build Challenge must design and construct fully functional houses. Teams choose to build a house compliant with the guidelines of one of two Divisions: the National Showcase or the Local Build. In the National Showcase Division, teams build a small house that will ultimately be displayed and operated as part of the Smithsonian Folklife Festival in June and July 2020 on the National Mall in Washington, D.C. In the Local Build Division, teams build, display, and operate houses in their own communities and bring a smaller representative exhibit to the Smithsonian Folklife Festival. All teams compete against each other, equally, regardless of Division.
Teams interested in participating in the Build Challenge should read carefully the Solar Decathlon Build Challenge Rules (see Section 3). A few key points are noted here:

- Applying teams choose to design and build a house for one of two Divisions:
  - Local Build
  - National Showcase

- Interested teams may begin projects as early as August 2018 and must apply by December 10, 2018. Based on the submitted applications, DOE expects to select approximately six teams to proceed in each of the two Divisions (i.e., 12 teams compete over the 2-year Challenge.)

- For the Build Challenge application, each team:
  - Identifies a faculty or student team lead with a preliminary roster of student members
  - Selects the Division in which it intends to compete
  - 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.

- Teams selected to proceed are announced in January 2019. Teams that are not selected have the option to enter the Design Challenge, with no additional application fee.

- Accepted teams are eligible for prize funding; additional details are available on the Solar Decathlon website.

- All selected Build Challenge teams are required to submit a variety of interim deliverables and present their designs and other required materials at the Design Challenge Weekend, held in April 2019 at the NREL main campus in Golden, Colorado.

- All Build Challenge participants will exhibit and compete as part of the Smithsonian Folklife Festival in the summer of 2020 and may optionally participate in additional public and industry events, to be specified along with prize funding.

- Winners will be awarded trophies at the biennial Build Challenge Event, held in June and July as part of the 2020 Smithsonian Folklife Festival in Washington, D.C. Awards will be determined based on the combined scores of the 10 Contests.

### 1.7 Ten Contests

Teams 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 (Section 2) and Solar Decathlon Build Challenge Rules (Section 3) for specific criteria.
1. **Energy Performance**
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. Energy performance is verified by evaluating building loads and 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 its overall energy performance. Finally, thoughtful selection and operation of lighting, plug loads, appliances, and other components is increasingly important, because they commonly represent more than 50% of total energy consumption in high-performance buildings.

2. **Engineering**
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 designs should reflect thoughtful consideration of different technologies 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.

3. **Financial Feasibility & Affordability**
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 that 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.

4. **Resilience**
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 postdisasters, and ensure long-term durability in response to local climatic conditions.
Resilience is the ability to anticipate, withstand, respond to, and recover from disruptions.\(^1\) The benefits of investing in highly efficient buildings are protected by also investing in resilient design. Buildings must demonstrate how they effectively address all these challenges.

5. **Architecture**

This Contest evaluates the building’s 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.

6. **Operations**

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.

7. **Market Potential**

This Contest evaluates the 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.

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 needs and 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.

8. **Comfort & Environmental Quality**

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

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\(^1\) [https://www.nrel.gov/resilience-planning-roadmap/](https://www.nrel.gov/resilience-planning-roadmap/)
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.

9. Innovation

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.

10. Presentation

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.

1.8 Choose Your Challenge

Take a careful look at the Challenges as summarized previously in Figure 1 and the considerations for Challenge participation noted in Table 1 below. Choose the Challenge that is best suited to your team. National and international teams of all collegiate levels are welcome to apply, as are teams representing multiple collegiate institutions. Within the Design Challenge ONLY, 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 Challenge to participate in, consult the detailed Rules for that specific Challenge and Division in this Guide. A collegiate institution may have teams participating in both the Build Challenge and the Design Challenge, potentially with multiple teams in the Design Challenge.
Table 1. Considerations for Challenge Participation

<table>
<thead>
<tr>
<th>Consideration</th>
<th>Design Challenge</th>
<th>Build Challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope of project</td>
<td>Design only</td>
<td>Design, build, and exhibit</td>
</tr>
<tr>
<td>Team commitment</td>
<td>One to two semesters</td>
<td>Two (or more) years</td>
</tr>
<tr>
<td>Building type</td>
<td>Residential and commercial</td>
<td>Residential</td>
</tr>
<tr>
<td>Exhibit activities</td>
<td>No public events; exhibit and presentations only open to participants</td>
<td>Public and industry showcase events</td>
</tr>
</tbody>
</table>
| Financial resources required            | Student(s) and faculty travel to Design Challenge Weekend (NREL; Golden, Colorado; April 2019) | • Cost of building house (can be through mix of collegiate institution, alumni, industry partner, and corporate or other sponsorship); partially offset by prize funding  
• Student and faculty travel to multiple events, including Design Challenge Weekend (NREL; Golden, Colorado; April 2019) and Smithsonian Folklife Festival (Washington, D.C., June-July 2020); select top-performing teams will be invited to exhibit at the National Association of Home Builders (NAHB) International Builders’ Show in February 2021 in Orlando, Florida. |
| Financial resources provided by competition organization | None                                                   | Cash awards to each team vary by Division and are provided in stages following progress checks. Cash awards will not be tiered based on scoring or ranking; they will be the same for all teams within each Division. Additional information is available on the Solar Decathlon website. |

All these competition options are designed to integrate into a variety of collegiate curricula and provide 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.

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2 NAHB International Builders’ Show Website: [https://www.buildersshow.com/Home/](https://www.buildersshow.com/Home/)
2 Solar Decathlon Design Challenge Rules

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

The Design Challenge is meant to encourage student participation for one or two academic semesters. Participants prepare creative solutions for real-world issues in the building industry. Qualifying teams complete a design project and attend the 2019 Design Challenge Weekend, where they present their designs to a panel of industry expert jurors, compare their projects to those of other teams, learn from presentations by thought leaders and collegiate peers, tour NREL facilities, and engage with a variety of organizations about careers in the energy industry. Winning teams are recognized at an Awards Banquet, and winning Project Presentations 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 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 knowledgeable future design and construction professionals.

2.1 Summary of Important Dates

Please note the following key milestones for the 2019 Design Challenge:

- **August 2018**: The 2019 Design Challenge Rules are released; the team application is available on the Solar Decathlon website.
  - After a team completes its application, it 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 communication with teams is the Groups.io Project Site, an online forum for participating students to receive timely information from organizers and access necessary resources.

- **Nov. 6, 2018, 5 p.m. Eastern Standard Time (EST)**: All teams must submit their team application by this deadline. The application must indicate which Division the team wants to enter. Teams can also submit an optional five-page Project Introduction, as detailed in Section 2.6.1. All teams that complete and submit their application by this deadline will be accepted as participants.
  - Teams that submit the optional Project Introduction will receive feedback on project compliance. See the requirements for the Project Introduction in Section 2.6.1.
  - Each team must pay a nonrefundable $100 fee, identify a faculty lead or student team lead, and submit a preliminary roster of student team members.


- **Feb. 19, 2019, 5 p.m. EST**: All teams must complete the Project Progress Report, confirm 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 by this deadline.

- The Project Progress Report, as detailed in Section 2.6.2, must be submitted via the file submission link posted to the Groups.io Project Site.
- Submissions are evaluated against criteria indicated in Section 2.6.2. Based on the Project Progress Report evaluation, up to eight teams per Division are invited to participate in the final competition.
- Teams not invited to participate as finalists in the Design Challenge Weekend are encouraged to complete their designs and the associated submissions. In such cases, one team member from each nonselected team may be invited to attend the final competition event and present a Project Poster.
- Design Challenge Weekend registration opens with the announcement of finalist teams. Up to five students, along with one faculty lead and/or advisor from each team, may attend in person.

**March 26, 2019, 5 p.m. Eastern Daylight Time (EDT):** Teams must submit their Project Report by this deadline.

- The Project Report, as detailed in Section 2.6.3, must be submitted via the file submission link posted to the Groups.io Project Site.
- 2019 Design Challenge Weekend registration closes. On-site or late event registration will not be offered.

**April 9, 2019, 5 p.m. EDT:** Teams must submit their Project Presentations (both Division and Grand Jury presentations) and optional Project Posters, as detailed in Sections 2.6.4 and 2.6.5, respectively, via the file submission link posted to the Groups.io Project Site. Presentations are not accepted after this date.

**April 12–14, 2019:** Finalist teams present to industry leaders at the Design Challenge Weekend on the NREL main campus in Golden, Colorado. Teams also participate in related competition weekend events. Design Challenge winners are announced.

**May 30, 2019:** The Faculty Report, as detailed in Section 2.6.6, is due to the organizers via email at SDdesign@nrel.gov.

### 2.2 Design Challenge Description

#### 2.2.1 Task Overview

- Read these Challenge Rules and form a team.
- Review [2018 winning teams’ presentations](#), [2018 event photographs](#), and the [Solar Decathlon website](#) to inform efforts.
- Submit a team application with a team roster using the instructions in the [team application site](#).
- For communications and questions, email the organizers. The Design Challenge email is SDdesign@nrel.gov.
• Ensure all team members have access to the Solar Decathlon Groups.io Project Site where competition updates, including attachments, are posted regularly. Within the Groups.io Project Site, there is a subgroup specifically for the Design Challenge.

• Ensure that all student team members complete the on-demand building science training course online or receive 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; air flow control; heat flow control; vapor and condensation control; roofs; ventilation and air pressure management; windows; durable, healthy, efficient housing; unique solutions (optional); multifamily/multiunit housing (optional); elementary schools (optional); OpenStudio (optional); REM/Rate™ (optional); and buildings and the grid (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 topical webinars as advertised on the Groups.io Project Site for technical, design, and competition guidance. These webinars are also available as recordings posted to the Project Site if attendance is not possible.

• Design and document a project compliant with the requirements listed in these Rules.

• Submit all materials by the deadlines. Note that all deadlines are 5 p.m. Eastern Time.

2.2.2 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 three students, with one student designated as the student team lead. Teams are encouraged to be multidisciplinary. Multiple collegiate institutions may combine to form teams. A collegiate institution may only submit one team application per Division (see Section 2.3.1). A team may choose to have several internal groups of students complete designs and then submit only one project design when the submission deadlines occur. The team application costs $100 per team and is nonrefundable. If a school has multiple teams compete in the Solar Decathlon, across the Design and Build Challenges, each team must have distinct designs and unique team leads and team members. A faculty advisor may counsel multiple teams.

If a team member who is not a U.S. citizen wants to participate in person at the Design Challenge Weekend held at the NREL campus, he or she must submit a Foreign National Data Card. Additional information and requirements are on the online team application site and the Groups.io Project Site.
2.2.3 Student Qualifications
Great teams are cross-functional. Student team members can be from any discipline and any level of collegiate schooling. Past teams have included students who majored in fields such as architecture, engineering, building science, construction management, interior design, marketing, management, and landscape architecture. Each student must be pursuing a degree and enrolled in at least one class at a participating collegiate institution at the time of the Design Challenge Weekend.

2.2.4 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; however, one faculty lead must be designated to serve as a primary contact, oversee the team, and maintain responsibility for verifying that participating students complete the building science training or equivalent curriculum. The faculty lead is encouraged to closely engage with the students on the project. The faculty lead provides support in many areas, including:

- Ensuring familiarity with the Design Challenge Rules and Challenge-specific guidance, as appropriate
- Making sure that all student team members complete the building science training. The faculty lead must ensure that the team meets this requirement 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 who will be on-site at the Design Challenge Weekend. The faculty advisors may attend the competition in person or join the presentation remotely, subject to participant constraints outlined in Section 2.3.2.

