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Solar Decathlon® Impact Evaluation: Final Publication

Prepared for the U.S. Department of Energy: Office of Energy Efficiency and Renewable Energy

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Opinion Dynamics

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Executive Summary

The U.S. Department of Energy's (DOE) Solar Decathlon competition challenges teams of college students to design, build, and operate highly efficient houses powered by renewable energy that are cost-effective and attractive. The completed homes are judged by experts and showcased in a public forum. The first Solar Decathlon was held in 2002, and the competition has occurred biennially since 2005.

This report presents the results from an impact evaluation of participants[2] and comparable nonparticipants for cohorts 5–8 of the Solar Decathlon (prize years 2011–2017). The goals of this evaluation were to assess the Decathletes on:

- knowledge gains;
- improved career readiness, job trajectories, and contributions to clean energy/sustainability industry; and
- startups and ventures created.

Methodology

To meet the evaluation goals, Opinion Dynamics fielded an online survey with former participants and comparable nonparticipants. We used several methods to identify and recruit the respondents, including program records, LinkedIn outreach, outreach through the Solar Decathlon Alumni Association, and through former faculty advisors. Nonparticipants attended universities that participated in the Solar Decathlon at least once but attended in years in which the school did not participate in the competition. This approach minimized the risks to validity associated with choosing potentially poor comparison schools and allowed us to choose students from the same schools as participants.

Our findings are based on a sample of 159 participants and 158 nonparticipants. The response rate to various outreach approaches ranged from 5% to 16%. The achieved survey sample sizes for participants and nonparticipants provide up to 8% precision at the 95% confidence level. Therefore, group differences may need to exceed 8% for statistical tests to determine whether the participant and nonparticipant differences are statistically significant. We used inverse propensity weighting (IPW) to statistically account for some of the characteristics related to the Decathletes' self-selection into program participation.

While we have taken every effort to make this study as rigorous as possible, there are limitations that may have implications for interpreting the findings in this report. Without an experimental program design, the possibility of self-selection bias could not be entirely eliminated. We used the IPW to minimize self-selection bias, but (1) we lacked the ability to obtain pre-participation data for the IPW and had to rely on survey self-reports of pre-participation activities, which may be subject to recall error, and (2) the factual survey questions describe only a few of the many ways participants and nonparticipants may differ. The study is also limited by coverage bias and nonresponse bias. We did not have a complete list of participants, and of those we did have, we had missing or outdated contact information. Missing data is rarely, if ever, random; therefore, it is possible that the study could suffer from coverage bias. Like all surveys, this study is also subject to survey nonresponse, which could bias results if those who complete the survey are different than non-responders in ways that are correlated with the study variables. This study also relies on self-report data, which could suffer from inaccurate reporting, incomplete reporting, and socially desirable reporting. Finally, we were unable to

[2] The terms *participants* and *Decathletes* are used interchangeably throughout this report to refer to individuals who competed in the Solar Decathlon.

control for variations among Solar Decathlon teams, such as the influence of professors, team members, and university culture.

Our guidance to readers interpreting the findings in this report is to keep in mind that the findings are reflective of the samples that responded to the surveys and that there are several study limitations. Given the limitations to this study are largely due to incomplete participant contact information, the potential for nonresponse and coverage bias may be sizable. Therefore, the findings may not be generalizable to the population of Solar Decathlon participants. There is no way to know how our survey sample results differ, if at all, from results obtainable for the full population.

The IPW analysis method weights the nonparticipant characteristics to match the participant characteristics more closely, facilitating comparability. We made every reasonable attempt to capture relevant pre-intervention characteristics to ensure comparability between the participants and nonparticipants but could not address every single factor. With those caveats in mind, we found that participation in the Solar Decathlon was linked with many positive and statistically significant outcomes. All differences that are statistically significant are measured at the ($p<.05$) level. Whenever the word "significantly" is used in this report, it reflects statistical significance.

Key Findings

Overall, we found that participation in the Solar Decathlon was linked with many positive and statistically significant outcomes. We offer the following findings, conclusions, and recommendations for the program.

Key findings include:

Solar Decathletes were significantly more likely to report they learned about several high-performance home topics during their time in school than nonparticipants, and they often attributed that knowledge to their participation in the Solar Decathlon. Of the five topics (reported in Section 3.1), Decathletes compared to nonparticipants were most likely to have learned how to design a highly energy-efficient home (82% vs. 44%) during their time in college. Decathletes were least likely to have learned about identifying "win points" or "sell points" for marketing a solar-powered home, but significantly more learned about that compared to nonparticipants (43% vs. 20%). Decathletes who majored in architecture exhibited the greatest high-performance home knowledge compared to Decathletes of other majors. Architecture majors were significantly more likely to learn about two topics than Decathletes of other majors: 96% learned about designing a highly energy-efficient home and 78% learned about siting a PV system. There was greater difference in energy knowledge between Decathletes and nonparticipants than there was among Decathletes with different majors.

Decathletes overwhelmingly attributed at least some of their knowledge on a given topic to what they learned from the competition. This attribution ranged from 88% who said the competition was of high or some importance for siting a PV system to 98% for designing an energy-efficient home. However, despite their levels of self-reported high-performance home knowledge, Decathletes tended to perform similarly to nonparticipants on questions testing their knowledge of energy efficiency and solar PV systems.

Participation in the Solar Decathlon is associated with greater levels of employment in the clean energy and sustainability sectors. Decathletes were significantly more likely than nonparticipants to have sought a clean energy or sustainability job (52% vs. 40%), to hold one of these jobs (39% vs. 23%), and to still be working in the job at the time of the survey (26% vs. 8%). Decathletes also stayed in their clean energy jobs longer than nonparticipants (2.5 years vs. 1.5 years). Engineering majors were most likely to report the Solar Decathlon as impactful on their employment in clean energy compared to other majors.

The Solar Decathlon improved networking opportunities in the clean energy industry. Decathletes reported the program had a strong influence on their ability to interact and network with industry professionals before graduation (68% said the Solar Decathlon "strongly" or "somewhat" contributed to their ability to interact with industry professionals) and soon after graduation (58%), with less long-term influence (48%). These professional networks Decathletes were able to access may be one contributing factor to their greater ability to gain employment in the clean energy industry.

Decathletes reported that their competition experience positively influenced their employment in the clean energy or sustainability industry. Over two-thirds of Decathletes employed in the clean energy/sustainability sector (69%) attributed at least some level of influence to the program in helping them obtain that job. More than one-third (37%) rated the program as highly influential to their employment.

There was no significant variation in the types of job duties among clean energy-employed Decathletes from different academic fields nor among Decathletes with different commitment levels to the program. Regardless of whether the participant was a self-reported team leader or acted in a supporting role, there were no significant differences in the roles and duties of clean energy-employed Decathletes.

The COVID-19 pandemic affected a minority of respondents' employment but had negative impacts for those affected. The pandemic reportedly reduced job opportunities and hampered respondents' ability to search for jobs. Some respondents were also considering founding a startup prior to the pandemic but were unable to do so.

Participation in the Solar Decathlon is linked with greater incidence of leadership roles in extracurricular clean energy industry organizations. Decathletes were significantly more likely than nonparticipants to report holding leadership positions in clean energy organizations outside of their job (7% vs. 1%). Most Decathletes (67%) said the program either "strongly" or "somewhat" contributed to their interest in joining the extracurricular clean energy industry organization.

Participation in the Solar Decathlon is linked with greater incidence of startup formation. While forming startups was uncommon with both groups, startup formation was significantly more likely among Decathletes (5%) compared to nonparticipants (1%). Of the eight Decathletes who created their own startups, three gave the program high levels of influence, four gave it moderate levels of influence, and one gave it low levels of influence.

Most Decathletes said Solar Decathlon did not highly influence their acceptance into a graduate program. About one-third of Decathletes (35%) reported their Solar Decathlon experience highly or moderately influenced their acceptance into graduate school, while the rest gave the program low or no influence.

Conclusions and Recommendations

We offer the following conclusions and recommendations for the program. As noted previously, study conclusions are based on data that have several limitations, which may affect the conclusions' validity.

- Conclusion: This study's ability to measure smaller differences between participants and nonparticipants was limited by the sample size, which was a result of the partial student records kept by program administrators. If more complete records had been available, we could have assessed the potential for nonresponse bias and made appropriate adjustments. This data would have also allowed us to determine the representativeness of our sample and the generalizability of the results.
  - Recommendation: For DOE's collegiate competition programs, the program manager should make good faith attempts to keep records of all student participants and their contact information. At a

minimum, the contact information should include the student email and, if possible, include a non-university-affiliated email address. If DOE institutes social equity goals for future competition programs related to increasing participation among traditionally underrepresented groups, then it will be important for future evaluators to be able to assess sociodemographic variables. In this case, the program manager should also track socioeconomic characteristics such as age, gender identity, race/ethnicity, first-generation college student status, and household income, among others.

