



U.S. DEPARTMENT OF ENERGY

# Solar Decathlon

## **Competition Guide: 2023 Design Challenge 2023 Build Challenge**

July 2022

## Foreword

Congratulations on your decision to participate in the U.S. Department of Energy (DOE) Solar Decathlon<sup>®</sup> 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:

- Reducing carbon emissions, both embodied and operational
- Making buildings more affordable for families
- Incorporating grid-interactive technologies
- Improving construction productivity
- Considering environmental justice, the fair treatment of all people with respect to environmental policy
- Providing greater comfort and healthier indoor environments
- 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 innovate in whole building design, 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 cycle, 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 the sponsors, jurors, design partners, and the buildings industry at large. With each new competition, we see significant growth and interest in how industry leaders engage students about job and professional development opportunities.

DOE is very excited to engage collegiate teams to become part of the next generation of building designers and engineering professionals. This document is designed to help ensure your success. We encourage you to read it in full and closely follow its guidance 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 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. Decarbonized. Innovative. Resilient. Smart. Inclusive. Market ready. These words describe more than the ideal building. They distinguish the students who have participated in DOE's premier building competitions.

The Solar Decathlon offers a unique experience that enables collegiate teams to develop critical career skills, learn from both national experts and peers, and gain valuable insights from world-class thought leaders and mentors. 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. Teams are evaluated on 10 Contests, and the winning teams are those that best blend the topics of architectural and engineering excellence with innovation, market potential, building efficiency, smart energy production, and environmental justice.

“For 20 years, DOE's Solar Decathlon has harnessed the ingenuity and enthusiasm of America's students to generate cutting-edge climate solutions,” said **U.S. Secretary of Energy Jennifer M. Granholm**. “The innovative building designs developed by this year's competitors demonstrate how clean energy technologies can be applied to households across the country, including slashing costs for American families, modernizing energy infrastructure, and decarbonizing the building sector.”

Keep reading to learn more about the history and structure of the Solar Decathlon and for more specifics about each of the 10 Contests.

## 2. History

The award-winning [Solar Decathlon](#) began with a public event on the National Mall in Washington, D.C., in 2002. DOE has since hosted a total of 10 Solar Decathlon Build Challenge competitions in the United States, growing technology and workforce benefits with each event. The Solar Decathlon has also expanded internationally, with six international regions that have hosted their own events and have several more planned.

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

### 3. Building Science to Ensure High-Performance Buildings

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

To help meet these objectives, participating students are provided with an online, comprehensive Building Science Education series designed to enhance their academic curriculum. In addition, other topical webinars are provided to support team members’ skill development and technical progress. Through the video and webinar series, students have the opportunity to learn more about fundamental building science, design strategies for high-performance buildings, energy efficiency, and energy production than they would in the classroom alone.