2.2.5 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 design.

For the design of the buildings, 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.

2.3 Design Challenge Project Requirements
Designs should represent a high-performance building so energy-efficient that a renewable energy system could offset all the building’s annual energy consumption. Along with achieving this level
of performance, teams demonstrate the effective integration of building science principles and best practice guidelines for the building enclosure and mechanical systems.

Teams may develop projects based on updates of existing professional designs or develop original work. Projects must be substantially different from any submitted to DOE competitions in the past. Teams may also retrofit or modernize an existing building. Eligible scenarios are varied, though the submission must conform to the listed conditions.

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. 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 Report.

**Note:** 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. Example: 38.1 meters (m) (125 feet [ft]). 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.

### 2.3.1 Design Challenge Divisions

Teams participating in the Design Challenge compete in one of six Divisions. In all Divisions, maximizing energy performance of the designed building is critical to success. Energy-efficiency decisions significantly impact virtually all design decisions and submissions associated with the project. Project designs should 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.

Each collegiate institution may submit up to six applications, but not more than one team in any Division. Only one design per team may be submitted to the organizers at the Project Progress Report and Project Report deadlines. If more than one is submitted, the organizers will review only the last-received file from that team. A design can only be used for one active application. Any school that has multiple teams must have substantially different designs for each, regardless of Challenge or Division.

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 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 (SSF)**

The parameters for the Suburban Single-Family (SSF) Division of the Design Challenge follow:

1. Building Size: 1,000–3,000 square feet (ft²) (93–279 square meters [m²])
2. Lot Size: At least 4,000 ft² (372 m²)
3. Meets or exceeds the [DOE Zero Energy Ready Home National Program Requirements (Rev. 06)]

**Urban Single-Family (USF)**
The parameters for the Urban Single-Family (USF) Division of the Design Challenge follow:

1. Building Size: 300–2,500 ft² (56–232 m²)
2. Lot Size: Up to 5,000 ft² (465 m²)
3. Meets or exceeds the [DOE Zero Energy Ready Home National Program Requirements (Rev. 06)]

**Attached Housing (AH)**
The parameters for the Attached Housing (AH) Division of the Design Challenge follow:

1. Row homes or flats, 2–12 dwelling units, up to three stories above grade
2. Building Size: 500–2,500 ft² (46–232 m²) per dwelling unit
3. Lot Size: Up to 3,000 ft² (279 m²) per dwelling unit
4. Meets or exceeds the [DOE Zero Energy Ready Home National Program Requirements (Rev. 06)]

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

1. Minimum of eight dwelling units, 3–5 stories above grade
2. Building Size: 350–2,000 ft² (33–186 m²) 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. 06)]
5. At least 80% of the building must be used for multifamily dwelling units
6. For the commercial portion of building, the source energy use intensity (EUI) must be less than the source EUI target shown in Section 2.3.2.

**Elementary School (ES)**
The parameters for the Elementary School (ES) Division of the Design Challenge are below. An ES is defined as a complete educational facility for grades kindergarten through fifth, and it 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 in grades kindergarten through fifth
2. Students per classroom: 20–30
3. Lot Size: 15 acres (60,703 m²) 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 2.3.2.

Office Building (OB)
The parameters for the Office Building (OB) Division of the Design Challenge 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: 30,000–80,000 ft² (2,787–7,432 m²) comprising 2–5 stories
2. 250–350 gross ft² (23–33 m²) per person
3. Lot Size: Up to three acres (12,141 m²)

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, trash, and recycling services
   v. Break rooms with kitchenettes

5. The source EUI target before renewables must be less than that shown in Section 2.3.2.

2.3.2 Additional Information for Evaluating Building Energy Performance
Energy-efficiency optimization can be conducted through a variety of software programs. Tools and resources for these calculations are provided in the Resources document on the Groups.io Project Site.

Total Area
A dwelling unit, as defined by the 2015 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: American National Standards Institute
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.

For commercial buildings, gross area is calculated as the total conditioned space within the exterior dimension of the finished space enclosed by the outside walls.

**Home Energy Rating System Index**

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 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. One of the RESNET-accredited programs, REM/Rate, is provided to teams at no charge after completing the team application; however, using it is not required.

**Energy Use Intensity**

Building-energy consumption is often evaluated based on EUI, which is measured as the total annual energy consumed annually divided by the gross floor area (kilo-British thermal unit per square foot [kBtu/ft²·yr]). These numbers can be calculated with respect to site energy as well as source 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. 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. It is calculated by taking the site energy and applying a site-to-source multiplier for each energy source.3

Commercial 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 [Btu]/ft² or kilo-Btu/m²). These numbers can be calculated with respect to source energy as well as site energy. 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.4 Alternative metrics for comparison are also useful, such as energy divided by total students (kilo-Btu/student). Target EUIs based on source energy for elementary schools, mixed-use multifamily, and offices are shown in Table 2.

These EUI values include all building loads, including plug loads and heating, ventilating, air conditioning, and lighting. Plug loads include vertical transportation and any other load in the building. The targets do not include exterior lighting loads. They are covered in Table 3.

---

3 For the calculation methodology on calculating source energy from site energy, see [https://buildingdata.energy.gov/cbrd/resource/1938](https://buildingdata.energy.gov/cbrd/resource/1938).

4 See “A Common Definition for Zero Energy Buildings” for calculating EUI.
Table 2. Source Energy\(^5\) Use Intensity Targets for Elementary Schools,\(^6\) Mixed-Use Multifamily Buildings with a Commercial Retail or Office Space,\(^7\) and Office Buildings\(^8\)

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Elementary School Source Energy (kBtu/ft(^2)-yr)</th>
<th>Mixed-Use Multifamily Source Energy (kBtu/ft(^2)-yr)</th>
<th>Office Building Source Energy (kBtu/ft(^2)-yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0A</td>
<td>69</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>0B</td>
<td>71</td>
<td>96</td>
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</tr>
<tr>
<td>1A</td>
<td>66</td>
<td>81</td>
<td>81</td>
</tr>
<tr>
<td>1B</td>
<td>67</td>
<td>89</td>
<td>89</td>
</tr>
<tr>
<td>2A</td>
<td>64</td>
<td>77</td>
<td>77</td>
</tr>
<tr>
<td>2B</td>
<td>60</td>
<td>79</td>
<td>79</td>
</tr>
<tr>
<td>3A</td>
<td>57</td>
<td>74</td>
<td>74</td>
</tr>
<tr>
<td>3B</td>
<td>58</td>
<td>73</td>
<td>73</td>
</tr>
<tr>
<td>3C</td>
<td>53</td>
<td>55</td>
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<td>4A</td>
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<td>75</td>
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<td>4B</td>
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<td>71</td>
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<tr>
<td>4C</td>
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<td>5B</td>
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<td>5C</td>
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</tr>
<tr>
<td>8</td>
<td>71</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

*Note: 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; and heating, ventilating, air conditioning, and lighting.

Table 3. Exterior Lighting Allowances for Mixed-Use Multifamily, Elementary Schools, and Office Buildings

<table>
<thead>
<tr>
<th>Exterior Location</th>
<th>Lighting Power Allowance</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entry doors</td>
<td>13 W*/linear foot of doorway</td>
<td>Dusk to dawn, reduction of 75% when no motion detected</td>
</tr>
<tr>
<td>Exterior stairs</td>
<td>0.70 W/ft(^2)</td>
<td>Dusk to dawn, reduction optional depending on local codes</td>
</tr>
<tr>
<td>Walkways</td>
<td>0.10 W/ft(^2)</td>
<td>Dusk to dawn, reduction of 75% when no motion detected</td>
</tr>
<tr>
<td>Driveways and parking lots</td>
<td>0.04 W/ft(^2)</td>
<td>Dusk to dawn, reduction of 75% when no motion detected</td>
</tr>
</tbody>
</table>

*W = watt

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\(^5\) Source energy is calculated by taking the site energy and applying a site-to-source multiplier for each energy source.

\(^6\) This is adapted from the “Advanced Energy Design Guide for K–12 School Buildings: Achieving Zero Energy”; see [www.ashrae.org/aedg](http://www.ashrae.org/aedg).

\(^7\) This is based on a simulation result for office and light retail. Documentation is not available at this time.

\(^8\) This is based on preliminary simulations for the “Advanced Energy Design Guide for Small to Medium Office Buildings: Achieving Zero Energy,” due to be released June 2019.
**OpenStudio**

OpenStudio® is an energy simulation software used to model complex integration of daylighting, lighting, and heating and cooling equipment often found in commercial buildings. It has an intuitive graphical user interface that helps users navigate through different inputs for the energy model. A unique feature of OpenStudio is that it provides the capability to quickly implement different energy efficiency and energy conservation strategies using a set of instructions called measures. It can be used to evaluate the impact of energy efficiency and energy conservation strategies on the EUI of the building and ensure that it is along the path to zero energy. OpenStudio is free to download; however, using it is not required.

### 2.3.3 Design Challenge Weekend Details

Based on the quality of the Project Progress Reports submitted in February 2019, up to 48 Design Challenge finalist teams will be invited to attend and compete in the Design Challenge Weekend in April. This event provides a rich experience for on-site participants to engage in networking opportunities and attend other team and professional presentations. Each team is expected to send at least one student and one faculty advisor to the competition. A team may send up to six team members total, including one spot reserved for a faculty advisor.

Teams that complete the Project Progress Report but are not selected to participate as finalists at the Design Challenge Weekend are invited to send one attendee to the competition to present a Project Poster, as outlined in Section 2.6.5, provided the team submits a complete Project Report on time.

We encourage all students who are on-site to participate in the team presentation; faculty may not participate in the team presentation.

The organizers do not provide financial assistance for lodging or travel expenses. A block of rooms at a hotel near the NREL campus will be available at a discounted rate. Meals and snacks will be provided at no cost over the weekend through organizer sponsorships. More information will be provided via the Groups.io Project Site prior to the event.

When registering for the Design Challenge Weekend, teams are expected to indicate interest in bringing an architectural-scale model, wall section, or related exhibit. The models may be on display during the team’s Division presentation and the Poster Session. These models are optional; all shipping/transportation costs are the responsibility of the teams.

### 2.4 Design Challenge Contests

Projects submitted to the Design Challenge demonstrate competency by applying principles of building science and best practice solutions. Teams are assessed on their Project Report 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.
The project submissions are evaluated by jurors according to the 10 Contests in Table 4. All contests are equally weighted. More details on each contest are provided in the following sections (Sections 2.4.1 through 2.4.10).

<table>
<thead>
<tr>
<th>Table 4. Contests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contests</td>
</tr>
<tr>
<td>1. Energy Performance</td>
</tr>
<tr>
<td>2. Engineering</td>
</tr>
<tr>
<td>3. Financial Feasibility &amp; Affordability</td>
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<tr>
<td>4. Resilience</td>
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<tr>
<td>5. Architecture</td>
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<tr>
<td>6. Operations</td>
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<tr>
<td>7. Market Potential</td>
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<tr>
<td>8. Comfort &amp; Environmental Quality</td>
</tr>
<tr>
<td>9. Innovation</td>
</tr>
<tr>
<td>10. Presentation</td>
</tr>
</tbody>
</table>

### 2.4.1 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. Energy performance is verified by measuring building loads and 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 its overall energy performance. Finally, thoughtful selection and operation of lighting, plug loads, appliances, and other components are increasingly important, because they commonly represent more than 50% of total energy consumption in high-performance buildings.

