



U.S. DEPARTMENT OF ENERGY

SOLAR DECATHLON

2022 Design Challenge Rules

January 2022

List of Acronyms

AH	Attached Housing
ANSI	American National Standards Institute
Btu	British thermal unit
DOE	U.S. Department of Energy
EB	Education Building
EDT	Eastern Daylight Time
EST	Eastern Standard Time
EUI	energy use intensity
HERS	Home Energy Rating System
HPwES	Home Performance with ENERGY STAR®
HVAC	heating, ventilating, and air conditioning
kBtu	kilo-British thermal unit
MB	Multifamily Building
NH	New Housing
NREL	National Renewable Energy Laboratory
OB	Office Building
pv	photovoltaic
RESNET	Residential Energy Services Network
RH	Retrofit Housing
USCS	United States Customary System

Foreword—Why Solar Decathlon Design Challenge?

Buildings account for 40% percent of total energy consumption in the United States, and 20% of global energy consumption.¹ Through direct use of fossil fuels and fossil-fuel-produced electricity, buildings have a substantial impact on the environment and long-term resource availability. Beyond environmental impact, buildings are a focal point for emerging crises related to environmental justice, affordability, health, disaster risks, and water shortages.

Shifting the building paradigm from resource-intensive to regenerative requires a skilled workforce of design professionals with multidisciplinary skills in high-performance building strategies. This demands whole building design that addresses comprehensive building science, energy efficiency, indoor air quality, occupant experience, human health, optimized mechanical systems, embodied environmental impact, affordability, resilience, and resource conservation. However, professional curricula and degree programs across the United States and around the world are inconsistent, with many lacking the resources needed to adequately address these complex issues.

To help address this gap, the U.S. Department of Energy (DOE) Solar Decathlon® Design Challenge focuses on two critical goals: to incorporate high-performance building design strategies into curriculum, and to inspire students to pursue sustainable building careers. Designed to support educational programs in training the next generation of designers, the Solar Decathlon's 10 Contests aim to transform the building industry by challenging student teams to think beyond a zero energy ready building and address complex real-world issues—energy insecurity, food systems, waste streams, climate change, carbon emissions, inequity, and social inequality through building design.

Design Challenge outcomes demonstrate substantial success toward these goals, including:

- Participation by more than 5,000 students from 197 collegiate institutions across 23 countries and 46 U.S. states
- A network of more than 1,000 industry partners
- A 300% increase in the number of Participant Teams since program inception
- 92% of Design Challenge students surveyed recommend participation to their peers.

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

¹ U.S. Energy Information Administration. April 2021. “Monthly Energy Review,” Table 2.1. <https://www.eia.gov/totalenergy/data/monthly/>.

Table of Contents

Foreword—Why Solar Decathlon Design Challenge?	ii
1 Challenge Overview	1
1.1 Summary of Important Dates	2
2 Building a Team	1
2.1 Team Requirements.....	1
2.2 Student Qualifications	1
2.3 Faculty Lead Role	1
2.4 Design Partners	2
2.5 Industry Engagement.....	2
2.6 Mentor Program	2
3 Project Requirements	3
3.1 Zero Energy Building Requirements.....	3
3.2 Divisions	6
4 Contests	8
4.1 Architecture.....	9
4.2 Engineering	9
4.3 Market Analysis	9
4.4 Durability and Resilience	10
4.5 Embodied Environmental Impact.....	10
4.6 Integrated Performance	11
4.7 Occupant Experience.....	11
4.8 Comfort and Environmental Quality.....	11
4.9 Energy Performance.....	12
4.10 Presentation	12
5 Evaluation Process	13
5.1 Evaluation Rating Scale	13
5.2 Project Summary	14
5.3 Solar Decathlon Semifinal Competition to Select Finalists	14
5.4 Final Submission to Select Winners.....	15
5.5 Competition Event.....	15
5.6 Grand Jury Award	16
5.7 Bonus Certificates for Creativity.....	17
6 Deliverables	18
6.1 Project Summary Submission Instructions.....	19
6.2 Semifinal Submission Instructions.....	20
6.3 Final Submission Instructions	22
6.4 Faculty Report Submission Instructions.....	27
Glossary	29
Appendix A: Resources	33

Solar Decathlon Design Challenge Competition Rules Authors: NREL’s Rachel Romero, Amanda Kirkeby, Jes Stershic, and Paul Torcellini.

1 Challenge Overview

This document outlines the Rules and evaluation criteria for teams competing in the Solar Decathlon Design Challenge, a collegiate competition with 10 Contests that challenge student teams to design innovative high-performance, low-carbon buildings powered by renewable energy. For additional information, refer to the [Solar Decathlon Competition Guide](#).

Over one to two semesters, Design Challenge participants prepare creative solutions that address real-world issues in the building industry. The experience offers students a unique opportunity to:

- Engage with real-world Design Partners,
- Collaborate with industry experts,
- Exchange design strategies with other teams around the world,
- Learn from national thought leaders and collegiate peers,
- Experience zero energy building design firsthand, and
- Engage with organizations about careers related to improving the built environment.

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

1.1 Summary of Important Dates

The following are key milestones for the 2022 Design Challenge:

- **July 2021:** 2022 Design Challenge Rules are released.
 - Team Application opens on the [Solar Decathlon website](#). To complete the application, teams use the [Project Site](#), which is an online platform used to communicate timely information from organizers and submit deliverables.
 - Once a team completes the application, they are a “Participant Team” and can begin work on their design.
 - Resources are provided on the [Project Site](#), including an on-demand Building Science Education course, topical webinars, and energy modeling software.
- **September 16, 2021:** Ready, Set, Solar Decathlon Event
 - A virtual event covering competition expectations, deliverables, timeline, and resources available to Participant Teams.
 - All students and faculty, new and returning, interested in participating are highly encouraged to attend.
- **October 26, 2021, 5 p.m. EDT:** [Team Application](#) is due on the [Project Site](#).
 - The Team Application must indicate which Division the team intends to enter.
 - Each team must pay a nonrefundable \$50 fee.
 - Teams are required to identify a Faculty Lead and a Student Team Lead.
- **November 30, 2021, 5 p.m. EST:** Teams submit a Project Summary via the [Project Site](#).
 - This submission is optional; however, teams will receive feedback on project compliance based on this submission.
- **January 2022:** An updated version of the Solar Decathlon 2022 Design Challenge Rules is released with clarifications and any needed corrections.
- **February 22, 2022, 5 p.m. EST:** Semifinal Submission deliverables are due on the [Project Site](#). These include:
 - Updated Project Summary
 - 8-minute Presentation Slides
 - Final Division selection
 - Building Science Education completion, or equivalency waiver from faculty.
- **February 25–26, 2022:** Solar Decathlon Semifinal Competition
 - Participant Teams present to industry leaders at the Solar Decathlon Semifinal competition.
 - Presentations are evaluated against criteria indicated in this Rules document.