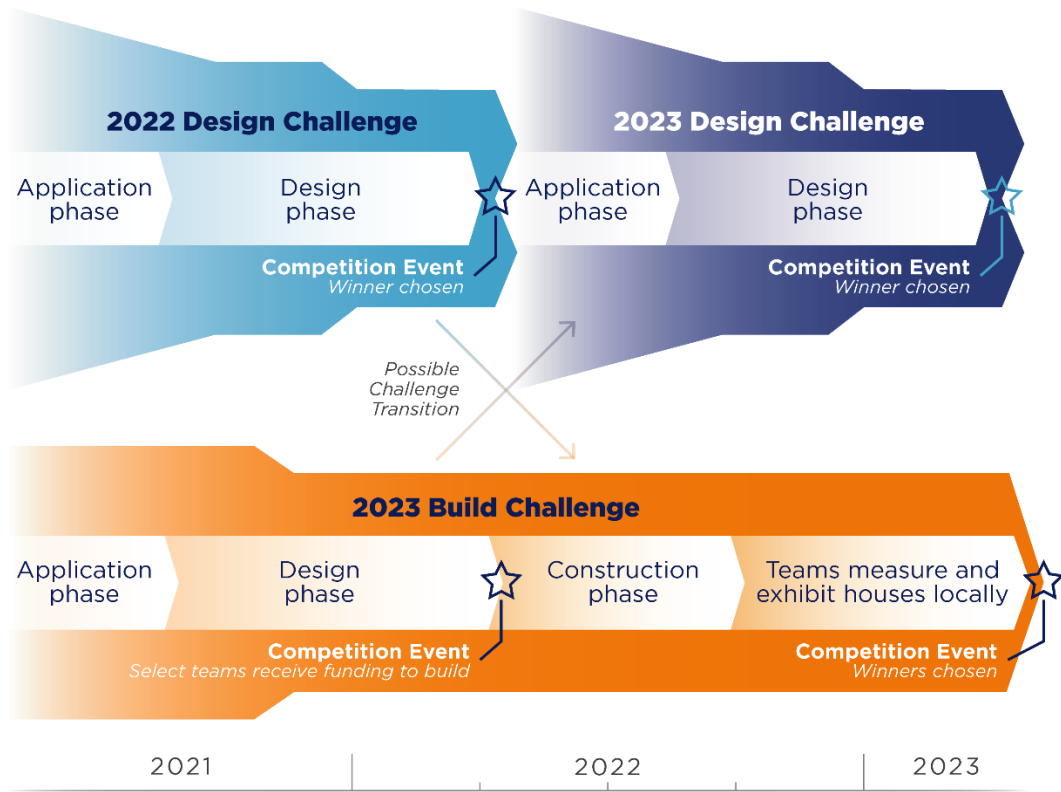
### 4. A True Decathlon: 10 Contests

This Solar Decathlon, which spans the 2023 Design Challenge and 2023 Build Challenge, gives teams the option to participate in either Challenge. Design Challenge teams must create their design from one of six allowable building types, called “Divisions.” Build Challenge teams will build or retrofit a residential unit in their local community and compete nationally.

For each Challenge, all teams are evaluated across 10 Contests, described in more detail in Section 8 of this document. As with athletic decathlons, teams must perform well across all 10 Contests to be victorious. Figure 1 shows the competition structure and Contests.



Figure 1. Structure of the Solar Decathlon



**Figure 2. Timeline of the Solar Decathlon**

Figure 2 depicts the annual cycle for the Design Challenge in conjunction with the two-year Build Challenge cycle, showing how the two Challenges run parallel amid individual deadlines and activities.

## 5. Design Challenge (Annual)

Teams that compete in the annual Solar Decathlon *Design Challenge* create residential or commercial building designs over one or two semesters. Designs are evaluated on how well they meet the nation’s rapidly evolving demand for zero energy buildings. Full details are provided in the separate [Design Challenge Rules](#) document, which should be reviewed carefully, and a few key points are noted here:

- Design Challenge teams choose to compete in one of six Divisions:
  - New Housing (NH)
  - Retrofit Housing (RH)
  - Attached Housing (AH)
  - Multifamily Building (MB)
  - Office Building (OB)
  - Education Building (EB).

- Teams register and begin projects as early as July of the year preceding the competition (for example, beginning in July 2022 for the 2023 Design Challenge). For the Design Challenge Team Registration, each team:
  - Identifies a Faculty Lead
  - Selects the Division in which the team intends to compete.
- Participant Teams are confirmed and announced in November. All teams that successfully complete their Design Challenge registration are accepted.
- Each Participant Team will complete a submission for evaluation the following February. Finalist Teams are selected based on these submissions.
  - All teams are invited to compete further with a final submission of their design at the annual hybrid Competition Event, held at the National Renewable Energy Laboratory (NREL) campus in Golden, Colorado.
- Winners from each Division are determined through juried evaluation across all 10 Contests, and winners are awarded with trophies at the Competition Event. Two Design Challenge Grand Winners (one for the Residential Divisions and one for the Commercial Divisions) are also selected from the pool of winners. See the [Design Challenge Rules](#) for more information on awards.

## 6. Build Challenge (Biennial)

Teams that compete in the Solar Decathlon *Build Challenge* design fully functional houses compliant with Challenge guidelines and then build/remodel, exhibit, and operate houses in their own communities. Each house is extensively measured to evaluate its performance, and teams present to multiple juries in competition with all other teams. For the Build Challenge, each of the 10 Contests are scored independently, and the team with the most points at the end of the competition wins.