**Design Challenge Criteria**

The jury evaluates each submission according to the following criteria:

- Comprehensive energy analysis showing the optimal interaction of efficiency features
- Optimization of lighting system effectiveness and energy efficiency to provide ambient, task, and mood lighting fully integrated with natural lighting
- Strategy for reducing plug loads and appliance loads
- Grid-interaction capabilities to include responsiveness of appliances to electric grid conditions to avert system stress and enhance grid reliability
• Strategies and design modifications for effectively integrating renewable energy
generation (on-site or off-site) sufficient to achieve zero annual energy use and offset
nonrenewable energy sources
• The final designed energy performance index score calculated with and without
renewable energy.9

2.4.2 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 designs
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.

Design Challenge Criteria
The jury evaluates each submission according to the following criteria:

• Overall approach addressing engineering challenges integrating structural, mechanical,
  electric, plumbing, energy production, and control systems in design
• Space-conditioning system integration within the building’s structural system
• Plumbing system layout for efficient hot water delivery and landscaping system for
  minimizing water use for irrigation
• 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
• Overall design principles of the water system, including the selection of water
  conservation fixtures, estimated loads, water heating equipment, supply piping, rainwater
  or gray water systems, and the hot water plumbing layout to minimize wait time, losses,
  and wasted water.

2.4.3 Financial Feasibility & Affordability

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

9 For residential buildings, use a HERS score. For commercial buildings, use the EUI. Mixed-use multifamily
buildings should use the approach that is most appropriate for their specific building.
The purpose of this Contest is to ensure that 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. A financial analysis document will be available on the Groups.io Project Site, for reference.

**Design Challenge Criteria**

The jury evaluates each submission according to the following criteria:

- Affordability/up-front cost of the design to the target market
- Quality of the financial feasibility analysis
- Rationality of the operational and maintenance cost estimate.

### 2.4.4 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 postdisasters, 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 these challenges.

**Design Challenge Criteria**

The jury evaluates each submission according to the following criteria:

- Building design details and construction practices to ensure moisture durability by integrating all four building science control layers (thermal, air, bulk moisture, and moisture vapor)
- Building design approach for the specified location to withstand and recover from potential disasters because of risks posed by weather, other natural or man-made events, and pests
- Building design approach for resilience that ensures the ability to meet critical loads after a disaster event or supply outage.

### 2.4.5 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.

Design Challenge Criteria
The jury evaluates each submission according to the following criteria:

- Quality of the design and project appearance, including quality of floor plan and interior details for flow, furnishings, storage, linkages to outdoors, and efficient use of space
- Effectiveness in integrating energy efficiency, building science principles, and energy production technology
- Effective use of natural methods to meet heating, cooling, and lighting needs
- Optimal use and consideration of specified site, including views, drainage, regionally appropriate materials, and community connection
- Effective integration of climatic considerations, including site design
- Overall ability for design to effectively enhance the life of intended occupants
- Interior design’s functionality, attractiveness, and enhancement of the occupants’ quality of life, health, and well-being.

2.4.6 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.

Design Challenge Criteria
The jury evaluates each submission according to the following criteria:

- Appliance (e.g., kitchen, hot water, laundry, lighting) selection and design integration for optimum efficiency and convenience
- Optimized domestic hot water delivery equipment selection and performance
- Effective integration of electric car charging system, where applicable
- Advanced smart building control technologies for appliances, equipment, security, and lighting systems that fully integrate with utility demand response programs and provide optimized convenience and safety
• Effective strategies for minimizing occupant maintenance.

2.4.7 Market Potential

Contest Intent

This Contest evaluates the 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.

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.

Design Challenge Criteria

The jury evaluates each submission according to the following criteria:

• How well the design reflects current market expectations for livability and convenience
• Effectiveness of drawings and documentation to demonstrate construction materials and practices conducive to housing industry adoption at scale
• Effectiveness of team market analysis and how well the design integrates key findings
• Ability to leverage growing interest in off-site construction or other innovations to improve quality, cost, and productivity
• Extent to which the interior design complements the exterior architecture
• Appropriateness, effectiveness, and attractiveness of the building’s floor plan to the intended occupant(s).

2.4.8 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.
Design Challenge Criteria
The jury evaluates each submission according to the following criteria:

- Complete heating, ventilating, and air-conditioning (HVAC) system design, including load calculations, equipment sizing, and duct sizing
- Effectiveness of strategy to ensure relative humidity control in humid climates with either dehumidification integrated into the HVAC system or an independent whole-building dehumidification system
- Comprehensive source control of contaminants, including chemicals, dust, pollen, biologicals, radon, and moisture through material selection, details, and construction practices
- Overall approach to high-capture filtration and whole-building ventilation
- Strategies for spot ventilation controlling moisture in bathrooms, as well as moisture and particulates from cooking in kitchens
- Strategies for controlling unwanted interior and exterior sources of noise
- Operations and maintenance strategy to ensure persistence of comfort and environmental quality performance.

2.4.9 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.

Design Challenge Criteria
The jury evaluates each submission according to the following criteria:

- Approach to integration of innovations
- Use of research and analysis
- Validation of innovation through collaboration with industry partners
- Alignment of innovations with intent
- Projected long-term impact of team innovation(s).
2.4.10 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.

Design Challenge Criteria

The jury evaluates each submission according to the following criteria:

- Completion and quality of project submissions relative to how effectively they convey the design solution
- Quality of presentation package, spoken remarks, and any visual aids (if applicable) relative to how effectively they convey the design solution
- Effectiveness of responses to juror questions that demonstrate a command of the design solution
- Timeliness of project submissions.

2.5 Design Challenge Evaluation Process

The evaluation process is multifaceted and includes the following:

- Division juries (each with 3–5 jurors) assess the team designs.
- One jury convenes for each of the Divisions. Each juror reviews up to eight Project Reports within his or her assigned Division.
- Individual Division jurors determine preliminary evaluation results based on the Project Reports.
- Preliminary team evaluation results are modified by the jurors based on the Project Presentations and associated question-and-answer period.
- Division juror panels select first-place award winners in each Division based on the following attributes:
  - Excellence in meeting the overall design intent of the competition
  - Excellence in understanding the contest criteria subject areas.
- If the first-place award winners of a Division are graduate student teams, then the jurors also select a top undergraduate team award winner.
- Each first-place team delivers an 8-minute short version of its full presentation at the Awards Banquet for evaluation by the Grand Jury, which chooses a Grand Winner according to the process described in Section 2.5.2.
• Division jurors develop written feedback for the teams that is shared with the teams within 2 weeks of the Design Challenge Weekend’s conclusion.

2.5.1 Evaluation Rating Scale
The jury scores each contest according to the following scale:

<table>
<thead>
<tr>
<th>Evaluation Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>MISSES EXPECTATIONS: Missing all items; no explanation of how the design addresses the criteria</td>
</tr>
<tr>
<td>APPROACHES EXPECTATIONS: Missing some items; minimal explanation of how the design addresses the criteria</td>
</tr>
<tr>
<td>MEETS EXPECTATIONS: All minimum requirements met; acceptable explanation of how the design addresses the criteria</td>
</tr>
<tr>
<td>EXCEEDS EXPECTATIONS: All minimum requirements met; full demonstration of how the design solution addresses the criteria</td>
</tr>
<tr>
<td>ECLIPSES EXPECTATIONS: All minimum requirements met; distinguished excellence in the explanations describing how the design exceeds the criteria</td>
</tr>
</tbody>
</table>

2.5.2 Grand Jury Award
A Grand Jury selects a Grand Winner from among the first-place teams based on the 8-minute presentations given at the Awards Banquet.

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

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

• Level of inspiration
• Attractiveness of the solution to the team-defined target market
• Ability to integrate comprehensive energy efficiency
• Cost-effectiveness
• Responsiveness of design to community, occupant, and climatic factors
• Architectural design aesthetics and functionality
• Constructability
• Innovation
• Presentation quality.

The Grand Jury evaluates each of these criteria on the scale shown in Table 5 to facilitate its selection of the Grand Winner.
## 2.6 Design Challenge Deliverables

Throughout the Design Challenge, the organizers will require teams to submit deliverables necessary for evaluating teams’ progress and design. The Design Challenge deliverables, file naming conventions, and due dates are listed in Table 6.

<table>
<thead>
<tr>
<th>Deliverable</th>
<th>Required Content</th>
<th>File Name</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Introduction (Optional)</td>
<td>Single, bookmarked PDF</td>
<td>DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]<em>INTRO</em> [SUBMISSION DATE (YYYY-MM-DD)][.EXTENSION]</td>
<td>Nov. 6, 2018, 5 p.m. EST</td>
</tr>
<tr>
<td>Project Progress Report</td>
<td>Single, bookmarked PDF</td>
<td>DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]<em>PROGRESS</em> [SUBMISSION DATE (YYYY-MM-DD)][.EXTENSION]</td>
<td>Feb. 19, 2019, 5 p.m. EST</td>
</tr>
<tr>
<td>Project Report</td>
<td>Single, bookmarked PDF</td>
<td>DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]<em>REPORT</em> [SUBMISSION DATE (YYYY-MM-DD)][.EXTENSION]</td>
<td>March 26, 2019, 5 p.m. EDT</td>
</tr>
<tr>
<td>Supplemental Documentation (Optional)</td>
<td>Single, bookmarked PDF</td>
<td>DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]<em>SUP</em> [SUBMISSION DATE (YYYY-MM-DD)][.EXTENSION]</td>
<td>March 26, 2019, 5 p.m. EDT</td>
</tr>
<tr>
<td>Project Images</td>
<td>Three images as files such as .jpg, .tiff, or .png</td>
<td>PHOTO1, PHOTO2, TEAMPHOTO e.g.: DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]<em>PHOTO1</em> [SUBMISSION DATE (YYYY-MM-DD)][.EXTENSION]</td>
<td>March 26, 2019, 5 p.m. EDT</td>
</tr>
<tr>
<td>Division Presentation</td>
<td>PDF and/or PPTX</td>
<td>DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]<em>PRESDIV</em> [SUBMISSION DATE (YYYY-MM-DD)][.EXTENSION]</td>
<td>April 9, 2019, 5 p.m. EDT</td>
</tr>
<tr>
<td>Grand Winner Presentation</td>
<td>PDF and/or PPTX</td>
<td>DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]<em>PRESGRAND</em> [SUBMISSION DATE (YYYY-MM-DD)][.EXTENSION]</td>
<td>April 9, 2019, 5 p.m. EDT</td>
</tr>
<tr>
<td>Project Poster (Optional)</td>
<td>Single, PDF</td>
<td>DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]<em>POSTER</em> [SUBMISSION DATE (YYYY-MM-DD)][.EXTENSION]</td>
<td>April 9, 2019, 5 p.m. EDT</td>
</tr>
<tr>
<td>Faculty Report</td>
<td>Single, bookmarked PDF</td>
<td>DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]<em>FACULTY</em> [SUBMISSION DATE (YYYY-MM-DD)][.EXTENSION]</td>
<td>May 30, 2019, 5 p.m. EDT</td>
</tr>
</tbody>
</table>
See Section 2.6.1 below for the requirements for each Design Challenge deliverable, as well as instructions for their submission.