- Conclusion: **The knowledge, skills, and experiences learned in program participation supported Decathletes' ability to enter and advance in the clean energy workforce.** Decathletes were significantly more likely than nonparticipants to still be working in the clean energy industry at the time of the survey, and Decathletes stayed in their clean energy jobs longer than nonparticipants. Decathletes' presence in the clean energy workforce is likely due to (1) knowledge gained, which they attributed to the Solar Decathlon experience as opposed to coursework or non-coursework activities, and (2) the improved networking ability Decathletes attributed to program participation.
- Conclusion: **The Solar Decathlon is already contributing some of the next generation of leaders to clean energy organizations.** Though the overall number is small (7%), participants are taking on leadership positions (such as being an officer or committee chair) at a greater rate than nonparticipants. Of the Decathletes that have taken on leadership positions in clean energy organizations outside of their job, 90% of them said the Solar Decathlon influenced their interest in doing so.
- Conclusion: **Architects' and engineers' careers, in particular, benefitted from participation in the Solar Decathlon program.** Some program outcomes were more influential for students of certain academic domains, such as architecture and engineering, though program benefits reached Decathletes of all types. For example, Decathletes who majored in architecture exhibited the greatest high-performance home knowledge (such as designing a highly energy-efficient home and siting a PV system), while engineering majors were most likely to report the Solar Decathlon as influential to their employment in clean energy. Despite these engineering majors reporting the highest program influence on their ability to get a job, they obtained jobs in the clean energy and sustainability fields at rates lower than Decathletes in other majors. Regardless of their academic domain or level of involvement in the program, Decathletes reported similar roles and duties in their jobs (no statistically significant differences in job duties were found).
  - Recommendation: To the extent possible, ensure that networking opportunities are equally applicable to engineering and non-engineering majors so all Decathletes may take advantage of networking and launch their careers.
- Conclusion: **The COVID-19 pandemic had minimal effects on respondents' employment outcomes, though the effects that occurred were negative.** One might expect potentially greater employment outcomes had the COVID-19 pandemic not occurred, but it is hard to know whether those outcomes would have been the same for participants and nonparticipants. Respondents noted fewer job opportunities available, and some respondents were laid off or had their pay reduced during the pandemic. Some respondents were considering founding a startup before COVID but did not, though this was a minority of respondents.

1. Background and Introduction

The Solar Decathlon program challenges teams of college students to design, build, and operate highly efficient houses powered by renewable energy that are cost-effective and attractive. The completed homes are judged by experts and showcased in a public forum. The first Solar Decathlon was held in 2002 and has occurred biennially since 2005.

The objectives of the Solar Decathlon Program are to:

- showcase innovatively designed, energy-efficient, and solar-powered houses for the general public;
- educate student participants and the public about clean energy; and
- provide participating students with training that prepares them to enter the nation's clean energy workforce.

At the outset of this evaluation, we created a Program Theory Logic Model (PTLM), which can be found in Appendix C. The top row of the PTLM lists activities student participants complete as part of their Solar Decathlon experience. These include participating in science, technology, engineering, and math (STEM) program training via their coursework; planning and designing a very high-efficiency home with renewable energy (shortened to VHE+RE in the model); building the VHE+RE home; showcasing it in a competition; and discussing the home with judges, mentors, and the public. Throughout the report, when we refer to Decathlete's experience in the competition or in the program, we are referring to the entirety of these activities. The participating students primarily came from the five following fields of study: engineering, architecture, business, computer science, communications/marketing, and sustainable technology.

Every Solar Decathlon takes place over a two-year period. The first year's activities include student teams working on the VHE+RE home design and development. The second year culminates with each team constructing and demonstrating their home, and having it judged by a team of experts. From 2002 through 2011, the competing teams displayed their homes to the public on the National Mall in Washington, D.C. In 2013 and 2015, the event was held in Irvine, California, to expand the program's reach. The 2017 Solar Decathlon took place in Denver, Colorado, at a stop on the commuter rail line connecting the city to the Denver International Airport.

Since its inception, the Solar Decathlon has included 10 contests, although the contests have been revisited and occasionally revised. Table 1 shows the contests included in each Solar Decathlon during the evaluation period. Changes to contests included the removal of some contests (e.g., Commuting), the combination of multiple contests into a single contest (e.g., Market Potential includes the parameters previously separated into two contests: Market Appeal and Affordability), and the addition of new contests (i.e., Innovation and Water, which include evaluation of unique approaches and solutions, and environmental and financial sustainability). The energy-related judging also changed to include measurement of energy production and consumption, as well as adding considerations of time-of-use and demand response.

Table 1. Decathlon Contests 2011–2017, by Year

2011	2013	2015	2017
Affordability	Affordability	Affordability	**Innovation**
Appliances	Appliances	Appliances	Appliances
Architecture	Architecture	Architecture	Architecture
Comfort Zone	Comfort Zone	Comfort Zone	Health and Comfort
Communications	Communications	Communications	Communications
Energy Balance	Energy Balance	Energy Balance	Energy
Engineering	Engineering	Engineering	Engineering
Home Entertainment Center	Home Entertainment Center	Home Life	Home Life
Hot Water	Hot Water	**Commuting**	**Water**
Market Appeal	Market Appeal	Market Appeal	Market Potential

Note: Bolded font indicates the contest was new that year.

Universities opt in to participate in the Solar Decathlon. Some schools participated in multiple competitions, while others participated in just one during the period under study. Some schools choose to incorporate Solar Decathlon activities as part of coursework, while others offer Solar Decathlon as an extracurricular activity. There is also variation in how students come to participate at different schools. Some may proactively seek out the Solar Decathlon program, while others may become engaged by happenstance through their studies.

The primary objective of this impact evaluation was to assess student-centered impacts of Decathletes who participated between 2010 and 2017. See Table 2 for the cohorts included in this evaluation.

Table 2. Solar Decathlon Cohorts Included in this Evaluation

Cohort	Competition Performance Period
Cohort 5	2010 to 2011
Cohort 6	2012 to 2013
Cohort 7	2014 to 2015
Cohort 8	2016 to 2017

The research objectives for this impact analysis were as follows:

1. Measure Decathlete knowledge gains in comparison to non-Decathletes.
2. Analyze Decathlete clean energy job readiness, participation, competitiveness, and persistence in comparison to non-Decathletes.
3. Analyze Decathlete contributions to the clean energy/sustainability industry in comparison to non-Decathletes.

The evaluation did not attempt to examine differences in outcomes among Cohorts and focused on comparing outcomes between the nonparticipants and the participants as a whole. There was one research question that sought to understand if knowledge outcomes among Decathletes differed pre- and post-2017. Please see Appendix B for a full list of the research questions.

2. Methods

Opinion Dynamics used a web survey to collect information from Decathletes and comparable nonparticipants to answer the research questions. Lawrence Berkeley National Laboratory (LBNL) staff reviewed the survey instrument, and we revised the instrument based on comments received.[3] The survey instrument can be found in Appendix E. Decathletes received a $25 gift card for taking the survey, and nonparticipants received a $50 gift card for taking the survey. We provided nonparticipants a larger incentive because it was assumed that nonparticipants would need a greater financial reward to motivate them to complete the survey than participants, thus reducing the possibility of greater nonresponse bias among nonparticipants.

This section explains our approach to identifying the Decathletes and comparable nonparticipants, the outreach methods used to recruit survey respondents, the results of those outreach methods, and the analysis approach. We conclude with a review of the study's limitations.

2.1 Fielding Methods

Survey fielding took place from August 2021 to May 2022. We used a variety of methods to identify and recruit respondents. The survey was hosted on the Qualtrics platform. The recruitment methods for both Decathletes and nonparticipants leveraged the LinkedIn website, and we were able to use additional avenues for recruiting participants.

2.1.1 Identifying and Recruiting Decathlete Respondents

The program administrators did not keep comprehensive records of student participants. As such, it is impossible to know the true population size or the size of each Cohort. For a summary of the program data we received, see Appendix D. A primary challenge for the evaluation, then, was to identify former Decathletes and obtain their contact information in order to invite them to complete the survey. We took an iterative approach to identifying Decathletes and eligible nonparticipants. We included a hidden "source" code in the survey links for the different methods so we could track from which outreach method a survey complete derived. We assessed the yield of each approach and continued with those that had the greatest yield to make the best use of evaluation funds.

