

U.S. DEPARTMENT OF ENERGY BUILDING TECHNOLOGIES OFFICE

### BTO Peer Review: Solar Decathlon Design Challenge



### **Solar Decathlon Design Challenge**



National Renewable Energy Laboratory (NREL) Taylor Ryan, Project Manager and Principal Investigator Taylor.Ryan@nrel.gov 1.4.2.2

## **Project Summary**

#### **OBJECTIVE, OUTCOME, & IMPACT**

The Solar Decathlon Design Challenge prepares students to become leaders in the skilled building decarbonization workforce through collegiate design competitions, building science education, and industry resources and connections. Skilled leadership in the building decarbonization workforce will help accelerate energy and emissions reductions in the U.S. buildings sector.

#### **TEAM & PARTNERS**

- **Program Sponsor & Leadership:** U.S. Department of Energy
- Competition Management & Project Execution: NREL
- Sponsorship Manager: Confluence Communications
- + Over 30 Sponsors, Affiliate Partners, and In-Kind Contributors



#### STATS

- Performance Period: 10/01/2023-06/01/2025
- DOE Budget: \$750,000 for 2025 Design Challenge
- Scope covers annual, design-only Design Challenge competition, which differs from historical Build Challenge competitions.
- Milestone 1: Release 2024 Design Challenge Rules (August 2023)
- Milestone 2: Announce 2024 Design Challenge participating teams
  (November 2023)
- Milestone 3: Announce up to 40 finalist teams (March 2024)
- Milestone 4: Host Solar Decathlon Competition Event at NREL (April 2024)



- According to A National Blueprint for the Buildings Sector from the U.S. Department of Energy (DOE), meeting building decarbonization goals will require a robust and diverse network of professionals to design, manufacture, market, install, and operate low-carbon building technologies and solutions (U.S. Department of Energy 2024).
- The Architecture, Engineering, and Construction (AEC) community has "tremendous potential" to create zero energy buildings... However, the AEC community still struggles with solution pathways like deep retrofits, new construction, and buildings decarbonization (Torcellini et al. 2022).



**Figure 1.** Barriers identified by the Better Buildings Design and Construction Allies for routinely delivering zero energy and zero carbon buildings. *Source:* NREL 2022.

#### Sources above:

- Decarbonizing the U.S. Economy by 2050: A National Blueprint for the Buildings Sector DOE, 2024
- Architects, Engineers, and Contractors: Key to Moving towards a Zero Carbon Future NREL, 2022



- The current and future Architecture & Engineering workforce will need to gain new skills, including a "systemic understanding of buildings, climate, and energy" (Truitt et al. 2022).
- These skills will need to be embedded deeply and shared widely across occupations in the future. Equipping new entrants with these skills and enabling them to work across existing industry boundaries will require interdisciplinary learning (Truitt et al. 2022).



**Figure 2.** Example skills to support Advanced Building Construction (ABC) and Grid-Interactive Efficient (GEB) Buildings. *Source:* NREL 2022.



## **Alignment and Impact**

#### Solar Decathlon Design Challenge is building a diverse, qualified, and "**skilled building decarbonization workforce** that will help...**enable deployment** of low-carbon technologies and solutions across the buildings sector"

(Decarbonizing the U.S. Economy by 2050: A National Blueprint for the Buildings Sector – U.S. Department of Energy, 2024).



Figure 3. Workers in Architecture, Engineering, and Related Services Across the United States. *Source:* Data USA 2022.



# **Alignment and Impact**

Success is measured by the **program's potential to transform industry**, including:

- Number and diversity of competing student teams
- Opportunities for building science-related training and education
- Engagement between students and industry.



Figure 6. Collegiate institution participation in the 2024 Design Challenge

Growth in Design Challenge Student Participation





Figure 7. Diversity of majors represented in 2024 Design Challenge students

# Approach: Comprehensive Training & Development

Solar Decathlon provides the structure, education, professional development, and resources that inspire and prepare collegiate students with career-ready knowledge and skills to join the skilled building decarbonization workforce and advance the AEC industry in meeting national climate targets.



# **Approach: Competition Structure**

The competition provides experiential, project-based learning with an open problem statement.





**Competition Timeline** 

#### **Competition Event Highlights**

- $\checkmark\,$  Tour NREL research facilities and zero energy buildings
- ✓ Present to industry experts for real-world feedback
- ✓ Network with sponsors and industry partners

·C×

# ××°

# **Approach: Competition Encourages Innovation**

Students utilize the competition structure to **collaborate** with industry, **co-design** with communities and potential occupants, and **innovate** across the ten Contest areas.

#### Project Example: 2024 Grand Winner (University of Arizona)

- Eco-friendly rowhouses designed in partnership with Hopi tribe in Arizona.
- Utilized traditional Hopi passive design techniques.
- Incorporated a community-level microgrid to promote energy sovereignty
- Used prefabricated panels for easy constructability
- Fostered workforce development in trades.