- Up to 10 Finalist Teams per Division will be selected to compete in the Competition Event.
- All Participant Teams are encouraged to complete their designs and the associated submissions regardless of finalist status. Teams that complete the final submission deliverables will be invited to participate in the Competition Event.
- **April 5, 2022, 5 p.m. EDT:** Final deliverables are submitted via the [Project Site](#). These include:
 - Updated Project Summary
 - Design Narrative
 - Multimedia Project Pitch
 - Team Photos
 - Supplemental Documentation (optional).
- **April 19, 2022, 5 p.m. EDT:** Teams must submit their Presentation Slides for the Competition Event.
 - Presentations are not accepted after this date.
- **April 22–24, 2022: Solar Decathlon Competition Event**
 - Finalist Teams present to industry leaders for Division Winner selection on the NREL Main Campus in Golden, Colorado, USA.
 - All Participant Teams take part in related competition events.
 - Design Challenge winners are announced.
- **May 24, 2022:** The Faculty Report is due to the organizers at SDdesign@nrel.gov.

2 Building a Team

2.1 Team Requirements

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

- Each team must be associated with a collegiate institution and include a Faculty Lead. Multiple collegiate institutions may combine to form a team. One Faculty Lead may counsel multiple teams.
- Each team must have at least three students, with one student designated as the Student Team Lead. There is no maximum number of student team members.
- The strongest teams are multidisciplinary, composed of students from a variety of degree programs. See Section 2.2 for more detail.
- A collegiate institution may only submit one Team Application per Division (see Section 0). A team may choose to have several internal groups of students complete designs and then submit only one project design at the submission deadline.
- The Team Application costs \$50 per team in each Division and is nonrefundable.
- At least one student and one Faculty Advisor from each Finalist Team are required to participate in the Competition Event.

2.2 Student Qualifications

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

In addition, students must meet the following:

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

2.3 Faculty Lead Role

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

- Ensuring familiarity with the Design Challenge Rules and guidance.
- Ensuring all student team members complete the Building Science Education course, or indicating that comparable building science training is part of the core curriculum by

providing an equivalency waiver. The Faculty Lead can also encourage the students to view additional webinars and access training materials that are most relevant to the team.

- Ensuring that the necessary information is provided to team members participating in the Competition Event.

2.4 Design Partners

Teams are strongly encouraged to engage a Design Partner in their project. Design Partners are organizations that have a planned new construction or major retrofit project in their building portfolio and would like to work with a team to develop a zero energy design option for the project. For example, a school district that is planning a major retrofit to an existing school could be a Design Partner and work with a team to receive a zero energy design and cost analysis for the retrofit.

Teams should secure their own Design Partner; a limited number of Design Partner opportunities will be posted on the [Solar Decathlon website](#). The Design Partner should:

- Provide teams with basic project information and requirements.
- Provide up to 30 hours of engagement with the team over the course of the competition for design programming, iterative schematics, and feedback.

A representative from each Design Partner organization may participate in the Competition Event.

2.5 Industry Engagement

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

2.6 Mentor Program

The Mentor Program pairs Solar Decathlon alumni from any competition year with participating Design Challenge teams to share best practices learned through their experiences. All teams may request a mentor in the Team Application and will be paired with mentors based on availability; teams are not guaranteed a mentor. Mentors provide up to 15 hours of support to student teams during the competition period, which may include nontechnical review and feedback on project management, direction, deliverables, and presentation. Mentors are not permitted to complete any project work on the team's behalf. Student teams are responsible for leading the relationship with their mentor and are expected to keep mentors updated on project progress and outcomes.

3 Project Requirements

Design submissions are required to meet the following specifications:

- The team must select 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.
- Projects must be substantially different from any submitted to DOE competitions in the past. If a school has multiple teams competing in the Solar Decathlon across the Design and Build Challenges, each team must have distinct designs.
- The building design must comply with zero energy building requirements, outlined in Section 3.1.
- The building design must comply with Division requirements outlined in Section 0.
- The team must address criteria for all 10 Solar Decathlon Contests, outlined in Section 4.
- Teams should follow applicable codes for the building’s expected jurisdiction. These include local, state, and national codes and 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 submissions.
- United States Customary System (USCS) units of measurement are required; a submission with both metric units and USCS units is acceptable. If metric units are used, state USCS units first, followed by metric equivalents in parentheses—example: 125 feet (ft) (38.1 meters [m]).

3.1 Zero Energy Building Requirements

Zero site energy is integral in reducing the impacts of carbon. As a central project requirement, a design project submission must be a zero energy building—a high-performance building with a renewable energy system that offsets all of the building’s annual energy consumption.

The pathway to a zero energy building begins with reducing the energy needs of buildings such that renewable energy can meet the remaining load. Renewable energy must be integrated into the project. After maximizing on-site generation, other options, such as participating in a community-scale renewable energy project or specifying utility-provided renewable power, can be used.

Evaluating Building Energy Performance

Energy analysis is invaluable for predicting energy performance and evaluating trade-offs to achieve energy goals. Energy analysis can be conducted using a variety of software programs. Free tools and resources for these calculations are on the [Project Site](#).

Home Energy Rating System Index

The residential building industry commonly uses the Home Energy Rating System (HERS) Index to indicate energy efficiency. A lower score signifies a more energy-efficient home. To determine the score, homes are compared to a benchmark based on the [2006 International](#)

[Energy Conservation Code](#). The HERS score can be calculated by using any Residential Energy Services Network (RESNET)-accredited HERS software.

HERS rating software calculates heating, cooling, hot water, lighting, and appliance energy loads, consumption, and costs for new and existing single-family and multifamily homes. Software licenses for RESNET-accredited programs, REM/Rate and Ekotrope, are provided to teams; however, using them is not required.