We used the following approaches:

- **Posted on LinkedIn with an anonymous survey link:** We made a post, or announcement, on LinkedIn using a Solar Decathlon hashtag that invited Decathletes from eligible competition years to take the survey. Within a few hours of posting, we received 420 responses to the survey. This was an unrealistically rapid response, so we closed the survey to assess the validity of these responses. We assessed the survey responses for duplicate IP addresses, low ReCAPTCHA scores, nonsensical answers in open-ended responses, and inconsistencies among answers (for example, reporting they participated in 2014 but in other answers saying they began college in 2016). Results of this assessment indicated that 97% of surveys were invalid. A robot likely took the survey over and over in rapid succession, given the similarities in open-ended answers. To ensure we were not eliminating any surveys from real Decathletes, we created a short verification survey asking respondents to briefly describe the competition and confirm key information provided in the survey. We sent this verification

[3] The true/false knowledge questions in the survey were pre-tested with industry professionals; other survey questions were not pre-tested.

survey to the email addresses provided in the survey response. Our assessment of the verification survey responses was that all survey responses resulting from the LinkedIn post were invalid.

- **Result**: 0 valid responses

- **Used emails of former Decathletes from program records:** The National Renewable Energy Laboratory (NREL) and the DOE provided Opinion Dynamics with their records of past Decathletes along with any emails on record. We received email addresses for 589 Decathletes from their time at the university (i.e., a .edu domain). We received 454 non-student emails with .com or .org domains. We sent up to three invitations to each email, requesting the Decathlete complete the survey. Reminder emails had slightly varied content and subject lines. The non-student email addresses produced a higher response, suggesting that Decathletes were no longer using or had access to their student email accounts.

  - **Result:** 43 valid .edu email responses, 126 valid .com or .org email responses (169 total)

- **Sent direct messages on LinkedIn (using LinkedIn Sales Navigator):** We sent Decathletes direct invitations to complete the survey via LinkedIn Sales Navigator, which allows direct messaging to individuals outside of one's network. We looked up individual Decathletes three ways: (1) by looking up individual names from the program data, (2) by using snowball references, or (3) by searching for the competition name, "Solar Decathlon," to identify individuals who listed the competition on their public profile. In all cases, we confirmed the individual participated in the competition years under study before inviting them to take the survey. We sent direct messages to 20 Decathletes on LinkedIn.

  - **Result:** 1 survey response

- **Posted on the LinkedIn Solar Decathlon Alumni Association (SDAA) page:** We made a post on the SDAA page inviting former Decathletes from eligible competition years to take the survey. The post yielded one survey complete. Believing we would achieve a greater response if someone officially affiliated with the page made a post, we asked the manager of the SDAA LinkedIn group to post our survey request. The SDAA manager's post resulted in five additional survey completes.

  - Result: 6 survey responses

- **Used faculty advisor outreach:** The lists provided by NREL and DOE included faculty contacts at the universities who oversaw participating Decathletes. We emailed the faculty and requested they forward the invitation to any students for whom they had contact information. We reached out to 122 faculty contacts and 29 emails bounced back. The number of students to whom the remaining faculty sent the survey invitation is unknown.

  - **Result:** 22 survey responses

- **Used snowball recruitment:** The final question of the survey asked Decathletes if they could provide the name and contact information of any of their teammates. We cross-checked the provided names with our current list and, if it was a new student or new contact information, invited the Decathlete to complete the survey. If a new name was provided but no contact information, we sent direct messages using LinkedIn Sales Navigator. We invited 29 of the snowball referrals to take the survey.

  - **Result:** 2 survey responses

We kept a comprehensive list of the students we invited to complete the survey across all approaches so we could perform a "duplication check." The duplication check helped us track if we identified a participant through multiple channels, such as a snowball referral or LinkedIn profile. If we found a new email address for a participant to whom we had previously reached out but had not completed the survey, we sent another invitation using the new email address. In other words, we reached out to former Decathletes using as many

methods of contact as possible until either they completed the survey or until we sent three invitations with no response to one email address.

Table 3 summarizes the results of our different outreach efforts to Decathletes and the known response rates. Contact information from program records resulted in the highest response rate, while other approaches were not as effective. We felt our attempts to identify former Decathletes were exhaustive. We engaged DOE staff, former Solar Decathlon staff and faculty, and leveraged online networks. The survey fielding period was lengthy to allow us to continue our iterative recruiting approach, and we recruited as many former Decathletes as we could, given the evaluation budget and timeline.

Table 3. Decathlete Survey Invitations and Responses

Method	Invitations	Survey Responses	Response Rate
Program Records	1,043	169	16.2%
Snowball References	29	2	6.9%
LinkedIn Direct Messages	20	1	5%
Post on SDAA	Unknown	6	--
Faculty Advisor Emails	Unknown	22	--
Total	**>1,092**	**200**	

2.1.2 Identifying and Recruiting Evaluation Nonparticipants

A key challenge for the evaluation was identifying comparable nonparticipants to survey. We considered multiple approaches. One option was to select nonparticipants from participating schools, thus removing the influence of university culture. However, the participants who self-selected into participation may be qualitatively different than those who had the option to participate but chose not to. One might reason that, at a participating school, participating students are more likely than nonparticipating students to be those who seek out professional development activities, and thus are more likely than nonparticipants to subsequently demonstrate higher levels of attainment irrespective of the program. If this phenomenon were to occur, the study would overestimate program impacts.

Another option was to draw nonparticipants from comparable nonparticipating schools; however, this approach also poses threats to validity. Determining which schools are "comparable" is a judgement call. There are many factors one could use to judge comparability (number of undergraduate students, tuition costs, urban/rural status, ranking of architectural program, etc.). Drawing nonparticipants from "comparable" nonparticipating schools would risk underestimation or overestimation of program effects.

We considered both approaches. We believed the threat to validity from potentially poor comparison schools was greater than the threat to validity from potentially obtaining nonparticipant responses from the same institutions during participating years. Therefore, we recruited nonparticipants from participating schools but restricted the recruitment of nonparticipants from these schools to students attending sometime during a four-year period in which no team from the school participated in the Solar Decathlon. We refer to these nonparticipating periods as "gap years." The nonparticipants had the same majors as the Decathletes (i.e., engineering, architecture, business, computer science, communications/marketing, and sustainable technology). See Appendix F for a list of participating schools and the years in which the school did not participate; these gap years represent the years from which we recruited nonparticipants.

For nonparticipants, we developed a short screener survey that asked about universities they attended, the years attended, and their majors. We pursued two approaches to identifying and recruiting eligible nonparticipants that used the screener survey:

- **Used a data vendor**: We engaged a vendor, Data Axel, that purportedly had current emails for a variety of alumni from universities across the United States. We provided Data Axel with a list of eligible universities and majors. To approximate the targeted years, we requested they invite alumni aged 22 to 36 years old. They sent one email to their alumni with an invitation to our screener survey. We received 12 screener completes; however, none of the respondents attended the universities during the eligible years and, therefore, were ineligible for the study.
  - Result: 0 valid responses
- **Used LinkedIn Campaigns:** LinkedIn Campaigns is a platform feature that allows users to send messages to other users based on set parameters on target characteristics. Using LinkedIn Campaigns, we specified the target universities and majors but were unable to specify target years. We sent the screener invitation to 21,482 LinkedIn users, and 862 completed the survey. We reviewed the results of the screener and invited 316 eligible respondents to complete the full nonparticipant survey. All nonparticipant survey completes came from this strategy.
  - **Result:** 173 valid responses

2.2 Data Cleaning and Final Sample Characteristics

Prior to conducting any analysis of survey data, we reviewed the data and removed incomplete and invalid respondents from the dataset. We removed 13 Decathletes and 15 nonparticipants from the dataset who only partially completed the survey. Additionally, we removed 28 participant respondents who self-reported as being non-student mentors during the competitions. Ultimately, 159 Decathletes and 158 nonparticipants remained in the dataset for analysis.

The resulting Decathlete sample represented a mix of participants across Solar Decathlon Cohorts 5–8 (Table 4).

Table 4. Number of Surveyed Decathletes by Cohort

Cohort	Competition Performance Period	Decathletes
Cohort 5	2010 to 2011	52
Cohort 6	2012 to 2013	35
Cohort 7	2014 to 2015	16
Cohort 8	2016 to 2017	63

Note: Sum of counts exceed final Decathlete survey sample size, as six respondents were members in multiple cohorts.

Across all cohort years, more undergraduate Solar Decathlon participants completed the survey than graduate student participants (Table 5).

Table 5. Number of Surveyed Decathletes by Competition and Educational Level at Time of Participation

Cohort	Competition	Undergraduate	Graduate
Cohort 5	2011 in Washington DC	41	11
Cohort 6	2013 in Irvine	24	11

Cohort	Competition	Undergraduate	Graduate
Cohort 7	2015 in Irvine	9	7
Cohort 8	2017 in Denver	47	16
Cohort 9	2020 in Washington DC[a]	3	0

Note: Sum of counts exceed final Decathlete survey sample size, as six respondents participated in multiple competitions.

[a] 2020 Decathlete respondents were not targeted in this study, as insufficient time may have passed since participation for impacts to accrue. However, three participant respondents from pre-2020 cohorts indicated they participated again in 2020.