Full details are provided in the separate [Build Challenge Rules](#) document, which should be reviewed carefully, and a few key points are noted here:

- The application period for the 2023 Build Challenge closed in October 2021.
- Teams will design and build a house for their local communities, competing nationally against other teams.
- For the Build Challenge application, each team:
  - Identifies a Faculty Lead or student Team Lead with a preliminary roster of student members
  - Submits a required Build Challenge Proposal including a conceptual house design, letters of team support from collegiate institution leadership and industry partners, and a project management plan.
  - Pays a nonrefundable \$50 application fee.
- Participant Teams are confirmed and announced by December. All teams that successfully complete their Build Challenge application are accepted.

- Each Participant Team presents its solutions at the Competition Event, held annually in April at the NREL main campus in Golden, Colorado. In 2022, Build Challenge teams presented their preliminary designs at the Competition Event, and in 2023 they will present their completed buildings.
  - At the 2022 Competition Event, 21 teams were selected as finalists and received Approval to Proceed to the competition's construction phase. Teams not selected for the construction phase will have the option to enter the next Design Challenge.
- Winners will be awarded trophies at the 2023 Competition Event.



## 7. Two Challenges

When considering participation in the Solar Decathlon, prospective students and teams should consider the expectations for each Challenge, summarized in Table 1.

**Table 1. Expectations for Participation in Design Challenge and Build Challenge**

<b>Expectation</b>	<b>Design Challenge</b>	<b>Build Challenge</b>
Scope of Project	Design and present	Design, build, operate, and exhibit
Team Commitment	One to two semesters	Two academic years
Building Type(s)	Residential and commercial	Residential
Industry Engagement	Design Partners and industry partners	Guidance and oversight during design and/or construction activities, as well as direct hands-on support as needed.
Exhibit Activities	Live presentations to competitors and jurors at the Competition Event; some activities will be available virtually to the public	Local community exhibition and tours of built house, as well as presentations to competitors and jurors at the Competition Event
Financial Resources Required	Optional cost of student and faculty travel to the annual Competition Event at NREL in Golden, Colorado (virtual options available); Cost of time for faculty leadership	\$50 Application Fee; Cost of building house, including all materials and infrastructure (often a mix of funds from institution, alumni, industry, and sponsorship); Optional cost of travel for students and faculty to multiple events (2022 Competition Event and 2023 Competition Event, both at NREL); Cost of time for faculty leadership, student stipends, and scholarships
Financial Resources Provided by Competition Organization	None	\$50,000 each for up to 30 teams, distributed as Prize Funding

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

### 7.1 Procedure for Transitioning Between Challenges

#### *2023 Build Challenge to 2023 Design Challenge Transition*

Teams participating in the 2023 Build Challenge may withdraw and register to compete in the 2023 Design Challenge by October 26, 2022. Registration for the 2023 Design Challenge by

2023 Build Challenge teams beyond this deadline may be approved at the discretion of the competition organizers.

A key stipulation that teams need to consider is the requirement that projects must show “substantial change” from the design that was previously presented in the Approval to Proceed phase for the 2023 Build Challenge. Interpretation of this stipulation will be considered on a case-by-case basis by the competition organizers.

**Transitions between the 2022 Design Challenge and 2023 Build Challenge are no longer possible. The information below lists the transition process and timeline for historical purposes only.**

### ***2023 Build Challenge to 2022 Design Challenge Transition***

Teams participating in the 2023 Build Challenge may transition to the 2022 Design Challenge with approval from the Solar Decathlon organizers.

To successfully complete this transition and maintain eligibility for the competition, teams must do the following before February 22, 2022:

- Notify the organizers via email of intent to transition, copying the Team Lead and Faculty Advisor.
- Submit the Semifinal Submission deliverable for the 2022 Design Challenge (due on February 22, 2022).