Energy Use Intensity

Building energy consumption is often evaluated based on the energy use intensity (EUI), which is measured as the total energy consumed annually divided by the gross floor area (kilo-British thermal unit [kBtu]/ft² or kilowatt-hours/m²). Alternative metrics for comparison are also useful, such as energy divided by total students (kBtu/student) for the Education Building Division.

EUI can be calculated with respect to source energy as well as site energy. Site energy is measured at the boundary of the site, often by electric or natural gas meters. Source energy accounts for all the upstream losses associated with converting and transporting energy to the building site. 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. Source energy is calculated by taking the site energy and applying a site-to-source multiplier for each energy source²:

$$Energy_{source} = Energy_{site} * Conversion\ factor_{site\ to\ source}$$

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

² See “[A Common Definition for Zero Energy Buildings](#)” for methodology in calculating EUI and source energy from site energy.

Table 1. Source Energy³ Use Intensity Targets for Education,⁴ Multifamily,⁵ and Office Buildings⁶

Climate Zone	Education Building Source EUI (kBtu/ft ² yr)	Multifamily Building ⁷ Source EUI (kBtu/ft ² yr)	Office Building Source EUI (kBtu/ft ² yr)
0A	69	80	80
0B	71	96	96
1A	66	81	81
1B	67	89	89
2A	64	77	77
2B	60	79	79
3A	57	74	74
3B	58	73	73
3C	53	55	55
4A	56	75	75
4B	55	71	71
4C	52	60	60
5A	57	80	80
5B	56	79	79
5C	50	61	61
6A	63	96	96
6B	58	86	86
7	66	88	88
8	71	100	100

Table 2. Exterior Lighting Allowances for Education, Multifamily, and Office Buildings

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

³ For the methodology for calculating source energy, see “[A Common Definition for Zero Energy Buildings.](#)”

⁴ This is adapted from the “Advanced Energy Design Guide for K–12 School Buildings: Achieving Zero Energy”; see <https://www.ashrae.org/technical-resources/aedgs/zero-energy-aedg-free-download>.

⁵ This is based on a simulation result for office and light retail. Documentation is not available at this time.

⁶ This is based on preliminary simulations from “Advanced Energy Design Guide for Small to Medium Office Buildings: Achieving Zero Energy”; see <https://www.ashrae.org/technical-resources/aedgs/zero-energy-aedg-free-download>.

⁷ EUI values for Multifamily Building can be applied to either the commercial portion of the space or the entire building, including vertical transportation, common areas, plug loads, HVAC, and lighting.

3.2 Divisions

Design Challenge Divisions represent different residential and commercial building types. Design Challenge teams must specify a single Division in which they will participate.

Each collegiate institution may submit up to six applications but may *not* have more than one team in any Division.

Residential Divisions:

New Housing (NH)

New Housing is defined as a residential new construction for one to two dwelling units.

1. New build for one to two dwelling units.
2. Independent, detached structure.
3. Building size: 300–4,500 ft² (28–418 m²) per dwelling unit.
4. HERS Score before renewable energy generation: 45 or less.
5. Meets [DOE Zero Energy Ready Home National Program Requirements \(Rev. 07\)](#).

Retrofit Housing (RH)

Retrofit Housing is defined as renovating an existing building for one to two dwelling units to zero energy construction through upgrades to systems, such as plumbing, electrical, mechanical, and envelope. This includes adaptive reuse.

1. Modifies an existing building for one to two dwelling units.
2. Independent, detached structure.
3. Building size: 300–4,500 ft² (28–418 m²) per dwelling unit.
4. HERS Score before renewable energy generation: 50 or less.

Attached Housing (AH)

Attached Housing is defined as multiple dwelling units within a single building.

1. Row homes or flats, 3–12 dwelling units; building is up to 3 stories above grade.
2. New construction or retrofit allowed.
3. Building size: 500–2,500 ft² (46–232 m²) per dwelling unit.
4. HERS Score before renewable energy generation: 50 or less.
5. For new construction, must meet [DOE Zero Energy Ready Home National Program Requirements \(Rev. 07\)](#).

Commercial Divisions:

Multifamily Building (MB)

A Multifamily Building is defined as a structure that contains multiple dwelling units.

1. Minimum of 8 dwelling units; building is up to 10 stories above grade.
2. New construction or retrofit allowed.
3. Building size: 350–2,000 ft² (33–186 m²) per dwelling unit.
4. Up to 50% of total area may be devoted to commercial use, such as retail, office, and industrial; remaining area is dedicated to residential use.
5. For new construction, dwelling units must meet [DOE Zero Energy Ready Home National Program Requirements \(Rev. 07\)](#). For the commercial portion of building, the source EUI must be less than the source EUI target shown in Table 1 in Section 3.1.

As an alternative, the entire building can comply with the source EUI target as shown in Table 1 in Section 3.1.

Office Building (OB)

An Office Building is defined as a commercial office building with full fit and finish including support functions, such as mechanical and electrical spaces, circulation, vertical transportation, and restrooms.

1. Building size: 10,000–250,000 ft² (929–23,226 m²) with 1–15 stories.
2. New construction or retrofit allowed.
3. Up to 50% of total area may be devoted to other commercial use, such as retail, laboratory, and industrial; remaining area is dedicated to office space.
4. To meet the zero energy building requirements, the source EUI target before renewables must be less than that shown in Table 1 in Section 3.1.

Education Building (EB)

An Education Building is defined as an educational facility for students and includes permanent provisions for food service, recreation, offices, classrooms, and other support functions, such as mechanical spaces, circulation, and restrooms.

1. New construction or retrofit allowed.
2. Any combination of grade levels in the range from pre-kindergarten to 12th grade.
3. The source EUI target before renewables must be less than that shown in Table 1 in Section 3.1.

4 Contests

Project submissions are evaluated across the 10 Contests outlined in Table 3. Jurors evaluate how well teams meet or exceed criteria for each Contest through design and technical documentation, project plans, reports for required analyses, and the quality and content of their presentations. Detailed evaluation criteria for each Contest are provided in the following sections (Sections 4.1–4.10).

Across all Contests, the Solar Decathlon values innovation and creative approaches informed by a strong understanding of fundamental building science. Teams are encouraged to incorporate solutions that use new technologies or creative strategies that leverage existing technologies for improving building performance and feasibility.

All Contests are equally weighted and should be addressed in a seamless, integrated design to demonstrate competency in applying building science and whole building design strategies.