#### **Technology Highlights: 2024 Teams** STRUCTURE **ENVELOPE** Modular construction Smart vapor barrier Retrofit over-cladding Mass timber Low-carbon concrete Mycelium insulation MARKET INNOVATIONS SITE/POWER Workforce • **Biophilic design** development Microgrids Peer-to-peer energy Agrivoltaics purchase ADUs & densification

# ××°

### **Approach: Engage Stakeholders**

The competition engages stakeholders in academia and industry to provide a **venue for connection and collaboration**, creating **feedback loops** that **address market barriers** related to equitable building decarbonization.



#### **Collegiate Faculty DOE & NREL** Industry & Students Understand • Complement Network with future academic and curriculum with workforce. industry needs to unique clean energy Build pipeline of scale building training. qualified talent. decarbonization Students build Two-way learning on Access student marketable, careerbuildings research. innovation. ready skills. 2024 Design Challenge Quick Stats LOWE'S 31 Industry Expert **18 Sponsor** Jurors Organizations 87% of Finalist **31 Alumni Mentors** Teams Engaged **ASHRAE** Industry

# Approach: Responsiveness to Industry Needs & Market Barriers

The competition evolves year-over-year to respond to industry needs and market barriers through strategic refinement of Contests and competition focus areas.

New competition requirements and encouragements related to equity, affordability, and resilience align with Blueprint cross-cutting goals.

#### **Related Solar Decathlon Contests**





 Encourages students to explore zero energy solutions for "equity-eligible buildings" (i.e., affordable housing, disadvantaged communities, and underserved commercial buildings).

# Approach: Complement Academic Curriculum

**Solar Decathlon helps fill gaps in academic programs.** 73% of Solar Decathlon participating faculty said their collegiate programs do not require any training on high-performance buildings, sustainable design, or building construction (Young et al., 2020).

Design Challenge Teams: Completion of Building Science Competition Requirement



#### Publication from 7-time Design Challenge faculty:

"The technical rigor required by the competition prompts students to learn new software... develop their technical competencies... elevate their knowledge and positions them for greater sustainable design leadership" (Collins et al., 2020).



95% of faculty say competition helps students learn more than coursework alone (Young et al., 2020).

# **Progress and Future Work: Accessibility & Growth**

The Design Challenge makes the educational successes of the Solar Decathlon **accessible to a wide set of students, educational institutions, and programs** (Young et al. 2020).

Metric	2024 Design Challenge Participation
Participating Teams	105
Participating Students	1,200
Collegiate Institutions	93
U.S. States	29
Countries	18

#### **Design Challenge: Growth in Participation**



\*Competition structure was downsized in 2024 to include 4 Divisions and 40 Finalist Teams, compared to 6 Divisions and 60 Finalist Teams in 2024.

Design Challenge Quick Stats (2014-2024)	11 competitions hosted	836 teams competed	27% Minority- Serving Institutions
	9,000+ student participants	274 collegiate institutions	38 countries

# Progress and Future Work: Student Diversity

The Design Challenge educates and engages a **diverse student population** who will **become the leaders** of the building decarbonization workforce.

Design Challenge MSI Participation: % of U.S.-based Institutions



The composition of MSIs in Design Challenge competitions can be compared to the national baseline that MSIs comprise 14% of all U.S. degree-granting institutions (Rivera, 2023).

Reported Gender Identity of Students in 2024 Design Challenge





- On average, women represent 16.7% of the workforce in engineering and architecture (BLS, 2024), compared to 48% of Solar Decathlon participants.
- Minorities in the engineering and science field make up 33% of the professional workforce, while in Solar Decathlon they make up 56% (NSF, 2017).

### Progress and Future Work: Students Tackle Industry-Relevant Challenges

Students respond to competition requirements and encouragement in technical focus areas, including retrofits and equity, creating innovative solutions for buildings with local community impact.

#### 2024 Design Challenge Quick Stats

38% of projects were focused on existing buildings and retrofit designs, an increase of 11% from 2023. 44% of projects addressed affordable housing, low-to-moderate income, and disadvantaged communities.

#### 2024 Case Study: Howard University

- Adaptive reuse and "industrial rebirth" of firehouse for affordable housing to address housing shortages in New Bedford, Massachusetts\*.
- Carefully selected retrofit measures include water-to-water geothermal heat pump and reclaimed materials.

\*Identified as disadvantaged community through the White House Climate & Economic Justice Screening tool.



# Progress and Future Work: Lessons Learned & Opportunities for Increased Team Support

Schools have varying levels of resources to devote to competition participation; the Design Challenge has responded with **options for integrated support to ensure diverse participation.** 

#### Support for All Teams

- ✓ Alumni Mentors.
- ✓ Building Science Education Series.
- ✓ Software licenses.
- ✓ Deliverable templates.
- ✓ Webinars.

 $\odot$ 

- Presentation opportunity at Semifinals available for all teams.
- ✓ Virtual participation at Competition Event available for finalist Teams.
- ✓ NEW: Technical Advisors.

#### Targeted Support

- ✓ \$22k in team travel scholarships.
- ✓ \$5k scholarship from Solar Decathlon sponsor to selected MSIs.
- ✓ \$2k travel scholarship to MSI faculty.
- ✓ Organizer engagement with first-time teams and MSIs.