2.6.1 Project Introduction Submission Instructions

The Project Introduction provides the information necessary to communicate the salient points of the projects to all competition participants. It should be considered a high-level summary to describe the project with key points.

Teams submit the optional Project Introduction first as a stand-alone document and then integrate it into the Project Progress Report and the Project Report.

Teams use the Project Summary template for inclusion in the Project Introduction; past project summaries can be viewed on the history web page. The template uses filler text as a placeholder for the content that teams insert. It is understood that for the initial submission, the project details might be considerations, aspirations, or otherwise tentative and subject to change in future submissions.

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: Five
- File type: Single, bookmarked PDF
- File size: Less than 10 MB
- File name: DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_INTRO_[SUBMISSION DATE (YYYY-MM-DD)].[EXTENSION]

Content Requirements

Project Summary (two-page maximum for all submissions)

- List your project name, team name, Division, and collegiate institution(s) in the header.
- Replace the logo in the upper right with your team or collegiate institution’s logo.
- Replace the building image with one or two graphics that best represent your project.
- Provide a concise description of the project, including a brief identification of the target market.
- Describe the relevance of your project to the goals of the competition.
- Summarize your design strategy and relevant key points.
- List the relevant project data, including cost estimates.
- Provide technical specifications for your project.
- Provide project highlights. Briefly explain how the design meets or exceeds the contest criteria.
Team Information (up to one page)

☐ Include an academic institution profile with particular focus on building science coursework, extracurricular activities, and/or resources.

☐ Include the names of the student team members, their academic majors, and levels; identify the student team lead.

☐ Include a summary of industry partners and their form of support.

Additional Information (as available, up to two pages)

☐ Note the structural and mechanical systems or approach.

☐ Include floor plans, exterior renderings, and/or interior renderings.

Feedback Criteria

The organizers provide feedback on the following:

- Compliance with Division definition
- Submission formatting compliance.

2.6.2 Project Progress Report Submission Instructions

The Project Progress Report provides an interim submission to demonstrate the team’s progress toward completing the Project Report and likelihood of a complete design and submission at the Project Report deadline. It includes an updated Project Introduction with additional project information and details. If a team conducts an internal competition and creates multiple projects, only one Project Progress Report per team can be submitted and reviewed for acceptance as a finalist team.

Teams also submit this Project Progress Report, including a further refined Project Introduction, as part of the Project Report.

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: No more than 10 pages; the cover, back pages, and table of contents are not included in this count

☐ File type: Single, bookmarked PDF

☐ File name: DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_PROGRESS_[SUBMISSION DATE (YYYY-MM-DD)].[EXTENSION]
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)
- Project Introduction (up to five pages, including 2-page Project Summary)

Design Constraints Description (1–3 pages)
- Summarize the lot location, size, shape, orientation, climate, and relationship to road(s).
- Summarize the intended occupants and their characteristics.
- Identify any programs or standards that form the basis for design and their roles in achieving competition goals.
- Describe the neighborhood and/or community setting, including density, access to, and reliance on various transportation modes.

Design Goals (one page)
- Summarize the goals the team considered when creating and developing the design.

Plans for Completing Project (one page, not to be included in Project Report)
- Summarize the building systems anticipated for the design.
- Provide a timeline for project completion.

Evaluation Criteria
The organizers evaluate the submissions according to the following criteria:

- Compliance with Division definitions
- Compliance with submission formatting
- Quality of target market description and associated design strategy constraints and goals, including local climate or building code constraints
- Level of inclusion and completion of content
- Quality of project design
- Consideration of the building science issues in the selected climate
- Other factors, such as geographic locations and technology choices, that help optimize program diversity and fairness.

2.6.3 Project Report Submission Instructions
The Project Report provides a complete submission to be reviewed by jurors in advance of the competition. It includes an updated Project Introduction as well as construction details and contest narratives. Only one Project Report per team will be reviewed for each finalist team.
Only the Project Report and the three specified Project Images are required. Organizers use images to recognize individual team performance, to integrate into event materials, or for outreach, as appropriate. Supplemental Documentation is not required.

The Project Report 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 Project Report. 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. Supplemental Documentation is not required.

**Format Requirements**

<table>
<thead>
<tr>
<th>Project Report (no more than 60 pages)</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Limit content to no more than 60 pages; the cover, back page, and table of contents are not included in this count.</td>
</tr>
<tr>
<td>□ Number pages; front-matter page numbers can use Roman numerals (e.g., i, ii, iii, etc.).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supplemental Documentation (no more than 100 pages)</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Number pages.</td>
</tr>
<tr>
<td>□ Plan accordingly. Jurors evaluating submissions have a limited amount of time to review the entire submission. They might not read all of the Supplemental Documentation in detail, and they are not expected to open any hyperlinks contained within.</td>
</tr>
<tr>
<td>□ Paper size: Standard 8.5 in. × 11 in. (216 mm × 279 mm), ANSI A</td>
</tr>
<tr>
<td>□ Construction drawings in Appendix B: 11 in. x 17 in. (279 mm x 432 mm), ANSI B</td>
</tr>
<tr>
<td>□ Formatting: Single-spaced, 11-point font for body text (diagrams may have smaller fonts)</td>
</tr>
<tr>
<td>□ Borders: 0.5-in. (12.7-mm) minimum, except for tables, figures, and images</td>
</tr>
<tr>
<td>□ File type: Single, bookmarked PDF</td>
</tr>
<tr>
<td>□ File names:</td>
</tr>
<tr>
<td>- Project Report: DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]<em>REPORT</em>[SUBMISSION DATE (YYYY-MM-DD)].[EXTENSION]</td>
</tr>
<tr>
<td>- Supplemental Documentation: DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]<em>SUP</em>[SUBMISSION DATE (YYYY-MM-DD)].[EXTENSION]</td>
</tr>
</tbody>
</table>

**Content Requirements**

<table>
<thead>
<tr>
<th>Project Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Table of Contents</td>
</tr>
<tr>
<td>□ List of Tables and/or List of Figures (as applicable)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section 1: Project Progress Report (up to 10 pages)</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ All content of the Project Progress Report, including the Project Summary with updates as desired</td>
</tr>
</tbody>
</table>
### Section 2: Contest narratives, including relevant images and figures (up to 27 pages)

- 1. Energy Performance
- 2. Engineering
- 3. Financial Feasibility & Affordability
- 4. Resilience
- 5. Architecture
- 6. Operations
- 7. Market Potential
- 8. Comfort & Environmental Quality
- 9. Innovation
- 10. Presentation

### Appendices (optional)

- A. Design renderings (up to five pages)
- B. Construction documentation highlights (up to 15 pages)
  - a. Site plan
  - b. Dimensioned floor plan(s)
  - 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, floor, and roof sections, including building science control layers
  - g. Typical window and door details (including flashing), schedule, and specifications
  - h. Air sealing approach and details
  - i. Mechanical plans and schedules, indicating duct sizing and layout, equipment locations and specifications, heating and cooling system capacity diagrams (Btu or tons/ft², or kilograms/m²), control design and specifications, and minimum installation requirements
  - j. Plumbing plans and schedules, including fixture locations, piping system layout and design, equipment location and specifications, and minimum installation requirements

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10 Teams should indicate system type, size, and quantity; however, full system layout and specifications are not required.
k. Electrical and lighting plans and schedules, including outlet locations, fixture specifications, installed lighting (watt/ft² or watt/m²) levels, control systems, and photovoltaic systems

C. Energy performance (up to three pages) (either HERS Index rating or EUI target)

1. 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.

2. 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. EUIs 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.

Supplemental Documentation (optional)

This is optional and might not be read in detail by jurors. This 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.

Project Images

Submit three images:

Two (2) images that best represent the project, such as renderings, drawings, photographs of scale models, or other team-generated content.

One (1) image of your team.

Ensure all images have a minimum resolution of 1,920 x 1,080 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 (YYYY-MM-DD)].[EXTENSION]
- DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_PHOTO2_[SUBMISSION DATE (YYYY-MM-DD)].[EXTENSION]
- DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_TEAMPHOTO_[SUBMISSION DATE (YYYY-MM-DD)].[EXTENSION]
2.6.4 Project Presentations Submission Instructions

Each team develops two presentations for the competition event: Division and Grand Winner presentation.

Format Requirements

- File type: PDF and/or PPTX (Ensure that presentation slides have an aspect ratio of 16:9.)
- To ensure all electronically submitted materials work with the organizer’s presentation computers, teams are encouraged to embed all videos in the team submission and to notify the organizers before arriving at the competition to allow them to ensure that the appropriate software is available to play the video.
- File sizes:
  - Division presentation: No maximum
  - Grand Winner presentation: 60 MB
- File names:
  - Division presentation: DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_PRESDIV_[SUBMISSION DATE (YYYY-MM-DD)].[EXTENSION]
  - Grand Winner presentation: DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_PRESGRAND_[SUBMISSION DATE (YYYY-MM-DD)].[EXTENSION]

Content Requirements

- Division presentation: A 25-minute presentation on the project to be delivered in person to the jurors during the Design Challenge Weekend, with an additional 10 minutes for questions, for a total 35-minute team presentation.
- Grand Winner presentation: An 8-minute short version of the 25-minute presentation with no additional time reserved for questions. Only the first-place winners in each Division give this 8-minute presentation to the competition participants during the Awards Banquet. A Grand Winner jury award will be made based on this presentation.

2.6.5 Project Poster Submission Instructions

Each team may develop an optional Project Poster that showcases its design and response to Contest criteria. A Poster Session during the Design Challenge Weekend displays all team projects.

Format Requirements

- Size: 3 ft wide x 2 ft tall (0.9 m wide x 0.6 m tall)
- File type: PDF
- File name: DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_POSTER_[SUBMISSION DATE (YYYY-MM-DD)].[EXTENSION]
Teams should print their poster and bring it to the competition event.

**Content Requirements**

- Include the Project Summary information, at a minimum.
- Include additional information, graphics, and images as desired.

**2.6.6 Faculty Report Submission Instructions**

The Faculty Report shall 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.

**Format Requirements**

- File type: Single, bookmarked PDF
- Length: Up to 20 pages
- File name: DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_FACULTY_[SUBMISSION DATE (YYYY-MM-DD)].[EXTENSION]

**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.
3 Solar Decathlon Build Challenge Rules

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.

The Build Challenge encourages student participation during a two-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 or during the 2020 Smithsonian Folklife Festival on the National Mall in Washington, D.C.

During the Solar Decathlon Build Challenge Event in summer 2020, all competing teams will present to the public and exhibit their solutions before panels of expert jurors. More than 350,000 visitors are expected to visit. Select top-performing teams will also be invited to exhibit at the National Association of Home Builders (NAHB) International Builder’s Show¹¹ in February 2021 in Orlando, Florida.

Build Challenge teams will also present to industry leaders for evaluation and feedback, meet with event organizers, compare their projects to those of other teams at the Solar Decathlon 2019 Design Challenge Weekend (see Section 2.3.2), learn from presentations by thought leaders and collegiate peers, and engage with a variety of organizations about energy careers at the Solar Decathlon 2019 Design Challenge Weekend (see Section 2.3.2). Through local and national exhibitions, 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 who collaborate with teams gain national and local recognition and have the opportunity to interact with knowledgeable future design and construction professionals.