Table 3. Contests

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

4.1 Architecture

Contest Intent

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

Design Challenge Criteria

The jury evaluates teams on each of the following:

- Integration of building form and function, including exterior and interior architecture with respect to the target market, climate, and zero energy building goals
- Quality of the design and appearance, including floor plan and interior details for flow, furnishings, storage, linkages to outdoors, and efficient use of space
- Consideration of specified site, including views, drainage, regionally appropriate materials, and community connection.

4.2 Engineering

Contest Intent

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

Design Challenge Criteria

The jury evaluates teams on each of the following:

- Effective building envelope design and material selection
- Comprehensive structural system considerations, including foundation
- Mechanical system selection and design, including HVAC systems
- Optimized lighting and electrical system design
- Plumbing system design for efficient water management.

4.3 Market Analysis

Contest Intent

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.

Design Challenge Criteria

The jury evaluates teams on each of the following:

- Execution of market analysis, including affordability and financial feasibility, to meet current market expectations for owner experience
- Application of market-ready construction materials and their cost-effectiveness in the design
- Life cycle cost comparison between a minimally code-compliant building and the proposed design
- Operational and maintenance cost estimate.

4.4 Durability and Resilience



Contest Intent

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

Design Challenge Criteria

The jury evaluates teams on each of the following:

- Building enclosure integration of all four building science control layers (e.g., thermal, air, bulk moisture, and moisture vapor), including foundation, walls, roof, and openings
- Analysis of the prevailing resilience risks associated with weather, natural or human-caused events, and grid disruptions
- Integration of building design and construction strategies to withstand and recover from identified resilience risks.

4.5 Embodied Environmental Impact



Contest Intent

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.

Design Challenge Criteria

The jury evaluates teams on each of the following:

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

4.6 Integrated Performance

Contest Intent

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.

Design Challenge Criteria

The jury evaluates teams on each of the following:

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

4.7 Occupant Experience

Contest Intent

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

Design Challenge Criteria

The jury evaluates teams on each of the following:

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

4.8 Comfort and Environmental Quality

Contest Intent

This Contest evaluates the building's capability to deliver healthy, comfortable environmental quality.

Design Challenge Criteria

The jury evaluates teams on each of the following:

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

4.9 Energy Performance



Contest Intent

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

Design Challenge Criteria

The jury evaluates teams on each of the following:

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

4.10 Presentation



Contest Intent

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

Design Challenge Criteria

The jury evaluates teams on each of the following:

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

5 Evaluation Process

The evaluation process of the competition is a multistage process:

- Teams submit an initial Project Summary to gain preliminary feedback on compliance with the Rules, Division definitions, and submission formatting (optional, but highly recommended).
- Solar Decathlon Semifinal Competition
 - Teams complete the Semifinal Submission deliverables and present to industry experts at the virtual Solar Decathlon Semifinal event.
 - Finalist Teams are selected to advance to the final stage of Competition.
- All teams regardless of Finalist status submit a final design, and associated deliverables submissions are evaluated by Division Jurors.
- Solar Decathlon Competition Event
 - Teams present to jury panels of industry experts within their Division.
 - Jurors select Division Winners from competing Finalist Teams.
 - Division Winners present to the Grand Jury to select Residential and Commercial Grand Winners.

Detailed descriptions of each stage of competition are outlined below.

5.1 Evaluation Rating Scale

The following scale is used to evaluate the submissions:

Table 4. Evaluation Scale

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

5.2 Project Summary

The first deliverable is an initial Project Summary, which provides an opportunity to submit preliminary information about each project. Though optional, it is highly recommended that teams submit the Project Summary to gain preliminary, qualitative feedback to improve and iterate upon their design. It also familiarizes teams with the submission process and how to comply with Rules requirements.

It is understood that the first submission of the Project Summary might be based on considerations and aspirations, or be otherwise tentative and subject to change in future submissions. The organizers will provide feedback on the following:

- Compliance with Division definition
- Submission formatting compliance.

Deliverables

See Section 6.1 for a full description of deliverable submission requirements.

- Project Summary submitted via the [Project Site](#).

5.3 Solar Decathlon Semifinal Competition to Select Finalists

The Solar Decathlon Semifinal Competition is a virtual event at which all Participant Teams present to panels of industry experts. At this stage, Finalist Teams are selected to advance to the final stage of competition.

Finalist Teams are selected based on the following:

- Teams submit the Semifinal Submission deliverables via the [Project Site](#).
- Each participating team will present a virtual 8-minute presentation to a panel of Division jurors, each with 1–3 industry experts.
- Jurors individually evaluate each team submission within their Division according to the following criteria:
 - Effectiveness of Project Summary in conveying the salient points of the project
 - Discussion of design goals
 - Discussion of target market, building occupant characteristics, and resulting impacts on the design constraints
 - Discussion of local climate and the impact of related building science considerations on design strategies
 - Discussion of building code constraints or standards and their impact on design strategies
 - Quality of team's plan for submitting the final design submission deliverables
 - Compliance with the Rules, including Division definitions and submission formatting

- Other factors, such as geographic locations and technology choices, that help optimize competition diversity and fairness.
- Up to 10 Finalist Teams per Division are selected to compete in the Competition Event based on evaluation of the presentation.
 - Regardless of finalist selection, all Participant Teams submit final design deliverables
 - Exhibition Teams – Teams that are not selected as Finalist Teams who submit a final design submission are invited to participate virtually in the final Competition Event in April 2022 as Exhibition Teams. Exhibition Teams cannot be selected as winners, but will present, gain feedback on their project, and participate in other events at the final Competition Event.
- Teams receive written feedback from Division Jurors via the [Project Site](#) within two weeks of the Semifinal event.

Deliverables

See Section 6.2 for a full description of deliverable submission requirements.

- Project Summary
- 8-minute Presentation Slides

5.4 Final Submission to Select Winners

The Final Submission deliverables fully document the final design. A panel of jurors for each Division evaluates and scores each team submission to select Division Winners.

The evaluation process is as follows:

- 3–4 industry experts are assigned to each Division Jury.
- Jurors individually review all Final Submission deliverables within their assigned Division and determine preliminary scores for each team.
- Preliminary team evaluation results are modified by the jurors based on the live Division Presentations and associated Q&A period during the Competition Event.

Deliverables

See Section 6.3 for a full description of deliverable submission requirements.

