Competition Guide
2019–2020

July 2019
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!
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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 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.

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.

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 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.

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.

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Figure 1. Structure of the Solar Decathlon

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 separate Design Challenge Rules document). A few key points are noted here:
• Design Challenge teams choose to compete in one of six Divisions:
  o Suburban Single-Family
  o Urban Single-Family
  o Attached Housing
  o Mixed-Use Multifamily
  o Elementary School
  o Office Building.

• Teams may apply and begin projects as early as August of the preceding year (for example, beginning in August 2019 for the 2020 Design Challenge). For the Design Challenge application, each team:
  o Identifies a faculty lead or student team lead with a preliminary roster of student team members
  o Selects the Division in which it intends to compete
  o Submits an optional five-page Project Introduction
  o 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.
  o 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 Design Challenge Weekend, held annually in April at the National Renewable Energy Laboratory (NREL) main campus in Golden, Colorado.
  o For this coming cycle, teams that apply in November 2019 and are selected to proceed after submitting their Project Progress Report in February 2020 will be invited to complete their project in March and then present at Design Challenge Weekend at NREL in April 2020.

• 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.
  o Additional awards may be given to recognize excellence, professionalism, hard work, and enthusiasm. See respective Rules related to Design Challenge and Build Challenge for more information.
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 carefully read the Solar Decathlon Build Challenge Rules (see separate Build Challenge Rules document). A few key points are noted here:

- **Applications closed on December 10, 2018, at 5 p.m. (EST).**
- 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 lead 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 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.

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 and Solar Decathlon Build Challenge Rules 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. The benefits of investing in highly efficient buildings reinforce the investment 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 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 needs and preferences of

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1 [https://www.nrel.gov/resilience-planning-roadmap/](https://www.nrel.gov/resilience-planning-roadmap/)
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 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.
8 Two Challenges

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

Table 1. Considerations for Challenge Participation

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<thead>
<tr>
<th>Consideration</th>
<th>Design Challenge</th>
<th>Build Challenge</th>
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<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 2020) | • 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(s) and faculty travel to multiple events, including Design Challenge Weekend (NREL; Golden, Colorado; April 2020) and the 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 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.