"MSIs tend to serve students who have been historically disadvantaged... total revenue per full-time equivalent student at four-year MSIs in fiscal year 2010 was just over half the amount at non-MSIs" (Espinosa et al. 2017).

### Progress and Future Work: Looking Ahead to 2025 Design Challenge

NEW

The competition will further incorporate new focus areas around **diverse building types**, **grid edge, resilience, and embodied carbon** to support **student learning and innovation** that aligns with DOE goals.





**Figure 17.** Buildings engage multiple critical pillars of economy-wide decarbonization. *Source:* U.S. Department of Energy 2024.



#### Innovative Retrofit Project & Innovative Equity Project Awards

- Provides additional recognition to teams that demonstrate innovative approaches to:
  - · Challenges with existing buildings, and
  - Buildings that benefit underserved communities, respectively.

## Thank you

National Renewable Energy Laboratory (NREL)

Taylor Ryan, Principal Investigator/Project Manager

Taylor.Ryan@nrel.gov

1.4.2.2



U.S. DEPARTMENT OF ENERGY BUILDING TECHNOLOGIES OFFICE

### **Reference Slides**

# References

Decarbonizing the U.S. Economy by 2050: A National Blueprint for the Buildings Sector. Washington, DC: U.S. Department of Energy. https://www.energy.gov/eere/articles/decarbonizing-us-economy-2050

Torcellini, Paul, Sammy Houssainy, Heather Goetsch, and Julia Sullivan. 2022. Architects, Engineers, and Contractors- Key to Moving towards a Zero Carbon Future. Golden, CO: National Renewable Energy Laboratory. NREL/CP-5500-83255. <u>https://www.nrel.gov/docs/fy22osti/83255.pdf</u>

Truitt, Sarah, Jonathan Bean, Julia Sullivan, Gokul Paranjothi, and Allison Moe. 2022. *Completing the Circuit: Workforce Development for Advanced Building Construction and Grid-Interactive Efficient Buildings*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5500-80480. <u>https://www.nrel.gov/docs/fy22osti/80480.pdf</u>

Rivera, Heidi. 2023. "HBCU and minority serving institutions facts and statistics". Bankrate. Accessed June September 18, 2024. <u>https://www.bankrate.com/loans/student-loans/hbcu-and-msi-statistics/</u>

Truitt, Sarah, Juliana Williams, and Madeline Salzman. 2020. *Building the Efficiency Workforce*. Golden, CO: National Renewable Energy Laboratory. NREL/CP-5500-75497. <u>https://www.nrel.gov/docs/fy20osti/75497.pdf</u>

Espinosa, Lorelle L., Jonathan M. Turk, and Morgan Taylor. 2017. Pulling Back the Curtain: Enrollment and Outcomes at Minority Serving Institutions. American Council on Education. <u>https://www.acenet.edu/Documents/Pulling-Back-the-Curtain-Enrollment-and-Outcomes-at-MSIs.pdf</u>

Collins, Tom and Daniel Overbey. 2020. "Leveraging the U.S. Department of Energy Solar Decathlon Design Challenge as a Framework for Student-Led Adaptive Reuse Projects to Address Context-Specific Sustainable Design, Housing Affordability, and Community Resilience." *Journal of Green Building* Volume 15 (Issue 4). 201-234. https://doi.org/10.3992/jgb.15.4.201

Young, Michael, Rachel Romero, Jes Stershic, Taylor Ryan, and Holly Jamesen Carr. 2022. *The Future of Building Science Education with the U.S. Department of Energy Solar Decathlon*. Golden, CO: National Renewable Energy Laboratory. NREL/CP-5500-81980. <u>https://www.nrel.gov/docs/fy22osti/81980.pdf</u>

2024. "Labor Force Statistics from the Current Population survey." U.S. Bureau of Labor Statistics. Accessed September 18, 2024. https://www.bls.gov/cps/cpsaat11.htm

2017. "Scientists and engineers working in science and engineering occupations: 2015". National Science Foundation. Accessed September 18, 2024. https://www.nsf.gov/statistics/2017/nsf17310/digest/occupation/overall.cfm



### **Project Execution**

		FY2024				FY2025					
Planned budget		\$750,000				\$750,000					
Spent budget		\$750,000				Planned \$750,000					
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4			
Past Work											
Announce 2024 Design Challenge participating teams											
Host 2024 Design Challenge Competition Event											
2024 Design Challenge Final Report											
Release 2025 Design Challenge Rules											
Current/Future Work											
Announce 2025 Design Challenge participating teams											
Announce 2025 Design Challenge finalist teams											
Host 2025 Design Challenge Competition Event											







Holly Jamesen Carr Solar Decathlon Director

Commercial Buildings Representative

Kassandra Grimes



**Taylor Ryan** 



Kelly MacGregor Communications Lead



**Aaron Blust** Assistant Competition Manager



Allison Georgeson **Project Coordinator** 



**Rachel Romero** Project Advisor

Principal Investigator, Competition Manager

- **Department of Energy:** Program sponsorship, leadership, and direction
- **NREL:** Project management and ٠ competition execution
- **Confluence Communications:** Subcontractor to manage sponsorship program