- Project Summary (updated)
- Design Narrative
- 3 Project Images
- Multimedia Project Pitch.

5.5 Competition Event

The Competition Event is the culmination of the competition. Finalist Teams compete for Division and Grand Winner Awards, and all teams who submit the Final Submission deliverables have the opportunity to present to industry experts. The Competition Event provides a rich

experience for participants to engage in networking opportunities and attend other team and professional presentations.

Based on performance in the Solar Decathlon Semifinal, up to 10 Design Challenge Finalist Teams in each Division will be invited to compete at the Competition Event, April 22–24, 2022.

- Finalist Teams will deliver an 8-minute Project Presentation live to the Division Jurors, with an additional 15 minutes for questions.
 - Faculty Advisors may not participate in the team’s presentation or Q&A.
- Division Juror panels select first-place, second-place, and third-place award winners in each Division based on the extent to which the design demonstrates the following attributes:
 - Understanding and application of building science
 - Excellence in aligning project design with competition intent
 - Excellence in the Contest criteria subject areas.
- The first-place team for each Division delivers a live presentation at the Awards Ceremony for evaluation by the Grand Jury, which chooses a Commercial Grand Winner and Residential Grand Winner according to the process described in Section 5.6.
 - The Grand Juror Presentation will be 8 minutes in length.
 - No time is reserved for questions during the Awards Ceremony.
- Division Jurors develop written feedback for the teams that is shared via the [Project Site](#) within 2 weeks of the Competition Event’s conclusion.

For the Competition Event:

- At least one student and one Faculty Advisor from each Finalist Team are required to participate in the Competition Event.
- Each team may have a maximum of 5 student team members present to juries. Additional team members may participate virtually in the Division Presentation Q&A.
- All team members may attend the Competition Event virtually.

Deliverables

See Section 6.3 for a full description of deliverable submission requirements.

- 8-minute Presentation Slides.

5.6 Grand Jury Award

The Grand Jury selects two Grand Winners from among the first-place teams based on the presentations given at the Awards Ceremony. One Grand Winner is selected from the residential Divisions, including NH, RH, and AH; the other is selected from the commercial Divisions, including MB, OB, and EB.

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

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

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

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

5.7 Bonus Certificates for Creativity

Bonus certificates are given to teams in addition to the Grand Winner awards and the Division awards. These are intended to recognize the excellence, professionalism, hard work, and enthusiasm that teams demonstrate beyond the required deliverables, and are selected by the organizers during the Competition Event. These may recognize excellence in:

- Team Spirit
- Team Virtual Background
- Team Name
- Team Photo
- Social Media Engagement
- First-Time Team
- Team Showcase Award
- Industry Engagement
- Addressing Environmental Justice
- Engagement at Competition Event
- First Complete Design Narrative Submitted
- Director's Award.

6 Deliverables

Throughout the Design Challenge, each team must submit scheduled deliverables for evaluation of its progress and design. The deliverables, file naming conventions, and due dates are below.

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

Deliverable	Required Content	File Name	Submit To
<u>November 30, 2021</u>			
Project Summary (2 pages)	Single, bookmarked PDF	22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_SUMMARY_2021-11-30.pdf	Project Site
<u>February 22, 2022</u>			
Updated Project Summary (2 pages)	Single, bookmarked PDF	22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_SUMMARY_2022-02-22.pdf	Project Site
8-minute Presentation Slides	Single, bookmarked PDF	22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_SEMIPRES_2022-02-22.pdf	Project Site
<u>April 5, 2022</u>			
Updated Project Summary (2 pages)	Single, bookmarked PDF	22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_SUMMARY_2022-04-05.pdf	Project Site
Design Narrative (Up to 60 pages)	Single, bookmarked PDF	22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_NARRATIVE_2022-04-05.pdf	Project Site
Project Images	.jpg, .tiff, or .png	PHOTO1, PHOTO2, TEAMPHOTO e.g.: 22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_PHOTO1_2022-04-05.pdf	Project Site
Multimedia Project Pitch	.mov or .mp4	22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_PITCH_2022-04-05.[EXTENSION]	Project Site
Supplemental Documentation (optional)	Single, bookmarked PDF	22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_SUP_2022-04-05.pdf	Project Site
<u>April 19, 2022</u>			
Final Presentation Slides	PDF and/or PPTX	22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_FINALPRES_2022-04-05.[EXTENSION]	Box
<u>May 24, 2022</u>			
Faculty Report	Single, bookmarked PDF	22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_FACULTY_2022-05-24.pdf	SDdesign@nrel.gov

Note that a “bookmarked” PDF means the file has each major header bookmarked for easy viewing. This makes it easier for the jurors and reviewers to move around within lengthy and

technical deliverables. For an example, note the bookmarks for this Rules document PDF. Guidance for creating a bookmarked PDF is provided on the [Project Site](#).

See Sections 6.1 through 6.4 for the requirements for each Design Challenge deliverable, as well as submission instructions.

Naming Files for Submissions

Please use the approved file naming convention below for all submissions; to use the example below, remove the brackets, [], with descriptive language and insert the appropriate abbreviation for your team. For example, the Project Summary naming convention is:

22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_SUMMARY_2021-11-30.pdf

For the National Renewable Energy Laboratory (NREL) team competing in the Retrofit Housing Division, the file name should be:

22DC_RH_NREL_SUMMARY_2021-11-30.pdf.

6.1 Project Summary Submission Instructions

The Project Summary communicates key aspects of the design project through a high-level description of the project and its highlights. Teams submit the Project Summary as a stand-alone document, developed via the Project Summary template found on the [Project Site](#). Past Project Summaries can be viewed on [past Design Challenges webpages](#), and an example is provided on the [Project Site](#).

For each deliverable submission phase, the Project Summary should follow the formatting outlined below. It is understood that for the first submission of the Project Summary, the details might be based on considerations and aspirations, or be otherwise tentative and subject to change in future submissions. The initial Project Summary will be revised for subsequent submissions.