Both Decathlete and nonparticipant respondents were slightly more likely to identify as male (Table 6). We cannot compare our respondents to all Decathletes on key characteristics such as gender because the competition did not collect information on student demographic characteristics. The sample's representativeness of the participant population is unclear, but gender differences in college majors are well known: according to data collected by the National Science Foundation's National Center for Science and Engineering Statistics, women received 58% of bachelor's degrees in 2019 but only 39% of STEM degrees went to women.[4] Given these documented gender differences in college degrees, the survey results suggest the competition is attracting a representative mix of genders relative to their composition of relevant university majors.

Table 6. Gender Characteristics of Final Sample (Unweighted)

Gender	Decathletes (n=159)	Nonparticipants (n=158)
Male	55%	61%
Female	43%	36%
Other/refusal	3%	3%

2.3 Analysis Methods

Following data cleaning, we performed an inverse propensity weighting (IPW) routine as a pre-analysis step to statistically correct for observed self-selection biases inherent within Solar Decathlon that may otherwise preclude this study's ability to measure program impacts. After applying IPWs, we performed univariate (and, when applicable, bivariate) analyses on all survey items to demonstrate program impacts.

The following sections provide a brief overview of the IPW method, its application in this evaluation, and additional details on the impact analysis methodology.

2.3.1 Overview of IPW

Randomized control trials are the gold standard for assessing causality (i.e., program impacts), but such an experimental design is not possible for collegiate programs like Solar Decathlon. Since participation in the program is voluntary, there may be traits that not only influence participation but also co-influence the program outcomes this study aims to assess. Thus, any pre-intervention differences between participants and nonparticipants could confound any observed program outcomes. IPW attempts to alleviate these issues, allowing for assessment of the counterfactual.

[4] NSF enrollment data summarized in an article in *Yale Scientific*: https://www.yalescientific.org/2020/11/by-the-numbers-women-in-stem-what-do-the-statistics-reveal-about-ongoing-gender-disparities/.

IPW is a statistical method that relies on logistic regression to identify pre-intervention variables (e.g., age, undergraduate major, and pre-college clean energy activities) that are associated with likelihood to participate in the program.[5] The IPW method then uses those variables to weight cases in the nonparticipant sample, such that the weighted non-participant sample mirrors the participant sample in terms of the pre-intervention variables that were found to predict likelihood to participate in the program. For each control case, the weight is calculated as shown in Equation 1

Equation 1. IPW Formula

$$\frac{p}{1-p}$$

where p is the probability that the case would have received the intervention based on the predictor variables in the logistic regression model. Intervention cases receive a weight of 1, effectively meaning that those cases are not weighted.

The benefit of this version of propensity score matching is that it takes advantage of all appropriate control data. That is, rather than selecting specific control cases to match to intervention cases on a one-for-one basis, it uses all appropriate control cases but weights them so that the resulting weighted control group represents the best possible comparison to the intervention group.[6]

2.3.2 Application of IPW

Following data cleaning, we developed an IPW scheme for the nonparticipants.[7] As described above, we first identified pre-intervention variables that could conceivably be associated with the likelihood to participate in the Solar Decathlon competition. We then used those variables to develop and apply weights to the non-participant sample to create the best possible comparison with participants. We outline that process in further detail below.

The survey fielded to both Decathletes and nonparticipants included a series of questions to use in the development of IPWs. In the survey, we specified we wanted to know if the respondent had done the actions (such as blogging, tweeting, or presenting at a conference) anytime during junior high, high school, or college for nonparticipants and before involvement in the Solar Decathlon for participants. We identified the following pre-intervention survey variables for IPW assessment because they are likely to influence self-selection into the program:

- Age Range: Respondents 40 years old or younger
- Architecture Undergrad: Undergraduate architecture major
- Engineering Undergrad: Undergraduate engineering major
- Computer Undergrad: Undergraduate computer science major
- Business Undergrad: Undergraduate business major
- Environment Undergrad: Undergraduate environmental studies major

[5] See, for example, Austin, Peter C. and Elizabeth A. Stuart (2015). "Moving towards best practice when using inverse probability of treatment weighting (IPTW) using the propensity score to estimate causal treatment effects in observational studies." *Statistics in Medicine*. Wiley Online Library, August 3, 2015. https://onlinelibrary.wiley.com/doi/full/10.1002/sim.6607

[6] Austin and Stuart (2015), *op. cit.*

[7] The study's analysis plan noted we would explore both IPW and cluster analysis as methods to mitigate self-selection biases. Achieved sample sizes precluded cluster analysis; thus, IPW was used.

- Other Undergrad: Undergraduate other majors
- Gender: Gender of respondent
- Science Olympiad: Participated in Science Olympiad
- School Newspaper: Published a clean energy article in a high school newspaper
- Local Newspaper: Published a clean energy article in a local newspaper
- Blogger: Started a blog about clean energy/sustainability
- Tweeter: Tweeted about clean energy/sustainability
- Published Journal: Published in an academic journal about clean energy/sustainability
- Presented Conference: Presented clean energy/sustainability topic at a conference
- Volunteer: Volunteered with a clean energy/sustainability organization
- Invention Idea: Thought up ideas for new inventions or ways of making things
- Invention Development: Developed a working model of a possible new invention or ways of making things
- Self-Employed (friends): Employed yourself by selling things/providing services to family/friends
- Self-Employed (others): Employed yourself by selling things/providing services to strangers

Table 7 shows the descriptive statistics for the pre-intervention variables: participants and nonparticipants demonstrated statistically similar values on most items.

Table 7. Comparison of Participants and Nonparticipants on Pre-Intervention Variables (Unweighted)

Pre-Intervention Variable	Participants (n=159)	Nonparticipants (n=158)
Age Range (40 or younger)	94%	98%*
Architecture Undergrad	34%*	10%
Engineering Undergrad	43%	53%
Computer Undergrad	3%	8%
Business Undergrad	3%	10%*
Environment Undergrad	11%	8%
Other Undergrad	15%	17%
Gender (Male)	55%	61%
Participated in Science Olympiad	13%	13%
Wrote a Clean Energy Article for a School Newspaper	6%	6%
Wrote a Clean Energy Article for a Local Newspaper	2%	3%
Wrote a Blog on Clean Energy	21%	20%
Tweeted about Clean Energy	10%	11%
Published a Journal Article on Clean Energy	5%	8%
Presented at a Conference on Clean Energy	13%	15%
Volunteered with a Clean Energy Group Prior to College	30%	32%
Invention Idea [a]	76%	69%
Invention Development [b]	41%	40%

Pre-Intervention Variable	Participants (n=159)	Nonparticipants (n=158)
Self-Employed (by Selling things to Friends or Family)	37%	29%
Self-Employed (by Selling Things to People They Did Not Know)	26%	26%

*Statistically significant difference ($p<0.05$).

[a] An invention idea was characterized as "Thought up ideas for possible new inventions or ways of making things."

[b] Invention development was characterized as "Developed a working model of a possible new invention or ways of making things."

The first logistic regression model included all identified pre-intervention variables that might predict likelihood to participate in Solar Decathlon in a multivariate logit model scenario (Table 8).

Table 8. All Pre-Intervention Variables IPW Logit

Parameter	B	S.E.	Wald	Sig.(p)	Exp(β)
Age Range (40 or younger)	-1.232	.849	2.104	.147	.292
Architecture Undergrad	2.799	.909	9.490	.002	16.430
Engineering Undergrad	1.152	.864	1.776	.183	3.164
Computer Undergrad	.455	.982	.215	.643	1.576
Business Undergrad	-.998	1.385	.519	.471	.369
Environment Undergrad	.765	.574	1.772	.183	2.148
Other Undergrad	1.189	.938	1.605	.205	3.283
Gender	.255	.311	.670	.413	1.290
Participated in Science Olympiad	.423	.398	1.125	.289	1.526
Wrote a Clean Energy Article for a School Newspaper	.264	.630	.175	.676	1.302
Wrote a Clean Energy Article for a Local Newspaper	.206	1.184	.030	.862	1.229
Wrote a Clean Energy Blog	.598	.447	1.784	.182	1.818
Tweeted about Clean Energy	-.235	.544	.186	.666	.791
Published a Journal Article on Clean Energy	-.553	.763	.525	.469	.575
Presented at a Conference on Clean Energy	-.100	.506	.039	.843	.905
Volunteered with a Clean Energy Group Prior to College	.097	.327	.088	.766	1.102
Invention Idea	.297	.361	.677	.410	1.346
Invention Development	-.357	.339	1.107	.293	.700
Self-Employed (by Selling Things to Friends or Family)	.471	.383	1.516	.218	1.602
Self-Employed (by Selling Things to People They Did Not Know)	.022	.400	.003	.956	1.022

In a stepwise fashion, we removed nonexplanatory independent variables until we arrived at a model with independent variables demonstrating $p<0.1$. Thus, the final regression model used in the IPW calculations only included pre-intervention variables that significantly ($p<0.05$) or marginally significantly ($p<0.1$) predicted likelihood to participate in Solar Decathlon (Table 9).