3.1 Summary of Important Dates

Note the following 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.

- **Dec. 10, 2018, 5 p.m. 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.

¹¹ NAHB International Builder’s Show Website: https://www.buildersshow.com/Home/
DOE will accept 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 will be 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 will be invited to participate in the competition.

If a team is not accepted into its desired Division, the organizers may 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 will be 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.

- **Jan. 31, 2019:** Updated Solar Decathlon Guide is released. Minimal revisions expected, primarily focused on clarifying intent or adding definition to dates or schedules.

- **Feb. 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 3.6.1, must be submitted via the file submission link posted to the Groups.io Project Site.

- **March 26, 2019, 5 p.m. EDT:** Teams must submit the Design Development deliverable by this deadline.
  - The Design Development deliverable, as detailed in Section 3.6.2, 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 3.6.3. Presentations will not be accepted after this date.
• **April 12–14, 2019: Solar Decathlon Design Challenge Weekend:** Participating teams present to industry leaders on the NREL main campus in Golden, Colorado, who evaluate each team’s Design Development Documentation deliverable and Design Presentation deliverable to determine which teams will receive 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 will be available on the Solar Decathlon website.

  o 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, as part of the overall Solar Decathlon Competition Guide, is released. Minimal revisions expected, primarily focused on clarifying intent or adding definition to dates or schedules.

• **Nov. 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 3.6.4.

  o The Construction Documentation deliverable, as detailed in Section 3.6.4, must be submitted via the file submission link posted to the Groups.io Project Site.

  o Teams will be 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 3.6.4.

  o 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 will be available on the Solar Decathlon website.

• **Jan. 31, 2020:** An updated 2020 Solar Decathlon Guide is released. Minimal revisions expected, primarily focused on clarifying intent or adding definition to dates or schedules.

• **Feb. 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 must indicate where they would like their house measurements collected.

  o The As-Built Documentation deliverable, as detailed in Section 3.6.5, must be submitted via the file submission link posted to the Groups.io Project Site.

• **March 31, 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 Public Exhibit Materials. 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 3.6.6, must be submitted via the file submission link posted to the Groups.io Project Site.

- **May 12, 2020, 5 p.m. EDT:** This is the deadline by which teams must have received a Certificate of Occupancy from their local Authority Having Jurisdiction, to have installed all Organizer Instrumentation Equipment, and to have 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 3.6.7, must be submitted via the file submission link posted to the Groups.io Project Site.

- **May 14–June 14, 2020: Solar Decathlon Build Challenge Local Build Exhibition:** 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. This is when the organizers will begin verifying functionality as part of the measured contest activities. 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. Note: for National Showcase teams who need to ship their house or elements prior to the conclusion of this month, alternative exhibition strategies will be accommodated, and alternative outreach will be considered. Teams may choose whether or not they would like their measurements collected locally or following arrival of their house on the National Mall in Washington, D.C.

- **June 21–24, 2020: Solar Decathlon Build Challenge National Showcase Setup:** This is the period during which all competing teams will prepare for exhibition and competition as part of the Build Challenge Events.

- **June 25–July 5, 2020: Solar Decathlon Build Challenge Events:** Competing teams exhibit and compete at the Build Challenge Events, existing as part of the Smithsonian Folklife Festival in Washington, D.C. National Showcase Division teams bring their complete, tourable house module. Local Build Division teams bring their compelling exhibit and associated signage. All teams will present to juries in Washington, D.C. Upon completion of assembly activities on the National Mall, teams will receive the final distribution of prize funding, as documented in the Approval-to-Proceed Procedures, which will be available on the Solar Decathlon website. All competing teams will earn points according to these rules and the team with the most points overall will win.

- **July 6–9, 2020: Solar Decathlon Build Challenge Events Teardown:** This is the period during which all competing teams will clear the site following the Build Challenge Events.

- **Sept. 1, 2020, 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 3.6.8, must be submitted via the file submission link posted to the Groups.io Project Site.

- **February 2021: Team Showcase at National Association of Home Builders (NAHB) International Builder’s Show:** Select top teams may be invited to exhibit their designs—and for National Showcase teams, their tourable house module—to tens of thousands of professionals at the NAHB International Builder’s Show. DOE may make some funding available to offset transportation and attendance costs. Additional information on this optional opportunity will come at a later date.

### 3.2 Build Challenge Description

#### 3.2.1 Task Overview

- Read this Build Challenge Rules and form a team.
- Review the past team entries and 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 Project Site if attendance is not possible as scheduled.

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12 NAHB International Builder’s Show Website: [https://www.buildersshow.com/Home/](https://www.buildersshow.com/Home/)
• Attend monthly all-team conference calls for project updates and important information from the organizers about Build Challenge requirements, as outlined in Section 483.3.2.

• 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 in May and June 2020.

• Exhibit the project, compliant with the requirements listed in the latest version of the Build Challenge Rules, nationally at the Smithsonian Folklife Festival in June and July 2020 in Washington, D.C.
  - Local Build teams will bring an exhibit—up to 10 feet (ft) wide x 20 ft long x 12 ft tall—and tour juries through their exhibit on the National Mall in Washington, D.C.
  - National Showcase teams will bring a tourable house module, and tour juries through their house module on the National Mall in Washington, D.C.

• Submit all materials by the deadlines. Note that all deadlines are 5 p.m. Eastern Time.

• Submit questions to SDbuild@nrel.gov.

3.2.2 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 7. 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 3.3, 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 2019 Design Challenge Weekend 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.
3.2.3 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 shall 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.

3.2.4 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 Build Challenge Event, including exhibition, 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.

3.2.5 Build Challenge Divisions
The Solar Decathlon Build Challenge comprises two Divisions: National Showcase Division and Local Build Division. Each collegiate institution may apply 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 will accept up to six teams per Division, based on the review criteria described in the Approval-to-Proceed Procedures, which will be 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 2015 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 will be used for 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 prepared in three days or less for exhibit on the National Mall. 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 must be a complete dwelling unit for part of its exhibition, whether locally or on the National Mall, 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, and the team may exhibit only one module on the National Mall, assuming the fully functional home is exhibited at their home site for the collection of measurements.

Teams are expected to exhibit and operate their house in their region in May and June of 2020. Teams are expected to exhibit and operate their house at the Smithsonian Folklife Festival on the National Mall in late June and early July 2020. Select top-performing teams may be invited to exhibit their house at the NAHB International Builders’ Show in Florida in February 2021. To comply with National Park Service rules and requirements, the exhibit must be designed for effective transportation and rapid assembly, shipping entirely constructed with limited work to do on-site to prepare the house for operation.
and touring. The organizers will provide equipment, such as a telehandler, and associated operators to unload elements from the transporting vehicle.

The National Showcase house will be limited to maximum dimensions of 15 ft wide, 14 ft tall while in transportation mode, and 60 ft long. Each house must have a minimum conditioned and finished area of 400 square feet (ft²), as measured according to ANSI Z765. Potential unfurling of elements such as panels, shading devices, or overhangs will be 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. The remainder of the house does not need to be accessible. The organizers will rent and install Americans with Disabilities Act (ADA)-accessible ramps to enable the public to tour the house while on exhibit at the Smithsonian Folklife Festival and, if applicable, the NAHB International Builders’ Show. The National Showcase house is expected to remain on its trailer for the duration of the exhibit, with tie-downs or weights added as necessary to meet Solar Decathlon Build Challenge Building Code requirements. International teams participating in the National Showcase Division must clearly demonstrate how their home will be transported and exhibited within these constraints.

**Local Build Division**

Teams shall design and build an energy-positive house in their region that can be effectively exhibited and operated in late May and early June 2020. 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 expected to exhibit and operate their house in their region in May and June 2020. All teams are expected to bring a compelling exhibit—up to 20 ft long, by 10 ft wide, by 12 ft tall—to the Smithsonian Folklife Festival on the National Mall in late June and early July of 2020. To comply with National Park Service rules and requirements, the exhibit must be designed for efficient transportation and unpackaging, shipping entirely constructed with minimal work to do on-site to prepare the exhibit. The organizers will provide equipment, such as a telehandler, and associated operators to unload an exhibit from its transporting vehicle.

The Local Build house must be between 600 ft² and 3,000 ft². 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.
3.2.6 Build Challenge Expectations

The Build Challenge Event 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 in the 2019 Design Challenge Weekend or the 2020 Build Challenge Event. 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 will be 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 the 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 the 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 the 2019 Design Challenge Weekend, team progress will be 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 will be 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 3.6. 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, and teams will be provided a mechanism for submitting proprietary information. 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 will be evaluated by experts for approval to proceed in the Challenge, as outlined in the Approval-to-Proceed Procedures, which will be 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. For National Showcase teams, the house will be built on, or integrated with, a trailer frame that allows the unit to be easily transported as a single module to the Build Challenge Event Site in Washington, D.C. Teams may choose to also have a permanent foundation created for eventual placement of the house following the competition. 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 in May 2020.

**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, and teams will present their solutions to juries at the Smithsonian Folklife Festival on the National Mall in Washington, D.C. The teams will present to juries using photographs, videos, models, and/or other mediums to demonstrate their design and as-built house. 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. Teams may also be asked to participate in related program activities as part of the Folklife Festival.

These activities run from June to July 2020.

**3.2.7 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.

### 3.3 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, though additional restrictions may exist for homes or exhibits that will be occupied by visitors on the National Mall as part of the 2020 Smithsonian Folklife Festival.

**Note:** 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](#).

#### 3.3.1 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 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 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.

3.3.2 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.

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](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 Project Site. The Build Challenge email address is [SDbuild@nrel.gov](mailto:SDbuild@nrel.gov). The overall Solar Decathlon Competition email is [solardecathlon@nrel.gov](mailto:solardecathlon@nrel.gov). Should a team need to contact DOE’s Solar Decathlon Director directly, the email is [solar.decathlon@ee.doe.gov](mailto: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 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 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 Build Challenge Event, the teams and organizers may have one or more in-person meetings. Notification of the date(s) and agenda(s) for these meetings is made via the Project Site. Meetings will also be held on a daily basis throughout the Build Challenge Event. 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 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 will be 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 will be available on the Solar Decathlon website.

c) Prizes will be 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) It is the sole responsibility of the team to determine any taxes or associated payments required as a result of this award. 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 Project Site represents the rules in effect.

**Decisions on the Rules**

The 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 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 during the Build Challenge Event. A filing fee of up to 10 points will be 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. EDT, and within 24 hours of the action being protested. The final opportunity to file a protest is 5 p.m. EDT on July 4 2020.

**Exception:** The results of the contests will be 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:

   o The Build Challenge Manager convenes the Protest Resolution Committee.

   o 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.

   o 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.

   o 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.

   o 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.

   o 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.

   o The Build Challenge Manager posts a copy of the protest and decision on the Project Site.
3.3.3 Participation

Contact Information

Each team shall provide contact information via the Project Site for the team officers listed in Table 7 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 7, 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 five 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 Decathlon. This evaluation will be 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 7. Team Officers

<table>
<thead>
<tr>
<th>Title</th>
<th>Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student team lead</td>
<td>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).</td>
</tr>
<tr>
<td>Construction officer</td>
<td>The construction officer is responsible for planning and executing the construction, transport, assembly, and disassembly of the house, including providing the necessary oversight on construction activities.</td>
</tr>
<tr>
<td>Measured contest officer</td>
<td>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.</td>
</tr>
</tbody>
</table>
Title | Responsibilities
--- | ---
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 during the Build Challenge Event, 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 8.