Project Summary Format Requirements

<input type="checkbox"/> Paper size: Standard 8.5 inches (in.) × 11 in. (216 millimeters [mm] × 279 mm), ANSI A
<input type="checkbox"/> Formatting: Single-spaced, 11-point font for body text (diagrams may have smaller fonts)
<input type="checkbox"/> Borders: 0.5-in. (12.7-mm) minimum, except for tables, figures, and images
<input type="checkbox"/> Maximum length: 2 pages
<input type="checkbox"/> File type: Single, bookmarked PDF
<input type="checkbox"/> File size: Less than 10 MB
<input type="checkbox"/> File name: 22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_SUMMARY_[SUBMISSION DATE in format of YYYY-MM-DD].pdf

Project Summary Content Requirements

Project Summary
<input type="checkbox"/> List the project name, team name, Division, and collegiate institution(s) in the header.
<input type="checkbox"/> Replace the logo in the upper right with the team or collegiate institution's logo.
<input type="checkbox"/> Replace the building image with one or two graphics that best represent the project.
<input type="checkbox"/> Provide a concise description of the project, including a brief identification of the target market.
<input type="checkbox"/> Describe the relevance of the project to the goals of the competition.
<input type="checkbox"/> Summarize the design strategy and relevant key points.
<input type="checkbox"/> List the relevant project data, including cost estimates.
<input type="checkbox"/> Provide technical specifications for the project.
<input type="checkbox"/> Provide project highlights. Briefly explain how the design meets or exceeds the criteria in each Contest: <ol style="list-style-type: none">1. Architecture2. Engineering3. Market Analysis4. Durability and Resilience5. Embodied Environmental Impact6. Integrated Performance7. Occupant Experience8. Comfort and Environmental Quality9. Energy Performance.

6.2 Semifinal Submission Instructions

Teams submit the Semifinal Submission deliverables via the [Project Site](#). These deliverables provide an interim submission to demonstrate each team's progress and likelihood of completing the final design submission. If a team conducts an internal competition and creates multiple projects, only one Semifinal Submission per team can be submitted and reviewed for acceptance as a Finalist Team.

Semifinal Submission deliverables include:

- Updated Project Summary
- 8-minute Semifinal Presentation Slides.

Project Summary Format Requirements

<input type="checkbox"/> Paper size: Standard 8.5 in. × 11 in. (216 mm × 279 mm), ANSI A
<input type="checkbox"/> Formatting: Single-spaced, 11-point font for body text (diagrams may have smaller fonts); add page numbers for reviewer convenience
<input type="checkbox"/> Borders: 0.5-in. (12.7-mm) minimum, except for tables, figures, and images
<input type="checkbox"/> Maximum length: <ul style="list-style-type: none"> ○ Project Summary: 2 pages, including tables and figures
<input type="checkbox"/> File type: Single, bookmarked PDF
<input type="checkbox"/> File name: <ul style="list-style-type: none"> ○ Project Summary: 22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_SUMMARY_[SUBMISSION DATE in format of YYYY-MM-DD].pdf

Project Summary Content Requirements

Project Summary
<input type="checkbox"/> List the project name, team name, Division, and collegiate institution(s) in the header.
<input type="checkbox"/> Replace the logo in the upper right with the team or collegiate institution’s logo.
<input type="checkbox"/> Replace the building image with one or two graphics that best represent the project.
<input type="checkbox"/> Provide a concise description of the project, including a brief identification of the target market.
<input type="checkbox"/> Describe the relevance of the project to the goals of the competition.
<input type="checkbox"/> Summarize the design strategy and relevant key points.
<input type="checkbox"/> List the relevant project data, including cost estimates.
<input type="checkbox"/> Provide technical specifications for the project.
<input type="checkbox"/> Provide project highlights. Briefly explain how the design meets or exceeds the criteria in each of the following Contests: <ol style="list-style-type: none"> 1. Architecture 2. Engineering 3. Market Analysis 4. Durability and Resilience 5. Embodied Environmental Impact 6. Integrated Performance 7. Occupant Experience 8. Comfort and Environmental Quality 9. Energy Performance.

Semifinal Presentation Slides Format Requirements

<input type="checkbox"/> File type: PDF and/or PPTX (Presentation Slides must have an aspect ratio of 16:9.)
<input type="checkbox"/> To ensure that all electronically submitted materials work with the organizers' presentation computers, teams should embed all videos in the team submission.
<input type="checkbox"/> File name: <ul style="list-style-type: none">○ 22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_SEMIPRES_2022-02-22.pdf

6.3 Final Submission Instructions

The Final Submission demonstrates the culmination of each team's design work and provides the final materials needed to evaluate the project.

Final Submission deliverables include:

1. Project Summary (updated)
2. Design Narrative
3. 3 Project Images
4. Multimedia Project Pitch
5. 8-minute Presentation Slides.

Teams also have the option to submit Supplemental Documentation, further detailed in Section 6.3.3. The Project Summary, Design Narrative, and Multimedia Project Pitch will be reviewed by jurors and used to determine preliminary scores prior to the Competition Event.

The submission instructions for the Final Submission deliverables are detailed below.

6.3.1 Project Summary

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

Project Summary Format Requirements

<input type="checkbox"/> Paper size: Standard 8.5 inches (in.) × 11 in. (216 millimeters [mm] × 279 mm), ANSI A
<input type="checkbox"/> Formatting: Single-spaced, 11-point font for body text (diagrams may have smaller fonts)
<input type="checkbox"/> Borders: 0.5-in. (12.7-mm) minimum, except for tables, figures, and images
<input type="checkbox"/> Maximum length: 2 pages
<input type="checkbox"/> File type: Single, bookmarked PDF
<input type="checkbox"/> File size: Less than 10 MB
<input type="checkbox"/> File name: 22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_SUMMARY_2022-04-05.pdf

Project Summary Content Requirements

Project Summary
<input type="checkbox"/> List the project name, team name, Division, and collegiate institution(s) in the header.
<input type="checkbox"/> Replace the logo in the upper right with the team or collegiate institution's logo.
<input type="checkbox"/> Replace the building image with one or two graphics that best represent the project.
<input type="checkbox"/> Provide a concise description of the project, including a brief identification of the target market.
<input type="checkbox"/> Describe the relevance of the project to the goals of the competition.
<input type="checkbox"/> Summarize the design strategy and relevant key points.
<input type="checkbox"/> List the relevant project data, including cost estimates.
<input type="checkbox"/> Provide technical specifications for the project.
<input type="checkbox"/> Provide project highlights. Briefly explain how the design meets or exceeds the criteria in each of the following Contests: <ol style="list-style-type: none">1. Architecture2. Engineering3. Market Analysis4. Durability and Resilience5. Embodied Environmental Impact6. Integrated Performance7. Occupant Experience8. Comfort and Environmental Quality9. Energy Performance.