Table 9. Final IPW Logit

Parameter	B	S.E.	Wald	Sig.(p)	Exp(β)
Age Range (40 or younger)	-1.210	.688	3.089	.079	.298
Architecture Undergrad	1.584	.320	24.476	.000	4.874

Following estimation of the final model, we calculated the IPW weights using Equation 1, noted above. The weights are shown in Table 10. Control weights were capped at 10, with one respondent receiving the weight cap. These weights were then used in all subsequent program impact analyses. All results in the Findings section (both counts and percentages) are weighted for nonparticipants. The p-values reflect analyses on these weighted data. The n-values presented in the figures and tables are unweighted.

Table 10. Distribution of IPW Weights

Weight	Number of Nonparticipants with Weight
0.7	141
2.36	2
3.43	14
10	1

As seen in Table 10, the IPW weighting scheme greatly improved the comparability of participants and nonparticipants on the pre-intervention variables that significantly predicted likelihood to participate.

Table 11. Comparison of Participants and Nonparticipants (Weighted and Unweighted) on Pre-Intervention Variables that Significantly Predict Likelihood to Participate

Pre-Intervention Variable	Participants	Nonparticipants	
		Unweighted	Weighted
Age Range (40 or younger)	93.7%	98.1%	90.1%
Architecture Undergrad	34.0%	9.5%	34.0%

2.3.3 Program Impact Analysis Methods

We compared participants and nonparticipants on all survey items asked of both groups, testing for statistically significant ($p<0.05$) differences throughout. We used four methods (chi-square, Mann-Whitney U, Kruskal-Wallis, and t-test) as dictated by the variable's level of measurement (Table 12).

Table 12. Statistical Tests Used by Level of Measurement

Level of Measurement	Statistical Test Used
Nominal	Chi-square
Ordinal (two groups)	Mann-Whitney U
Ordinal (more than two groups)	Kruskal–Wallis
Scale	t-test

2.4 Study Limitations

While we have taken every effort to make this study as rigorous as possible, there are limitations that may have affected our ability to identify program impacts.

- **Timing of program effects:** The study has a limited ability to assess long-term program outcomes. The study investigated relatively recent cohorts, particularly Solar Decathlon cohorts 7 and 8. Decathletes' participation occurred 4 to 11 years prior to the survey. It is possible that some of the most important

program effects occur over a longer period. At the same time, recall bias may affect the responses of the earlier cohorts because more time has passed since their program experience.

- **Timing of the survey:** Our survey fielding period occurred during the COVID-19 pandemic and resulting societal shutdown. This period was characterized by more white-collar workers and students staying home while many service industry jobs were lost. The turbulence in the job market and uncertainty about the future may have affected people's willingness to respond to the survey or may have unconsciously biased their answers.
- **Participant self-selection bias:** We attempted to limit the impact of program self-selection bias with the IPW weighting, but our method has the following limitations: (1) we lacked the ability to obtain pre-participation data and had to rely on self-reports of pre-participation activities, which may be subject to recall error, and (2) the factual survey questions describe only a few of the many ways participants and nonparticipants may differ. The method does not incorporate information on motivation, time taken and effectiveness of job search, and other attitudinal and behavioral information. Thus, while the study takes steps to lower self-selection bias, without an experimental program design, self-selection bias cannot be entirely eliminated.
- **Student need to work:** The survey did not include questions about a student's need to work while attending college. To the extent that Solar Decathlon activities occurred outside of the classroom, the need to earn income could have prevented participation for an otherwise interested and qualified student and could be a potential issue on comparability between participants and nonparticipants.
- **Comparability of nonparticipants:** As discussed earlier, we believe the threat to validity from selecting nonparticipants from nonparticipating schools was greater than the threat to validity from obtaining nonparticipant responses from nonparticipants at participating schools during the time of program participation. Therefore, we recruited nonparticipants from participating schools but restricted the recruitment of nonparticipants from these schools to students attending sometime during a four-year period in which no team from the school participated in the Solar Decathlon. The nonparticipants had the same proportion of architecture majors as the Decathletes after the IPW weighting.
- **Sample sizes, confidence and precision, and statistical significance:** The achieved survey sample sizes for participants and nonparticipants provide up to 8% precision at the 95% confidence level. In other words, we are 95% confident that the point estimates presented in this report are within +/- 8% of the real population values. Although not an exact replica of statistical power, achieved confidence and precision tends to track with our ability to observe group differences that are deemed statistically significant by statistical tests. Therefore, group differences may need to exceed 8% for statistical tests to determine whether the participant and nonparticipant differences are statistically significant.[8] As some questions were only asked of subsets of respondents, smaller sample sizes—and therefore reduced statistical precision and a need for larger group differences to trigger statistical significance—may be found throughout this report.
- **Coverage bias and survey nonresponse bias:** We did not have a complete list of participants, and of those we did have, we had missing or outdated contact information. Missing data is rarely, if ever, random; therefore, it is possible that the study could suffer from coverage bias in which the reason for having or not having good contact information for a participant is associated with our study variables of interest. This lack of contact information also required us to use additional methods to identify Solar Decathlon participants such as LinkedIn recruiting. The participants who are on LinkedIn may be

[8] Achieved confidence and precision differs by sample size and point estimate. The reported confidence and precision estimates are the most conservative, using a 50%-point estimate assumption in the calculation. The closer the observed point estimate is to 0% or 100%, the greater the achieved confidence and precision is. Similarly, increasingly smaller magnitudes of group differences may be deemed statistically significant by statistical tests as the group point estimates approach 0% or 100%.

different from those who are not in ways that could bias results. Like all surveys, this study is also subject to survey nonresponse bias in which those who complete the survey are different than non-responders in ways that are correlated with our study variables. We minimized these threats to validity by (1) seeking contact information and survey participation from a variety of sources, (2) offering survey participation incentives to encourage response, and (3) seeking survey completes through a variety of methods (LinkedIn messages, SDAA alumni group, team members, and former faculty mentors).

- **Self-report data bias**: This study relies on self-report data. There can be many limitations to self-report data such as survey participants' (1) inaccurate reporting, (2) incomplete reporting, (3) socially desirable reporting, and (4) biases introduced by unconscious psychological processes. The study minimizes the likelihood of self-report data bias by using questions of fact to the extent possible. The study also minimizes the likelihood of self-report data bias by using data from participants' self-report of program influence as only one of several indicators of program effect. Most indicators are based on a comparative analysis of participant and nonparticipant responses to questions of fact.
- **Internal variances and external contextual influences:** We were unable to control for or minimize the influence of variations among teams that may affect program factors such as the (1) contributions of professors, mentors, and team members; (2) financial and in-kind resources available to the team; (3) competing academic and non-academic demands; and (4) university and extra-curricular activities and culture. Other external conditions that vary regionally and temporally and were not possible to account for in student self-reported outcomes include (1) the price of solar home components, (2) consumer interest in highly efficient solar-powered homes, and (3) ongoing investment in clean energy residential technologies. The latter includes utility and state programs that drive up the number of clean energy jobs and lower the price of clean energy homes. These market factors may have affected the students' career trajectories.

3. Findings

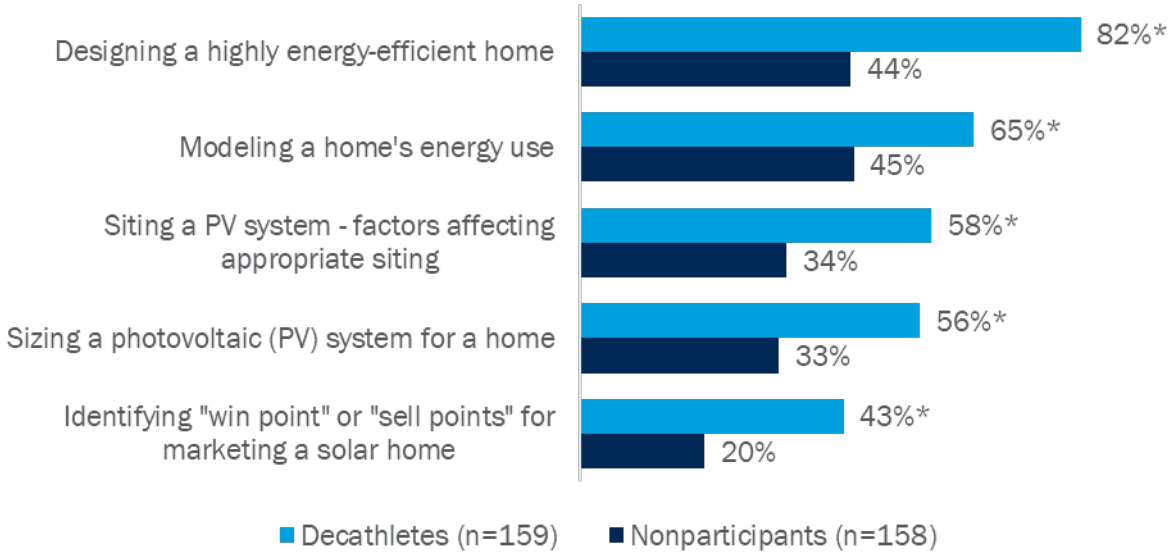
This section presents findings organized by the overarching research questions related to knowledge gain, career readiness, and job trajectory, as well as startup venture creation.