This will allow transitioning teams to participate in the Solar Decathlon Semifinal Event, February 25–26, 2022, to be evaluated for selection as a Finalist Team in the 2022 Design Challenge.

After February 22, 2022, Build Challenge teams wishing to transition should sign up for the 2023 Design Challenge and participate according to the Rules.

### ***2022 Design Challenge to 2023 Build Challenge Transition***

Teams participating in the 2022 Design Challenge have two options to transition to the 2023 Build Challenge. Both require approval from the Solar Decathlon organizers.

#### ***Option One***

**To maintain eligibility to compete for Approval to Proceed and Build Challenge prize funding in April 2022**, teams must do the following before March 29, 2022:

- Notify the organizers via email of intent to transition, copying the Team Lead and Faculty Advisor.
- Provide all Build Challenge deliverables to date by April 12, 2022.

#### ***Option Two***

**To transition after the 2022 Solar Decathlon Competition Event**, and therefore relinquish eligibility to compete for Build Challenge prize funding, 2022 Design Challenge Finalist Teams must do the following between April 24, 2022, and June 1, 2022:

- Notify the organizers via email of intent to transition, copying the Team Lead and Faculty Advisor.
- Provide all Build Challenge deliverables to date within two (2) months of starting Build Challenge for review by organizers.
- Acknowledge the forfeiture of eligibility for prize funding awarded to 2023 Build Challenge teams in April 2022 upon the receipt of Approval to Proceed.
- Acknowledge that the transition to the 2023 Build Challenge is subject to receipt of Approval to Proceed from the Build Challenge jury and competition manager.
- Use the 2022 Design Challenge submission as the basis of Build Challenge design development.

After June 1, 2022, Design Challenge teams wishing to transition will need to complete a Team Application for the 2025 Build Challenge, beginning in July 2023, and participate according to the Rules.

## 8. Descriptions of the 10 Contests

Teams in both Challenges are evaluated to determine how effectively they integrate energy efficiency into well-designed, high-performance buildings that “push the envelope” for consumers and industry. More specifically, all Participant Teams compete in the following 10 Contests. See the [Design Challenge Rules](#) and [Build Challenge Rules](#) for specific evaluation criteria.

### 1. Architecture

This Contest evaluates the building’s architecture for creativity in matching form with function, overall integration of systems, and ability to deliver both outstanding aesthetics and functionality.

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

### 2. Engineering

This Contest evaluates the effective design of high-performance engineering systems, technologies, and techniques that enable energy efficiency adoption and renewable energy production.

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

### 3. Market Analysis

This Contest evaluates the building’s appeal, affordability, and attainability to the stated target market. This includes addressing specific market needs and socioeconomic barriers to increase likelihood of adoption by intended occupants and the construction industry for impactful, cost-effective design.

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

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

#### **4. Durability and Resilience**

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

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

#### **5. Embodied Environmental Impact**

This Contest evaluates cumulative environmental impact of all processes over the course of the building life cycle, including extraction of raw materials, production and manufacturing processes, shipping, construction, operation, and end-of-life.

Various measurements and calculations are used to quantify the environmental impacts that are embodied into the building at each life cycle stage. As buildings become more resource efficient during occupancy, the environmental impact during this stage decreases. Consequently, the other life cycle stages—such as material production, manufacturing, construction processes, and end of life—become larger contributors to a building's total environmental impact and, therefore, become more important to address. The building industry must go beyond the occupancy stage to address these impacts in all life cycle stages.

## 6. Integrated Performance

This Contest evaluates the interdependencies of building design elements to achieve optimized whole building performance. In a truly integrated design, when any element is altered or removed from the building, overall building performance is diminished.

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

## 7. Occupant Experience

This Contest evaluates how the building design prioritizes the occupant experience, productivity, and quality of life.

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

## 8. Comfort and Environmental Quality

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

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

## 9. Energy Performance

This Contest evaluates whole building energy consumption and how it is offset by renewable energy systems.

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

## 10. Presentation

This Contest evaluates effective communication of design strategies to relevant audiences, including written, verbal, multimedia, and visual presentation materials.

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

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

**10** Contests | **2** Challenges | **1** Decathlon



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