6.3.2 Design Narrative

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

Design Narrative Format Requirements

<input type="checkbox"/> Paper size: Standard 8.5 in. × 11 in. (216 mm × 279 mm), ANSI A
<input type="checkbox"/> Formatting: Single-spaced, 11-point font for body text (diagrams may have smaller fonts)
<input type="checkbox"/> Borders: 0.5-in. (12.7-mm) minimum, except for tables, figures, and images
<input type="checkbox"/> File type: Single, bookmarked PDF
<input type="checkbox"/> Limit content to no more than 60 pages; the cover, back page, and table of contents are not included in this count
<input type="checkbox"/> Number pages; front-matter page numbers can use Roman numerals (e.g., i, ii, iii, etc.)
<input type="checkbox"/> Construction drawings: 11 in. x 17 in. (279 mm x 432 mm), ANSI B
<input type="checkbox"/> File Name: 22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_NARRATIVE_2022-04-05.pdf

Design Narrative Content Requirements

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

Appendices	
<input type="checkbox"/>	A. Design renderings (up to 5 pages)
<input type="checkbox"/>	B. Construction documentation highlights (up to 20 pages)
<input type="checkbox"/>	a. Site plan
<input type="checkbox"/>	b. Representative floor plan(s) with dimensions
<input type="checkbox"/>	c. Building elevations
<input type="checkbox"/>	d. Building sections, including building science control layers
<input type="checkbox"/>	e. Interior details, including a rendered floor plan showing typical furniture layout and option details on finishes, cabinetry, and other fixtures
<input type="checkbox"/>	f. Wall, window, door, floor, and roof details, including building science control layers, schedule, and specifications
<input type="checkbox"/>	g. Mechanical plans and schedules, ⁸ indicating equipment locations and specifications as well as heating and cooling system capacity diagrams (Btu/hr·ft ² , tons/ft ² , or kilowatt/m ²)
<input type="checkbox"/>	h. Plumbing plans and schedules, ⁸ including fixture locations, piping system layout and design, and equipment location and specifications
<input type="checkbox"/>	i. Electrical and lighting plans and schedules, ⁹ including installed lighting (watt/ft ² or watt/m ²) levels, control systems, and renewable systems
<input type="checkbox"/>	C. Energy performance (HERS Index rating and/or EUI target) (up to 4 pages)
<input type="checkbox"/>	HERS Index Rating Documentation Summary
<input type="checkbox"/>	1. Include the house size adjustment factor calculations as required for homes exceeding the area specified in the size adjustment factor table.
<input type="checkbox"/>	2. Perform a HERS Index analysis to include the home with and without the renewable energy system.
<input type="checkbox"/>	EUI Target Documentation Summary
<input type="checkbox"/>	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.
<input type="checkbox"/>	2. Demonstrate compliance with the Division definition. EUI should be provided in both site and source metrics. Show summary calculations of the potential for on-site or off-site renewable energy to offset the annual energy consumption of the building on a source basis.

⁸ Teams should indicate system type, size, and quantity; however, full system layout and specifications are not required.

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

6.3.3 Supplemental Documentation

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

Supplemental Documentation Format Requirements

<input type="checkbox"/> Paper size: Standard 8.5 in. × 11 in. (216 mm × 279 mm), ANSI A
<input type="checkbox"/> Formatting: Single-spaced, 11-point font for body text (diagrams may have smaller fonts)
<input type="checkbox"/> Borders: 0.5-in. (12.7-mm) minimum, except for tables, figures, and images
<input type="checkbox"/> File type: Single, bookmarked PDF
<input type="checkbox"/> Limit content to no more than 100 pages
<input type="checkbox"/> Number pages
<input type="checkbox"/> File name: 22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME] SUP 2022-04-05.pdf

6.3.4 Multimedia Project Pitch

Each team must submit a 90 second Multimedia Project Pitch via the [Project Site](#). This deliverable provides the opportunity to highlight key design aspects in a short amount of time. Teams may be creative in how they chose to develop their Multimedia Project Pitch.

Each team’s Multimedia Project Pitch will be reviewed by jurors prior to the Competition Event as part of the Final Submission. Content from the winning teams will be shared via Solar Decathlon social media following the Competition Event. Unlike the live 8-minute presentation to Juries, there is no limit on the maximum number of team members who can participate in the Multimedia Project Pitch.

Multimedia Project Pitch Format Requirements

<input type="checkbox"/> Length: 90 seconds or less
<input type="checkbox"/> File type: .mov or .mp4
<input type="checkbox"/> File name: 22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME] PITCH 2022-04-05.pdf

6.3.5 Project Images

Each team must submit 3 project images: 2 images that best represent the project, such as renderings, drawings, photographs of scale models, or other team-generated content, and at least one image of your team. These images must be submitted via the [Project Site](#). Organizers use images to recognize individual team performance, to integrate into event materials, or for outreach, as appropriate.

Project Images Format Requirements

<input type="checkbox"/> Ensure all images have a minimum resolution of 1920 x 1080 pixels.
<input type="checkbox"/> Ensure the images have an aspect ratio of 16:9.
<input type="checkbox"/> Submit the images as files such as .jpg, .tiff, or .png.
<input type="checkbox"/> File names:
<input type="checkbox"/> 22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_TEAMPHOTO_2022-04-05.EXTENSION]
<input type="checkbox"/> 22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_PHOTO1_2022-04-05.EXTENSION]
<input type="checkbox"/> 22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_PHOTO2_2022-04-05.EXTENSION]

6.3.6 Presentation Slides

Teams develop one set of slides for the Competition Event, to be used for Division presentations, and Grand Jury presentations if the team is selected as a first-place Division winner. The Presentation Slides are submitted via a Box link provided on the [Project Site](#).