### Table 8. Team Leads (Optional)

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

**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 3.6.4.

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 on the National Mall, including any assembly 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.

f) Individuals under the age of 18 are not permitted to be on the competition site during assembly and disassembly.

g) Smoking is not permitted on the site of the Build Challenge Event at any time.

h) For exhibit or house assembly at the Build Challenge Event, organizers may issue a stop work order at any time during the project if a hazardous condition is identified. The duration of the stop work order is at the discretion of the organizers; additional construction time will not be provided.

i) Failure to follow the procedures and requirements outlined in each team’s Health and Safety Plan on the Build Challenge Event Site is considered a rule violation, and violations are subject to penalty points. All electrical work on the Build Challenge Event Site shall meet electrical lock-out/tag-out requirements indicated in each team’s approved Health and Safety Plan. Fall protection systems shall be used in a manner to provide protection against fall exposures 100% of the time.

Conduct
Improper conduct, the use of alcohol or marijuana, and the use of illegal substances are not permitted on the competition site. 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. ET 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 will be 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. ET up until 11:59 p.m. ET 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 11 for a summary listing deliverables and due dates.

**3.3.4 Build Challenge House Restrictions**

**National Showcase Size Restrictions**

The organizers and teams must meet National Park Service requirements for access throughout the National Mall at all times during assembly and operation. At all times, the house module must remain on the gravel pathway of the mall, in the area designated on the site map. 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 and conditioned space of the National Showcase house shall be at least 400 ft² as measured according to ANSI Z765.

Teams may compete using one unit of a multifamily property, where additional dwelling units are placed adjacent to or otherwise surrounding the competition prototype.

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:

   o The team makes a request to the Build Challenge Manager for an exemption prior to the start of assembly.
The element can be rapidly deployed, erected, or unfurled upon arrival on the competition site. Construction of any element newly existing is not permissible on-site.

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.

d) The organizers will rent and install ADA-compliant ramps for access to and from the house on the competition site. The ramps may protrude beyond the dimensions stated above, but orientation and placement must be coordinated with the organizers so as to minimize impact on the National Mall’s existing infrastructure, such as park benches, light poles, and trash cans.

The finished square footage, as defined by Square Footage—Method for Calculating: ANSI Z765-2003 (R2013), shall be at least 400 ft² (55.742 square meters [m²]). 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 ft² but shall not exceed 3,000 ft².

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.
3.3.5 **House Design Requirements**

### Structural Design Approval

Each team shall submit structural drawings and calculations that have been stamped by a qualified, licensed design professional. 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 the structure 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 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 present 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, may be evaluated by juries. It is permissible to show the competition prototype house in context in renderings, photographs, or other media.

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.

3.3.6 **Energy**

### Photovoltaic Technology Limitations

a) Bare photovoltaic (PV) cells and encapsulated PV modules must be commercially available by May 14, 2020, which is the beginning of the Solar Decathlon Local Build Division exhibit period, or approved by the organizers prior to the beginning of the Solar Decathlon Local Build Division exhibit period.

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 arrival at the competition site.
**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.

**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.

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 Build Challenge Event, 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 section 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 Build Challenge Event, 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 will be 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 will be 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:

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.

### 3.3.7 Build Challenge Events

Build Challenge Events include Design Challenge Weekend occurring April 12-14, 2019 at NREL in Golden, Colorado, the Local Build Division exhibit, which runs May 14–June 14,
2020, and the National Showcase Event at the 2020 Smithsonian Folklife Festival in Washington, D.C. Optionally, select top-performing teams may be invited to participate in the 2021 NAHB’s International Builders’ Show.

Registration
All Solar Decathlon Build Challenge Event participants must register.

a) The following rules apply to all participants:
   o Each event participant must register individually. Group registrations are not allowed.
   o When registering, event participants must complete all required information and forms before access to the competition site 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 Build Challenge 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 on the competition site.

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 on the competition site. The Solar Decathlon logo must be at least three times the size of all other logos, as outlined in the Solar Decathlon identity guidelines. As appropriate, the team may be asked to recognize the Smithsonian Folklife Festival as part of their elements on the national mall site.

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.

a) The information in the Construction Equipment at the Build Challenge Event Site section applies, but is not limited, to all communications materials that will be on display or distributed on the Build Challenge Event Site.

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13 Solar Decathlon identity guidelines are expected to be made available by fall 2018.
b) Communications materials or other products that exist largely for the recognition of sponsors are limited to 20 ft² (1.858 m²), on the National Mall at the Build Challenge Event. “Other products” include, but are not limited to, signs, exhibits, posters, plaques, photos, wall art, and furnishings.

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

d) 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.

e) Team uniforms are exempt.

**Logistics at the Build Challenge Event**

a) Each team is responsible for the transport of its house or its exhibit, including the house’s contents, and all necessary tools and equipment to the Build Challenge Event Site. Each team is responsible for any damage to or loss of such items.

b) The organizers will provide a telehandler and operator for unloading exhibits or elements. The specifications of the equipment available will be provided on the Groups.io Project Site so teams can design their exhibits accordingly.

c) Each team is responsible for procuring all necessary equipment, tools, and supplies to build its house and to exhibit at the Build Challenge Event.

d) Each team is responsible for transportation, accommodations, lodging, food, and beverages. The organizers will make drinking water available on the competition site to all team members for the duration of the Build Challenge Event.

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

**Inspections**

Each Contest 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 2018 International Residential Code. Inspections are expected to occur throughout the construction process and must be completed for a team to be eligible to compete in the Build Challenge Event.

b) Each team shall be required to demonstrate 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) Additional random inspections for compliance shall take place throughout the Build Challenge Event.

d) The Build Challenge Manager shall check each team’s inspection status, as indicated on the team’s official inspection card, to determine which houses are eligible to participate in the contests. All final inspections shall be passed by the deadline indicated on the Build
Challenge calendar, which is available on the Groups.io Project Site. Failure to pass inspections by the required deadline may disqualify a team for participation in the Build Challenge Event and will be considered a rules violation. A team must have passed inspections by the conclusion of the inspector’s workday for a team to be eligible to participate in the following day’s contests, which officially start at midnight.

**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.

e) 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.

### 3.3.8 Site Operations at the Build Challenge Event Site

The following sections apply only to activities on the Build Challenge Event Site on the National Mall in Washington, D.C., as part of the 2020 Smithsonian Folklife Festival. For any construction done off-site, either in preparation for exhibition on the Event Site or as part of the Local Build Division, teams are expected to follow local rules and regulations.

**Damage Liability**

Each team is financially responsible for any damage it causes to the Build Challenge Event Site.

**Construction Equipment at the Build Challenge Event Site**

a) Trailers, semitrailer trucks, and related vehicles are limited to the approved surfaces of the Build Challenge Event Site.

b) Heavy construction equipment, including cranes, are prohibited at all times for use by teams on the Build Challenge Event Site without prior approval from the Build Challenge manager. A team may use a scissor lift or similar equipment for safe movement of personnel during the unfurling of the National Showcase houses.

c) Teams shall not permit the use of any equipment or tools at the Build Challenge Event that are not safe and/or do not comply with applicable requirements of OSHA and/or other related regulatory standards. Teams are expected to follow safe and applicable practices at their own local build sites.

**Ground Penetration at the Build Challenge Event Site**

Ground penetration on the Build Challenge Event Site on the National Mall is not permitted unless explicitly approved by the Solar Decathlon Build Challenge organizers, whose approval is subject to consultation with the 2020 Smithsonian Folklife Festival site operations staff. Ground penetrations should be avoided and, if necessary, must be approved by the organizers in advance. All other ground penetrations shall not be permitted.

**Impact on the Build Challenge Event Site**

Low-impact footings, or the use of appropriate trailer wheels and stabilizing elements, shall be used to support all house and site components. All footings shall comply with the bearing pressure criteria specified in the Solar Decathlon Building Code.
**Generators**
Teams are not allowed to use generators at the Build Challenge Event Site. Minimal power will be available from the organizers for teams use to power tools and lights.

**Spill Containment**
The release of water or other liquids onto the Build Challenge Event Site or into nearby storm drains is prohibited.

**Lot Conditions**
A vertical elevation change of up to 18 in. (45.72 centimeters [cm]) may exist across an area designated for team use at the Build Challenge Event. Teams must plan for adjusting the levelness of their finished floor and plan accordingly to meet the specific conditions. While each National Showcase house is expected to remain on its transportation trailer, some teams may choose to use adjustable jacks or footings to level the floor and provide additional stability. For National Showcase teams, the organizers will provide and install ramps with handrails as necessary for an accessible route from each team’s ingress and egress doors to the Event Site.

**Vegetation Placement**
The use of vegetation is permitted. All vegetation shall comply with the Impact on the Build Challenge Event Site rules and the Spill Containment rules. Vegetation may be moved until the beginning of the Build Challenge Event, after which time it shall remain stationary until the conclusion of the Build Challenge Event, unless the drawings clearly show how some or all vegetation is designed to be moved as part of an integrated system.

**Gray Water Storage**
The organizers will provide water to National Showcase teams for use in their houses to assist with the completion of measured contest activities; however, teams are required to store any water used in storage tanks under the house until it is removed by a suction-pump truck at the conclusion of the Build Challenge Event.

a) Primary gray water containers shall be located outside of the finished square footage. These containers may be located beneath the finished square footage. Juries will be directed to disregard the presence of any temporary tanks in their evaluation.

**Exception:** Teams may utilize one or more small tanks, up to a maximum aggregate volume of 20 gallons (gal) (75.708 liters [L]), to accept wastewater discharge in preparation for delivery to the main wastewater tank(s).

b) Solar storage, hot water, or other thermal storage containers may be located within the finished square footage.

**Team-Provided Liquids**
A team may provide its own liquids for the following purposes:

a) Personal hydration

b) Irrigation (one-time delivery before water delivery day, 50 gal [189.271 L] limit, water only)
c) Thermal mass
d) Food preparation
e) Hydronic system pressure testing
f) Assembly (e.g., hydraulic fluid), finishing (e.g., paint), and cleaning (e.g., mineral spirits)
g) Glycol, deionized water, or other working fluids for thermodynamic systems using working fluids other than nonpotable water if approved by the organizers prior to arrival at the competition site.

Water Supply
National Showcase Division teams will be able to receive water from the organizers. The procedure and associated requirements for water delivery are as follows:

a) Team design deliverables shall clearly indicate the connection location(s), quantity of water requested, and clearance for connecting to the fill location(s) (minimum 12 in. [30.48 cm]). All locations shall be easily accessible.
b) Teams are responsible for distributing water within their houses. This includes all necessary pumps, containers, lines, valves, and so on.

Water Removal
Teams are required to provide gray water storage tanks for any water they use during the competition. The procedure and associated requirements for water removal follow:

a) On water removal day, a water truck will service each house. Each truck will be equipped with a pump to aid in water removal.
b) Teams shall supply a minimum of six people, on command, to help move the water hose to their house from the previously serviced house.
c) After the two trucks have serviced all houses once, they will visit the village again to service any house needing remaining water removed.
d) Teams that delay the water removal process may be required to pay for their own water removal. Teams required to pay for their own water removal shall use a company approved by the organizers.
e) Team design deliverables shall clearly indicate the removal location(s), quantity of water to be removed from each removal location, container dimensions, diameter of the opening(s) (minimum 4 in. [10.16 cm]), and clearance above the container(s) fill location(s) (minimum 12 in. [30.48 cm]). All openings shall be easily accessible.
f) Teams are responsible for either removing remaining water from the site.