3.1 Knowledge Gain

Participation in the Solar Decathlon is intended to educate Decathletes about clean energy and provide them with experience that prepares them to enter and advance in the clean energy workforce. We found **more Decathletes reported obtaining energy industry knowledge during their time in school than nonparticipants and often attributed that knowledge gain to their participation in Solar Decathlon.**

In the survey, we asked respondents whether they learned about five topics related to high-efficiency home design and marketing in their coursework or non-coursework activities. These topics were chosen because they directly related to program learning objectives. Of the five topics, Decathletes compared to nonparticipants were most likely to have learned how to design a highly energy-efficient home (82% vs. 44%) during their time in college. Decathletes were least likely to have learned about identifying "win points" or "sell points" for marketing a solar-powered home but were significantly more likely to learn about that than nonparticipants (43% vs 20%). These findings demonstrate that Decathletes gained more technical knowledge than soft skills, such as those involved in marketing and selling. Decathletes were significantly more likely to report learning about all high-performance home topics in the survey than were nonparticipants (Figure 1).

Figure 1. Knowledge of High-Performance Home Topics by Participation Status

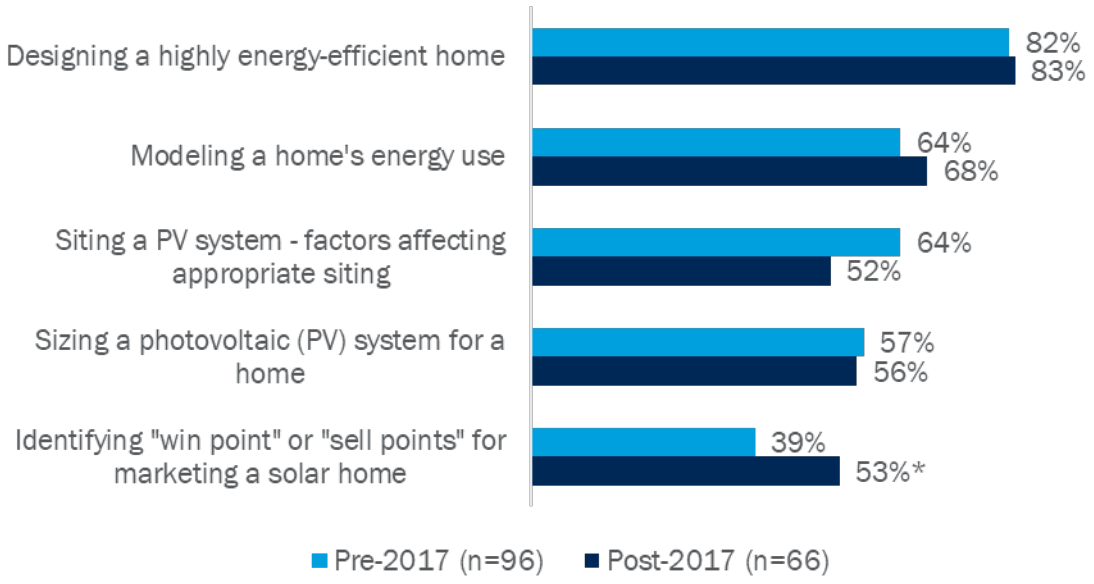


*Statistically significant difference ($p<0.05$).

As noted in Section 1, DOE made some program changes for the final cohort in this study, notably eliminating the upfront payments to universities and modifying the judging competitions. **Program changes implemented in 2017 seem to have had little effect on Decathletes' knowledge gains.** Participants from 2017 and later

were more likely to have learned how to identify sell points to market a solar home, but all other surveyed knowledge areas were similar between cohorts (Figure 2).

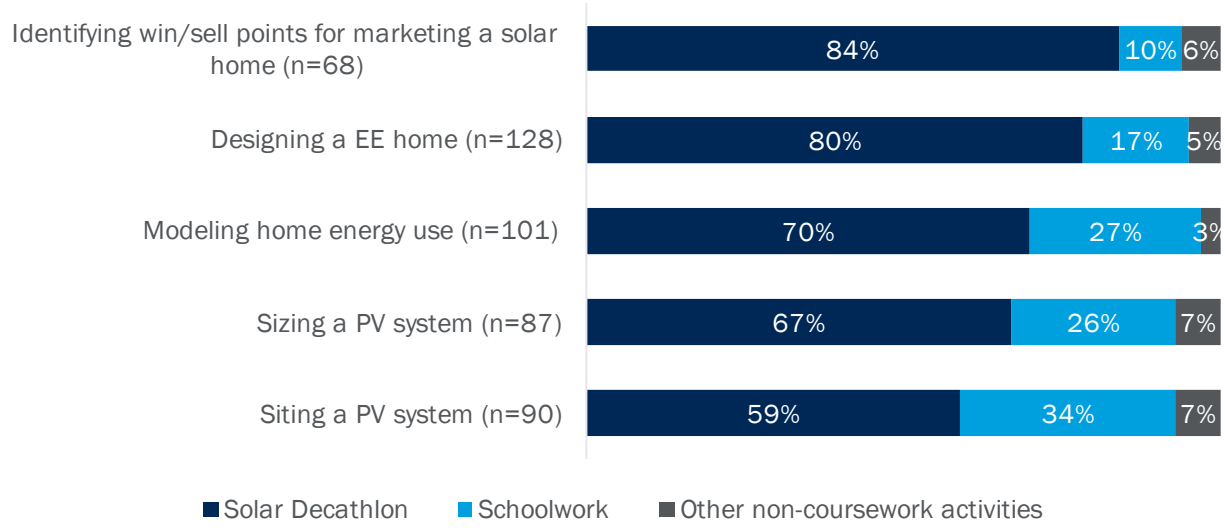
Figure 2. Decathlete Knowledge of High-Performance Home Topics by Competition Year



*Statistically significant difference at the p-value <= 0.05 level

A majority of surveyed Decathletes attributed their high-performance home knowledge to the Solar Decathlon program instead of other sources such as their schoolwork or non-coursework activities (Figure 3). Decathletes were most likely to credit the Solar Decathlon for teaching them about identifying “win points” or “sell points” (84%) and least likely to do so with siting a PV system (59%). They ranked schoolwork as the next most common source of their high-performance home knowledge.

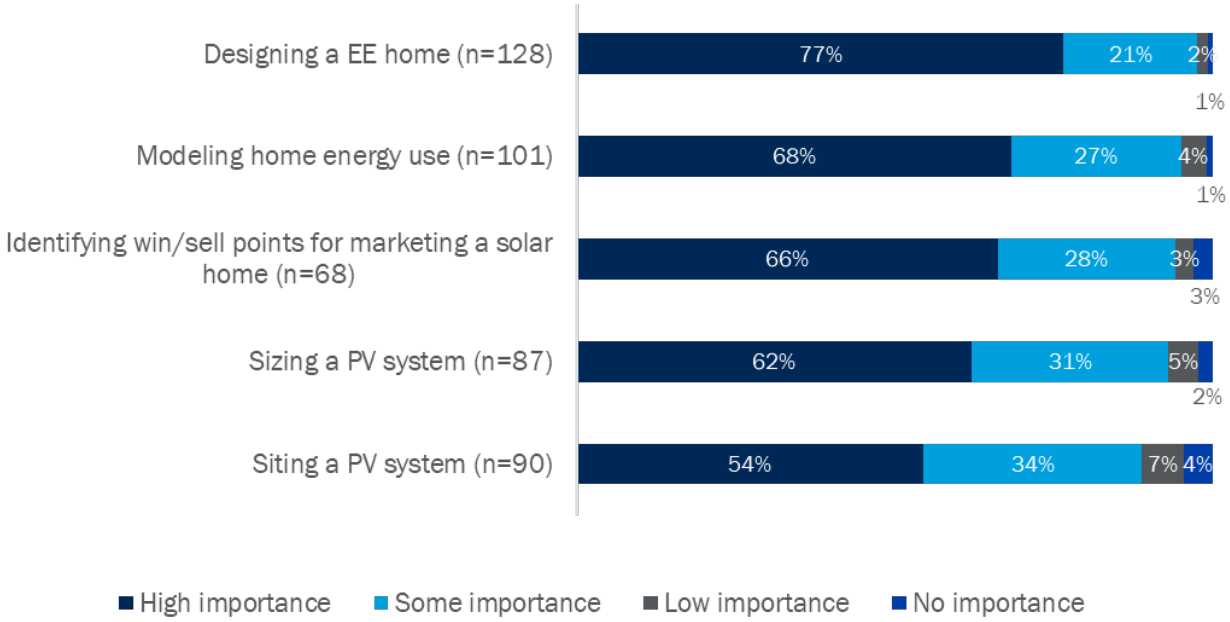
Figure 3. Decathletes' Main Source of Knowledge



*Statistically significant difference at the p-value <= 0.05 level

Decathletes overwhelmingly attributed at least some of their knowledge on a given topic to what they learned from the competition, ranging from 88% who said the competition was of high or some importance for siting a PV system to 98% for designing an energy-efficient home (Figure 4).