Presentation Slides Format Requirements

<input type="checkbox"/> File type: PDF and/or PPTX (Presentation Slides must have an aspect ratio of 16:9.)
<input type="checkbox"/> To ensure that all electronically submitted materials work with the organizers' presentation computers, teams should embed all videos in the team submission.
<input type="checkbox"/> Maximum file size:
<input type="checkbox"/> 100 MB
<input type="checkbox"/> File name:
<input type="checkbox"/> 22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_PRESDIV_2022-04-05.EXTENSION]

6.4 Faculty Report Submission Instructions

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

Faculty Report Format Requirements

<input type="checkbox"/> File type: Single PDF
<input type="checkbox"/> Length: Up to 20 pages
<input type="checkbox"/> File name: 22DC_[DIVISION]_[SHORT COLLEGIATE INSTITUTION NAME]_FACULTY_2022-05-24.PDF

Faculty Report Content Requirements

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

Glossary

Attached Housing

Multiple dwelling units within a single building

Challenge

Either of two avenues for team participation in the Solar Decathlon competition: the Design Challenge and/or the Build Challenge

Competition

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

Competition Event

The period when Finalist Teams are presenting to juries and related activities

Contest

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

Design Challenge

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

Design Challenge Manager

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

Design Narrative

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

Design Partner

An organization or client that has a planned construction, major retrofit project, or new construction project in their building portfolio and works with a collegiate team to develop a zero energy design option for the project

Director

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

Division

A category based on building type in which a team competes

Division Jury

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

Dwelling unit

A dwelling unit is a single unit that provides complete independent living facilities for one or more people, including permanent provisions for living, sleeping, eating, cooking, and sanitation. See the [2018 International Energy Conservation Code](#) for more information.

Education Building

An educational facility for students that includes permanent provisions for food service, recreation, offices, classrooms, and other support functions, such as mechanical spaces, circulation, and restrooms

Exhibition Team

Participant Teams that are not selected as Finalists but submit a final design submission and are invited to participate virtually in the final Competition Event; Exhibition Teams cannot be selected as winners but will gain feedback and participate in competition activities

Faculty Advisor

A faculty member who advises the team and represents a competing collegiate institution

Faculty Lead

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

Faculty Report

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

Finalist Teams

Participant Teams that are selected to present their final design to Division Jurors at the Competition Event

Floor Area

The sum of the floor areas of the spaces within the building, including basements¹⁰; the floor area is measured from the exterior faces of the exterior walls or from the centerline of walls separating buildings. For more information, see [ANSI Z765-2003](#) and [ASHRAE 90.1-2019](#).

Finished Area

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

¹⁰ Floor area is sometimes referred to as the finished floor area or gross floor area.

Grand Jury

A group of Jurors evaluating the first-place Division Winners of the Design Challenge

Industry Partner

Industry professionals who offer expertise and experience to the project

Juror

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

Multifamily Building

A blend of residential and commercial building area

Multidisciplinary Team

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

New Housing

A residential new construction for one to two dwelling units

Office Building

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

Organizer

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

Participant Team

A team participating in the Solar Decathlon Design Challenge

Project Site

An online site that includes official competition communications and guidelines; accessible by all teams and organizers

Project Summary

A two-page, high-level description of the project with key takeaways and introductions of the team and collegiate institution; a preliminary Project Summary is submitted early in the competition and is updated in later deliverables.

Resilience

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

Retrofit Housing

Renovation of an existing building for one to two dwelling units to zero energy construction through upgrades to systems, such as plumbing, electrical, mechanical, and envelope. This includes adaptive reuse

Rules

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

Rules Official

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

Sponsor

A business or organization that provides funds for the competition

Staff

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

Team

The combination of team members representing a single entry to a Solar Decathlon Challenge

Team member

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

U.S. Department of Energy Solar Decathlon®

A collegiate competition, comprising 10 Contests, that challenges student teams to design and build highly efficient and innovative buildings powered by renewable energy

Appendix A: Resources

This appendix lists key resources. Additional resources and software are available on the [Project Site](#).

[U.S. Department of Energy](#)

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

- [Building America Solution Center](#)
The Building America Solution Center provides access to expert information on hundreds of high-performance construction topics, including air sealing and insulation, HVAC components, windows, indoor air quality, and more.
- [Home Performance with Energy Star](#)
The Home Performance with ENERGY STAR (HPwES) program connects homeowners with experienced and trusted contractors who can help them understand their home's energy use and identify home improvements that increase energy performance, improve comfort and health, and lower utility bills.
- [Zero Energy Ready Home Program Guidelines](#)
DOE Zero Energy Ready Homes are verified by a qualified third-party and are at least 40%–50% more energy efficient than a typical new home. This generally corresponds to a Home Energy Rating System (HERS) Index Score in the low- to mid-50s, depending on the size of the home and region in which it is built.
- [DOE Zero Energy Ready Home](#)
This website provides a virtual tour of Zero Energy Ready Homes and a map of builders.
- [Zero Energy Ready Home Recommended Quality Management Provisions](#)
This website provides a quality management checklist.
- [Environmental Justice](#)
This website details DOE's commitment to environmental justice and related activities and resources.

[National Renewable Energy Laboratory](#)

NREL specializes in the research and development of renewable energy, energy efficiency, energy systems integration, and sustainable transportation. NREL resources include:

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

[ASHRAE](#)

ASHRAE is dedicated to advancing the arts and sciences of HVAC and refrigeration to serve humanity and promote a sustainable world. ASHRAE resources include:

- [ASHRAE Advanced and Zero Energy Design Guides](#)
The Design Guides offer designers and contractors the tools needed to achieve significant energy savings compared to buildings that meet the minimum requirements of Standard 90.1-2004.

[National Institute of Building Sciences](#)

The National Institute of Building Sciences created the Whole Building Design Guide to share information across industry, academic, and federal partners to advance high-performing facilities. National Institute of Building Sciences resources include:

- [Whole Building Design Guide](#)
The Guide presents the philosophy of the integrated design approach and design objectives for whole building design, and includes guides for building envelope design.

[PHIUS+](#)

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

[Smart Home America](#)

Smart Home America provides information on how to build stronger, sustainable, and more resilient communities. Smart Home America resources include:

- [FORTIFIED](#)
FORTIFIED provides standards for coastal and inland construction. FORTIFIED Home helps strengthen new and existing homes through system-specific building upgrades to minimum building code requirements that can reduce damage from specific natural hazards. FORTIFIED Commercial is a voluntary construction standard and designation program to help strengthen new commercial buildings during severe weather.

[U.S. Environmental Protection Agency](#)

The mission of the U.S. Environmental Protection Agency (EPA) is to protect human health and the environment, ensuring clean air, land, and water, and promoting environmental stewardship. EPA resources include:

- [Environmental Justice Screening and Mapping Tool](#) (EJSCREEN)
EJSCREEN is an environmental justice mapping and screening tool that provides a nationally consistent dataset and approach for combining environmental and demographic indicators.