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14 The water may only fill isolated loops; it shall not enter tanks.
15 The teams shall include a detailed water budget in the project manual.
3.3.9 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 3.2.3, 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 competition site.

Late Design Changes

The final project assembled on the competition 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 and Solar Decathlon Build Challenge Safety Officer as soon as possible after the inconsistency is known. The Safety Officer will review the changes against the team’s final EHS Plan to assess whether the changes warrant additional or different safety 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 Build Challenge Event.

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 Build Challenge Events shall be compliant with National Park Service rules and the Smithsonian Folklife Festival Branding Guidelines.

e) Teams are prohibited from selling items to the general public on at the Build Challenge Event.

f) Only organizer-approved vendors may provide food and beverages to the general public at the Build Challenge Event Site.

g) Each house shall be impounded on specified nights as indicated in the Build Challenge calendar under the direct supervision of the organizers or staff. Team members shall not occupy the competition site during impound hours to be indicated in the competition calendar.

**Team Uniforms**

a) During the Build Challenge Events and special events specified by the organizers, all team members present on the competition site or the site of a special event 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.

e) A built-in clothing manufacturer logo may be visible on the front or back of the team uniform, or both.

### 3.4 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 7. 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 3.5.
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3.4.1 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 one year, including the charging and operation of an electric vehicle estimated to be driven 20 miles per day. This evaluation will be completed in accordance with the usage schedule outlined in the Build Challenge calendar, which is available on the Groups.io Project Site.

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 peak 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 peak load. Reduced points are scaled linearly. If automated load-shedding is not possible, no points will be 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 four 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.

### 3.4.2 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 preliminary evaluation of the design prior to its arrival at the competition site?

**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 will be 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?

3.4.3 **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**

• 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

**3.4.4 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:

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16 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 will be 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.
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)?
- 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 will be 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?

3.4.5 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?\(^{17}\)
- 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?

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\(^{17}\) 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.
• 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?  
• 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 will be 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?

3.4.6 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.

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.

18 Deliverables are required to accurately reflect the competition prototype as it appears on the competition site.
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 (4.444°C).
   - The refrigerator volume published in the manufacturer’s specifications shall be a minimum of 4.5 cubic feet (ft³) (0.127 cubic meters [m³]).
   - 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 ft³ (0.0566 m³).
   - 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 (176.667°C) and 450°F (204.444°C) during scored periods.
   - Reduced points are earned if the time-averaged interior oven temperature is between 250°F (-34.444°C) and 400°F (-28.889°C) or between 5°F (-15°C) and 15°F (-9.444°C). Reduced point values are scaled linearly.
   - The oven volume published in the manufacturer’s specifications shall be a minimum of 2 ft³ (0.0566 m³).
   - The oven may not contain any food or beverages during the measurement period.
   - Teams will be 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 temperature of 212°F (100°C) during a scored period.
   - Reduced points are earned if the temperature of the water is between 100°F (37.778°C) and 212°F (100°C). Reduced point values are scaled linearly.
   - Teams will be provided two attempts to meet this requirement, with each attempt separated by at least 8 hours of time. The evaluation begins when a team indicates it is ready for the organizers.

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 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 and 20 cups. Reduced point values are scaled linearly. If more than 20 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 will be 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 will be 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 will be 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 will be 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 during the time period 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:

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

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

d) Prepare and cook all food and beverages in the house during the period of time indicated in the Build Challenge calendar, which is available on the Groups.io Project Site.

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

f) Comply with the following safety requirements:
   o Do not use any flames, including candle flames.
   o Do not serve or use any alcoholic beverages.
   o Use only drinking water purchased in sealed containers.
   o Wash and rinse all dishes and cookware before use.
   o Store all food and beverages properly while on the competition site.
   o Do not use coolers to store food, beverages, or ice on the competition site.

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 Build Challenge 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.

3.4.7 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 10. 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 will be 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?

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### 3.4.8 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 (CO₂) level below 1,000 parts per million (PPM) following occupancy of six individuals for 1 hour. The CO₂ levels will be measured when the house is occupied as part of the House Occupancy Subcontest.

a) Reduced points are earned for time-averaged interior CO₂ levels between 1,000 PPM and 2,000 PPM. Reduced point values are scaled linearly. No points are earned for time-averaged interior CO₂ levels above 2,000 PPM.

b) The organizers will identify at least one zone in each house and measure the CO₂ level of each zone. If more than one measurement is collected, the CO₂ level deviating farthest from the target CO₂ level is the CO₂ level of record.

**Air Tightness Subcontest**

All available points will be earned for a measured air tightness of less than or equal to 0.05 cubic feet per minute (cfm) 50/ft².

a) Reduced points are earned for measurements between 0.05 cfm 50/ft² and 0.25 cfm 50/ft². Reduced point values are scaled linearly. No points are earned for measurements above 0.25 cfm 50/ft².

b) Air tightness may be evaluated in advance of the competition at the team site by a qualified third-party provider hired by the organizers. For the National Showcase teams, it may be measured in advance or on the competition site at the time indicated in the Build Challenge Event calendar.

**Exterior Noise Infiltration Subcontest**

The measurement will be done according to the global method proposed in the International Organization for Standardization (ISO) 140-5:1998 standard. The sound insulation decibel (dB) values for each of the 1/3 octave bands will be calculated between 100 hertz (Hz) and 5 kilohertz (kHz). dB calculated according to ISO 717-1:1996 will be used as an assessment parameter. All available points will be earned for a measured sound pressure level from outside noise intrusion
less than or equal to 35 A-weighted decibels (dBA) based on the peak hour sound level equivalents (Leq).¹⁹

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 preagreed-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 will be 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), is less than or equal to 25 dBA, based on the peak Leq. ¹⁹ These acoustic measurements will be performed according to the ISO 10052: 2004 standard.

a) Reduced points are earned for measurements between 25 dBA and 40 dBA. Reduced point values are scaled linearly. No points are earned for a measured maximum background noise in the home greater than 40 dBA.

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

### 3.4.9 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?
- 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?

3.4.10 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 competition prototype, and evaluate the public exhibit 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, the local public, and the public at the Build Challenge Event in Washington, D.C.?
- 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, locally and in Washington, D.C.?

3.5 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, as part of house tours for the National Showcase teams and as jury-specific presentations for the Local Build teams. All jury presentations will take place in Washington, D.C. 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 receive a scheduled presentation from each of the National Showcase Division teams through a scheduled private walk-through tour of each house on the National Mall as part of the 2020 Smithsonian Folklife Festival.
The juries will receive a scheduled presentation from each of the Local Build Division teams accompanied by photographs and video of the as-built house at an industry venue in Washington, D.C.

3. Step 3: Deliberation

3.5.1 Step 1: Deliverables Review

Each juror will spend approximately one-to-two hours reviewing the submitted deliverables to explore the relevant details of each team’s project. An outline of the reviews is listed in Table 11.
Table 11. Jury Reviews

<table>
<thead>
<tr>
<th>Jury</th>
<th>Time Commitment for Phase 1 Deliverables Review</th>
<th>Relevant Deliverables for Review</th>
<th>Time Commitment for Phase 2 Team Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering</td>
<td>1–2 hours per team</td>
<td>Engineering Narrative&lt;br&gt;Energy Model Analysis and Results&lt;br&gt;Architectural Photography and 3D Tour&lt;br&gt;As-Built Drawings&lt;br&gt;As-Built Specifications&lt;br&gt;Audiovisual Presentation, including video of house</td>
<td>30 minutes per team</td>
</tr>
<tr>
<td>Financial Feasibility &amp; Affordability</td>
<td>1–2 hours per team</td>
<td>Financial Feasibility and Affordability Narrative&lt;br&gt;Construction Cost Estimate&lt;br&gt;Operational Cost Estimate&lt;br&gt;Architectural Photography and 3D Photo Tour&lt;br&gt;As-Built Drawings&lt;br&gt;As-Built Specification&lt;br&gt;Audiovisual Presentation, including video of house</td>
<td>30 minutes per team</td>
</tr>
<tr>
<td>Resilience</td>
<td>1–2 hours per team</td>
<td>Resilience Narrative&lt;br&gt;Architectural Photography and 3D Photo Tour&lt;br&gt;As-Built Drawings&lt;br&gt;As-Built Specifications&lt;br&gt;Audiovisual Presentation, including video of house</td>
<td>30 minutes per team</td>
</tr>
<tr>
<td>Architecture</td>
<td>1–2 hours per team</td>
<td>Architecture Narrative&lt;br&gt;Architectural Photography and 3D Photo Tour&lt;br&gt;As-Built Drawings&lt;br&gt;As-Built Specifications&lt;br&gt;Audiovisual Presentation, including video of house</td>
<td>30 minutes per team</td>
</tr>
<tr>
<td>Market Potential</td>
<td>1–2 hours per team</td>
<td>Market Potential Narrative&lt;br&gt;Architectural Photography and 3D Photo Tour&lt;br&gt;As-Built Drawings&lt;br&gt;As-Built Specifications&lt;br&gt;Audiovisual Presentation, including video of house</td>
<td>30 minutes per team</td>
</tr>
<tr>
<td>Presentation</td>
<td>1–2 hours per team</td>
<td>Presentation Narrative&lt;br&gt;Local Attendance and Engagement Stats&lt;br&gt;Team website and/or social media accounts&lt;br&gt;Architectural Photography and 3D Photo Tour&lt;br&gt;Public exhibit materials&lt;br&gt;Audiovisual Presentation, including video of house</td>
<td>30 minutes per team</td>
</tr>
</tbody>
</table>
3.5.2 Step 2: As-Built House Evaluation

Each jury will complete an extensive evaluation of the house as-built by the competing team. Prior to the Build Challenge Event at the Smithsonian Folklife Festival, the house will be documented by professional architectural or real estate photographers hired by the organizers, including extensive exterior and interior photography and a 3D photographic walk-through. When possible, a 3D photographic walk-through will also be taken of the house under construction. The on-site jury presentations take place on the National Mall in Washington, D.C., and 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.

3.5.3 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 12) 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) on will be announced during a scheduled announcement at the Build Challenge Event. Pending the jurors’ availability, the organizers will invite one or more jurors to make the announcement. The scores for all of the teams will be 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.