Figure 4. Decathlete Attribution of Program Influence by Topic



*Statistically significant difference (p<0.05).

Some participants wrote in the survey that their program experience provided useful technical knowledge on sustainable architecture, building design, and techniques. One Decathlete wrote in the survey,

> *"The Decathlon not only provided me with technical skills on architectural design, environmental sustainability and engineering, but also gave me confidence and soft skills, including communication/outreach, public speaking and journalism."*

Despite their levels of self-reported high-performance home knowledge, Decathletes tended to perform similarly to nonparticipants on questions testing their knowledge of energy efficiency and solar PV systems. In three of five true/false questions we asked respondents, Decathletes and nonparticipants answered questions correctly at roughly the same rate (Table 13). Decathletes correctly identified that thermal bridging is unrelated to air sealing at a significantly higher rate than nonparticipants. However, nonparticipants were significantly more likely to identify that PV systems are cost-effective or worthwhile in any state regardless of sunshine. It is important to note that the prior Solar Decathlon impact report conducted in 2012 found similar levels of correct answers to true/false knowledge questions between Decathletes and nonparticipants.[9]

Table 13. Correct Responses to Energy Quiz Questions by Participation Status

True/False Question	Solar Decathletes (n=159)	Nonparticipants (n=158)
It is important that a house not be sealed too tightly in order to avoid mold and moisture issues. (False)	57%	54%
Although most states have enough sunshine for households to take advantage of PV systems, the weather in a few states just doesn't make PV systems worthwhile. (False)	48%	68%*
To reduce the size of heating and cooling equipment needed, architects and other designers can take advantage of thermal bridging, which describes the transfer of heat through building materials. (False)	27%	25%
Thermal bridging is a very important consideration when air sealing a home. (False)	21%*	8%
Sizing and placement of PV systems on a home's roof is challenging and needs to consider many factors, including the size and orientation of the roof, the building's structural integrity, fire codes, historic building laws, and rules issued by the Federal Aviation Administration (FAA) and the U.S. Department of Energy (DOE). (False)	5%	6%

*Statistically significant difference ($p<0.05$).

Decathletes who majored in architecture reported the greatest gain in energy industry knowledge during college. The difference in high-performance home knowledge was greater between Decathletes and nonparticipants than between Decathletes with different majors. Architecture majors were significantly more likely to have learned how to design a highly energy-efficient home and to have learned how to site a PV system compared to engineering and other majors (Table 14). Otherwise, Decathlete knowledge was not major-dependent. Each major in Table 14 is represented by a capital letter, and superscript capital letters appearing next to a percentage indicate statistically significant ($p<.05$) differences from the groups represented by a given letter.

[9] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. Impact Evaluation of the U.S. Department of Energy's Solar Decathlon Program. DOE/EE-0843. Prepared by Lockheed Martin (December 2012).

Table 14. Decathlete Knowledge of High-Performance Home Topics by Undergraduate Major

	Engineering (n=69) (A)	Architecture (n=54) (B)	Other (n=23)[a] (C)
Designing a highly energy-efficient home	78%	96%[AC]	75%
Modeling a home's energy use	61%	72%	63%
Sizing a photovoltaic (PV) system for a home	57%	61%	51%
Siting a PV system	48%	78%[AC]	49%
Identifying "win points" or "sell points" for marketing a solar home	41%	43%	47%

[a] Other majors consist of environmental studies (n=18) and majors with 5 or fewer respondents, including computer science, business/finance, economics, physics, biology, chemistry, and communications.

One goal of the Solar Decathlon program is to raise public awareness of high-efficiency solar-powered houses. This was not one of the study research objectives and was outside the scope of this study..

3.2 Job Trajectory and Career Readiness

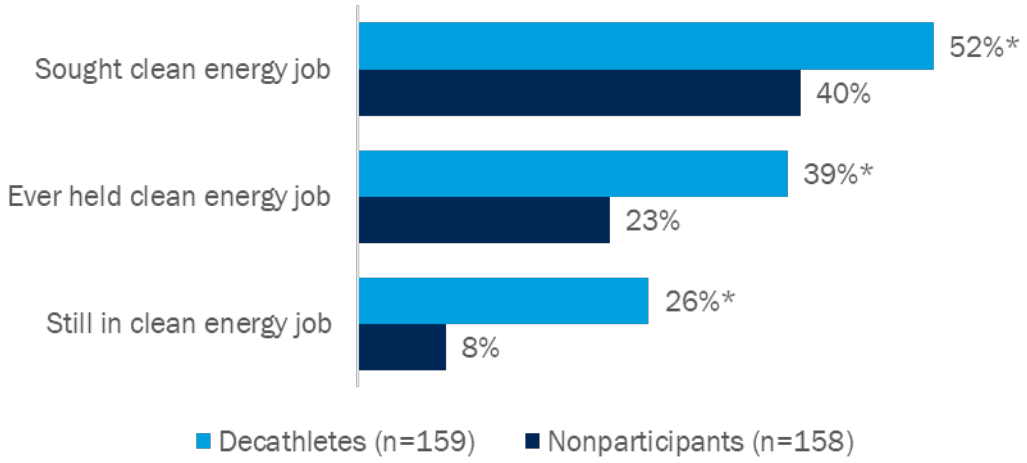
Another key goal of the Solar Decathlon is to provide participating students with training that prepares them to enter and advance in the nation's clean energy workforce. We investigated whether students pursued career opportunities in sustainability and clean energy fields, obtained employment in such fields, and their tenure in their clean energy careers.

For the purposes of the survey, a clean energy job relates to energy efficiency or renewable energy, while a sustainability job relates to reducing the environmental impact of economic activity. The job could be partially or fully focused on clean energy or sustainability. These jobs could be full-time, part-time, an internship, contracted work, or independent consulting. Respondents were instructed to not include employment at a startup venture they founded.

Participation in the Solar Decathlon was associated with greater levels of employment in the clean energy and sustainability sectors.[10] Decathletes were significantly more likely than nonparticipants to have sought a clean energy or sustainability job (Figure 5). Just over half of Decathletes sought a clean energy or sustainability job (52% compared to 40% of nonparticipants), but it is worth noting that an additional 7% of Decathletes were still in graduate school at the time of the survey and may seek a clean energy job in the future. Decathletes were also significantly more likely than nonparticipants to hold one of these jobs (39% of Decathletes compared to 23% of nonparticipants) and to still be in a clean energy job at the time of the survey (26% of Decathletes compared to 8% of nonparticipants). Of respondents who sought a clean energy job, Decathletes were more likely to have held a clean energy job (75%) than nonparticipants (58%). Additionally, Decathletes' average duration in a clean energy job was significantly longer than nonparticipants: about two and a half years compared to one and a half years for nonparticipants.

[10] See Appendix A for definitions of clean energy and sustainability jobs provided in the survey.

Figure 5. Clean Energy and Sustainability Sector Careers by Participation Status



*Statistically significant difference ($p<0.05$).

The likelihood that Decathletes had ever held a clean energy job was the same regardless of their undergraduate majors. There were no significant differences among Decathletes with architectural, engineering, or other majors (Figure 6).

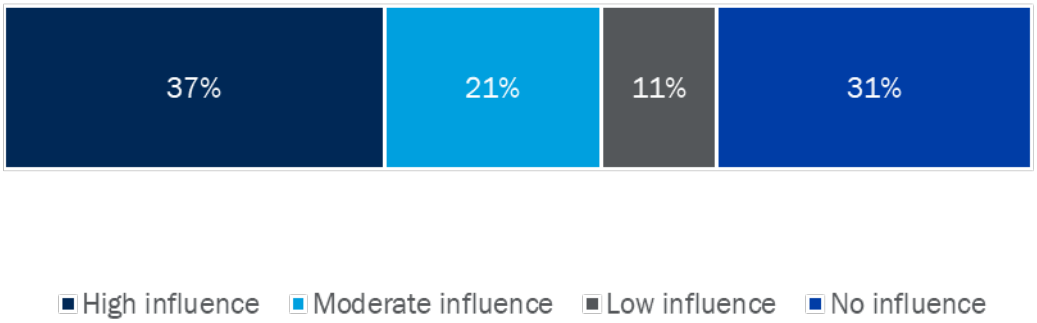
Figure 6. Decathletes Who Have Held a Clean Energy Job by Undergraduate Major

Many Decathletes reported that their competition experience positively influenced their employment in the clean energy or sustainability industry. Over two-thirds of Decathletes employed in the clean energy/sustainability sector (69%) attributed at least some level of influence to the program in helping them obtain that job (Figure 7). More than one-third (37%) rated the program as highly influential to their employment. Seven Decathletes mentioned in open-ended survey responses that the competition helped kickstart their careers and was the main reason they were employed in the clean energy industry at the time of the survey. Comments participants wrote in the survey included:

"I loved working on the Solar Decathlon projects. It renewed my passion for engineering at a time when I was considering changing my major. The experience I had made it possible to get highly paid internships, got me invited to graduate school, and helped me build a reputation that enabled me to find great jobs quickly. By getting in touch with my passion for sustainability/clean energy, I was able to choose a career that I excel in and enjoy."