3.5.4 Evaluation Rating Scale

The jury scores each parameter according to the scale in Table 12 below.
### Table 12. Evaluation Scale

<table>
<thead>
<tr>
<th>Class</th>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>0%–20%</td>
<td>MISSES EXPECTATIONS: Missing all requirements; no explanation of how the design addresses the criteria</td>
</tr>
<tr>
<td>4</td>
<td>20%–40%</td>
<td>APPROACHES EXPECTATIONS: Missing some requirements; minimal explanation of how the design addresses the criteria</td>
</tr>
<tr>
<td>3</td>
<td>40%–60%</td>
<td>MEETS EXPECTATIONS: All requirements met; acceptable explanation of how the design addresses the criteria</td>
</tr>
<tr>
<td>2</td>
<td>60%–90%</td>
<td>EXCEEDS EXPECTATIONS: All requirements met; full demonstration of how the solution addresses the criteria</td>
</tr>
<tr>
<td>1</td>
<td>90%–100%</td>
<td>ECLIPSES EXPECTATIONS: All requirements met; distinguished excellence in how the design exceeds the criteria</td>
</tr>
</tbody>
</table>

### 3.5.5 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 will be 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 jury will have 25 minutes to meet with team, followed by a 5-minute deliberation period. During the 25 minutes with each team, the entire time will be allocated for team members to lead the jury through their design and answer any questions the jury may have. After 25 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 will have 5 minutes to prepare for the next team presentation.

   - All teams will present to juries on the National Mall, including showing juries through their competition prototype house or competition exhibit supplemented by presentations utilizing digital technologies or other means.

   - For the Presentation Contest jury, the team shall present its Public Outreach Activity to the jury on the National Mall. 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 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.

3.5.6 **Public Exhibit Requirements**
The team shall prepare two versions of its public outreach.

**Local Exhibition**
- All teams are required to exhibit their house to their own community at least two weekends in May or June 2020, as noted in the Build Challenge calendar, which is available 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.

**Build Challenge Event Exhibition**
- As part of the 2020 Smithsonian Folklife Festival, teams will host hundreds of thousands of visitors and 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 visitors could adopt technologies or energy-efficient practices in their own homes.
- National Showcase Division teams will provide tours of their as-built competition prototype house module.
- Local Build Division teams will utilize their unique exhibit to tell visitors about their team, competition house design, and other elements.

**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.
3.6 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 13) 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 on the competition site 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 on the competition site, the **submitted Jury Documentation deliverables** are the only means for a team to provide a detailed presentation of its project to the juries. In the weeks leading up to Build Challenge Event, each juror shall evaluate the submitted Jury Documentation deliverables. The primary purpose of the juries’ visits on the competition site is to verify that the project, as assembled on the competition site, was accurately represented in the jury deliverables and to ask the decathletes any clarifying questions that may arise during the evaluation of the design via the jury deliverables.
<table>
<thead>
<tr>
<th>Deliverable Name</th>
<th>Required Content</th>
<th>Use of Submission</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1: Project Introduction</td>
<td>Team short description</td>
<td>Feedback to team</td>
<td>Feb. 19, 2019</td>
</tr>
<tr>
<td></td>
<td>Project management plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Design summary</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Initial Design Renderings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2: Design Development</td>
<td>50% complete construction drawings</td>
<td>Evaluated as part of approval to proceed to Phase 2 and first prize disbursement</td>
<td>March 26, 2019</td>
</tr>
<tr>
<td>Deliverable</td>
<td>Initial project report</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D3: Design Presentation</td>
<td>20-minute presentation on design</td>
<td>Evaluated as part of approval to proceed to Phase 2 and first prize disbursement</td>
<td>April 9, 2019</td>
</tr>
<tr>
<td>Deliverable</td>
<td>Optional poster</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D4: Construction</td>
<td>Public project renderings</td>
<td>Evaluated as part of approval to proceed to construction and second prize</td>
<td>Nov. 5, 2019</td>
</tr>
<tr>
<td>Documentation</td>
<td>95% complete construction documentation (drawings and specifications)</td>
<td>disbursement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interim project report</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D5: As-Built Documentation</td>
<td>Updated public project renderings</td>
<td>To be used by juries for scoring teams and by organizers for scoring measurement</td>
<td>Feb. 18, 2020</td>
</tr>
<tr>
<td></td>
<td>100% complete construction documentation (reflecting house under construction)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Construction progress photos</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D6: Project Summary</td>
<td>Final project report</td>
<td>To be used for public outreach about the team, reviewed by juries</td>
<td>March 31, 2020</td>
</tr>
<tr>
<td></td>
<td>Public project summary</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Public exhibit materials, including signage, uniform, and website</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D7: Jury Deliverables</td>
<td>Jury narratives</td>
<td>To be used by juries for scoring the team</td>
<td>May 14, 2020</td>
</tr>
<tr>
<td></td>
<td>Architectural photography of as-built house</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3D tour of house</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Final construction documentation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D8: Final Report</td>
<td>Postevent project report</td>
<td>To be used by organizers for lessons learned</td>
<td>Sept. 1, 2020</td>
</tr>
</tbody>
</table>
3.6.1 D1: Project Introduction

The Project Introduction deliverable will be reviewed by organizers, and feedback will be provided to teams to help increase their likelihood of success in the remainder of the Challenge. It will not be used as the basis of the approval to proceed and prize disbursement in accordance with the Approval-to-Proceed Procedures, which will be available on the Solar Decathlon website.

The Project Introduction will not be 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 will be 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**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packaged into a single PDF file</td>
<td>Renderings and/or audiovisuals may be submitted separately, if desired.</td>
</tr>
<tr>
<td>Up to 30 pages</td>
<td></td>
</tr>
<tr>
<td>File name abbreviation</td>
<td>INTRO</td>
</tr>
</tbody>
</table>

**Content Requirements**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Updated 100-word description of team and its goals for public release</td>
<td></td>
</tr>
<tr>
<td>Strategy for winning the Challenge</td>
<td>including a contest-by-contest approach (3–5 pages)</td>
</tr>
<tr>
<td>Team structure</td>
<td>including detailed descriptions of roles and responsibilities (2 pages)</td>
</tr>
<tr>
<td>Description of the team’s approach to successfully build the house</td>
<td>including a detailed project schedule, explanation of any coursework integration, description of transport plan of house module or exhibit to the National Mall, and summary of any research positions offered to enable successful student commitment (4 pages)</td>
</tr>
<tr>
<td>Summary of potential innovations and nonstandard elements being pursued</td>
<td>(1–2 pages)</td>
</tr>
<tr>
<td>Fundraising approach, schedule, and current progress</td>
<td>along with a current total estimated project budget and description of any current industry partnerships (2 pages)</td>
</tr>
<tr>
<td>Schematic Project representation</td>
<td>(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)</td>
</tr>
<tr>
<td>Team photograph</td>
<td>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)</td>
</tr>
<tr>
<td>Description of public exhibit, communications, and outreach strategy and coverage included to date</td>
<td>including a summary of team’s current online presence, including social media accounts and website URLs (1–2 pages)</td>
</tr>
</tbody>
</table>
3.6.2 **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 on the competition site. 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 will be reviewed by organizers, and feedback will be provided to teams to help increase their likelihood of success in the remainder of the Challenge. It will be used as the basis of the approval to proceed and prize disbursement. It will also be used as the basis for presentation at the 2019 Design Challenge Weekend.

**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
    - o For Local Build teams, the house location and site work necessary, with particular attention paid for public visitor tour access and routes
    - o For National Showcase teams, the proposed ramp locations and directions, how the unit will be safely accessed while remaining on the transportation trailer, etc.
  - 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 description of transport plan of house module or exhibit to the National Mall, assembly methodology, and staging

---

**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
- Logistics plan, including a description of transport plan of house module or exhibit to the National Mall

**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.

### 3.6.3 D3: Design Presentation

Each team shall develop presentation files on its design, which will be presented at the 2019 Design Challenge Weekend. The presentations, together with D2: Design Development Documentation deliverable will be 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 2019 Design Challenge Weekend, 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 2019 Design Challenge Weekend will display all team projects.

Teams should print their poster and bring it to the 2019 Design Challenge Weekend.

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

3.6.4 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 will be 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
      
      o For Local Build teams, the house location and site work necessary, with particular attention paid for public visitor tour access and routes
      
      o For National Showcase teams, the proposed ramp locations and directions, how the unit will be safely accessed while remaining on the transportation trailer, etc.
  
  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, assembly 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
- Detailed water budget
- 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
- Logistics plan, including a description of transport plan of house module or exhibit to the National Mall

### 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

#### 3.6.5 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
### 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

### 3.6.6 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 on the competition site, 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 May 14, 2020.

**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).
**Team Photograph**

**Format Requirements**

<table>
<thead>
<tr>
<th></th>
<th>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</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>File name abbreviation: TEAMPHOTO</td>
</tr>
</tbody>
</table>

**Content Requirements**

|   | Include all team members (if possible) and strive for creativity. |

**Team Logo**

**Format Requirements**

<table>
<thead>
<tr>
<th></th>
<th>Vector or high-resolution format appropriate for print (EPS preferred)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>File name abbreviation: TEAMLOGO</td>
</tr>
</tbody>
</table>

**Content Requirements**

<table>
<thead>
<tr>
<th></th>
<th>Graphic logo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Associated text file containing name, phone number, and email of person submitting logo</td>
</tr>
</tbody>
</table>

**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**

<table>
<thead>
<tr>
<th></th>
<th>Packaged into a single, zipped file. If elements are hosted online, a link shall be included in the submission.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
</tbody>
</table>
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

### 3.6.7 D7: Jury Documentation Deliverables

The Jury Documentation deliverables provide an opportunity for teams to present their projects to each jury prior to arrival on the competition site. 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 will be 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 will be 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)
- 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. Inclusions of a logistics plan, including a description of transport plan of house module or exhibit to the National Mall

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

3.6.8 D8: Final Report

The Final Report shall reflect the results of the team’s Solar Decathlon project. It will be 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

Assembly
The period of time between the allowed arrival of trucks on-site and the beginning of the Build Challenge Event on the National Mall

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 Event
The activities that take place for the Local Build Division exhibit, which runs May 14–June 14, 2020, and the National Showcase Event at the 2020 Smithsonian Folklife Festival in Washington, D.C., in July. These activities include, but are not limited to, registration, assembly, inspections, contests, special events, public exhibits, and disassembly

Build Challenge Event Site
The area provided by the organizers for showcasing team solutions to the public as part of the Build Challenge

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 3.2.3

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

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

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

Disassembly
The period of time between the closing of the Build Challenge Event and the completion of competition site cleanup

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

Elementary School
A complete educational facility for grades kindergarten through fifth that includes permanent provisions for a cafeteria; gym; offices; classrooms; and other support functions, such as mechanical spaces, circulation, and restrooms
**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 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 Design Challenge Weekend or the Build Challenge Event.

**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.

**Faculty Report**
A 20-page maximum Design Challenge deliverable that reflects the results of a team’s Design Challenge 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.

**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

**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

**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
**Project Summary**
A two-page summary of the Design Challenge project that gives key points of the design

**Project Introduction**
A five-page optional deliverable for the Design Challenge deliverable that provides the information necessary to communicate the salient points of the projects to all competition participants

**Project Poster**
A Design Challenge deliverable that showcases a team’s design and response to Contest criteria

**Project Progress Report**
A 10-page maximum Design Challenge deliverable that provides an interim submission to demonstrate a team’s progress toward completing the Project Report and likelihood of a complete design and submission at the Project Report deadline

**Project Report**
A 60-page maximum Design Challenge deliverable that provides a complete submission to be reviewed by jurors in advance of the competition

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

**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 of the competition site 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 competition 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 postdisasters, and ensure long-term durability in response to local climatic conditions

**Rules**
All principles or regulations governing conduct, action, procedure, arrangement, etc., for the duration of the project, represented in aggregate by this Solar Decathlon Rules document
**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 during the Build Challenge Event

**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 during the Build Challenge Event

**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 competition 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 competition site