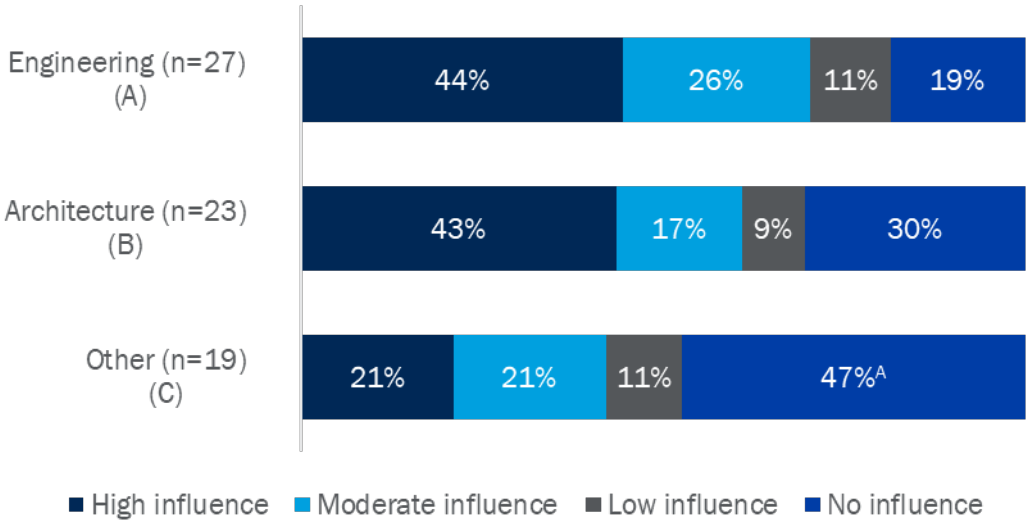
"The Solar Decathlon had a huge impact on me personally and professionally. I learned a ton about building design and sustainability, about the permitting process and building codes, and about fundraising. It's the reason I work in the construction industry today."

Figure 7. Influence of Solar Decathlon on Clean Energy/Sustainability Employment (n=62)



While most Solar Decathletes reported that their program participation positively influenced their career trajectories, the proportion of Decathletes who reported their program experience helped them obtain employment varied by major. Engineering majors were significantly more likely than non-engineering majors to report that the Solar Decathlon helped them obtain employment in clean energy (81), in comparison with those from other non-architecture majors (53%) (Figure 8).

Figure 8. Participant Attribution of Solar Decathlon on Clean Energy/Sustainability Employment by Undergraduate Major[a]



[a] Superscript letters appearing next to a percentage indicate statistically significant (p<.05) differences from the group[s] represented by a given letter.

Solar Decathlon teams can be large, comprised of two dozen students or more. The teams may subdivide by academic major to focus on different aspects of designing and constructing the highly efficient solar-powered home. One hypothesis was that the differing experiences students had during the competition could have

influenced career trajectories. We found, however, that Decathletes who have held a clean energy job after graduation performed similar job functions regardless of their academic major (Table 15). Though the proportions by academic major vary, the differences are not statistically significant. Not finding statistically significant differences could be due to the small sample sizes.

Table 15. Clean Energy Job Functions by Academic Domain

Job Functions	Engineering (n=27) (A)	Architecture (n=23) (B)	Other (n=19) (C)
Designing, manufacturing, selling, installing, or maintaining clean energy/sustainable products, equipment, buildings, processes, or services	59%	65%	58%
Developing, implementing, or supporting clean energy/sustainability policies and programs; working in governmental or non-governmental offices, energy utilities, consulting firms, or academia	30%	39%	42%
Advising or consulting on clean energy/sustainability	26%	13%	25%
Focus on increasing clean energy/sustainability in your employer's facilities or supply chain	26%	22%	42%
Providing clean energy/sustainability philanthropy, financing, investment funding, or support to startup accelerators or startup incubators	0%	13%	8%

Note: Due to small sample sizes, results presented here should be interpreted with caution.

Students could also have taken on leadership roles (e.g., team leader) or supportive roles during their participation in the Solar Decathlon. However, Table 17 shows that clean energy job functions did not vary significantly among Decathletes with varying levels of involvement in the program.

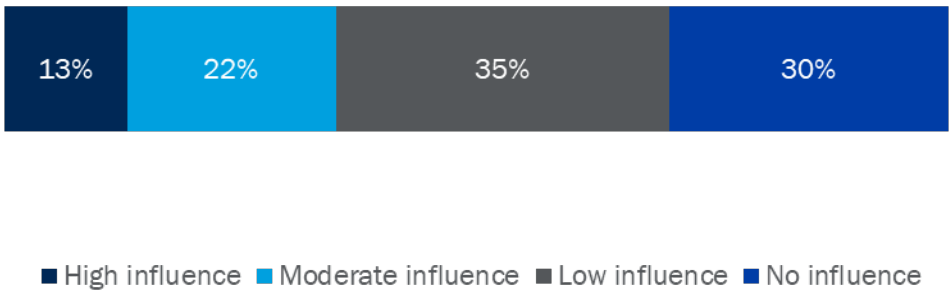
Table 16. Clean Energy Job Functions by Role on Solar Decathlon Team

Job Functions	Leadership Role (n=28) (A)	Substantial Role (n=21) (B)	Supporting Role (n=13) (C)
Designing, manufacturing, selling, installing, or maintaining clean energy/sustainable products, equipment, buildings, processes, or services	71%	52%	54%
Focus on increasing clean energy/sustainability in your employer's facilities or supply chain	25%	19%	15%
Advising or consulting on clean energy/sustainability	25%	38%	15%
Developing, implementing, or supporting clean energy/sustainability policies and programs working in governmental or non-governmental offices, energy utilities, consulting firms, or academia	25%	43%	46%
Providing clean energy/sustainability philanthropy, financing, investment funding, or support to startup accelerators or startup incubators	11%	0%	8%

Note: Due to small sample sizes, results presented here should be interpreted with caution.

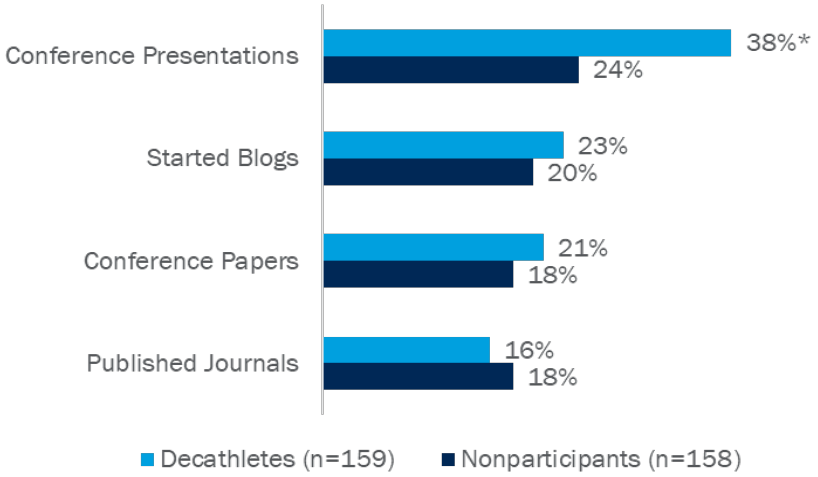
Most Decathletes said Solar Decathlon did not highly influence their acceptance into a graduate program. About a third of Decathletes (35%) reported their Solar Decathlon experience highly or moderately influenced their acceptance into graduate school, while the rest gave the program low or no influence (Figure 9).

Figure 9. Participant Attribution of Program Influence on Graduate School Acceptance (n=54)



Conference presentations are one way of sharing findings on emerging clean energy technologies and practices and may be an indicator of a Decathlete's level of influence in the clean energy industry. **Decathletes were significantly more likely than nonparticipants to have presented at conferences on clean energy/sustainability during or after college,** but there was no evidence of significant differences in other areas of industry involvement (Figure 10).

Figure 10. Industry Publications and Presentations by Participation Status



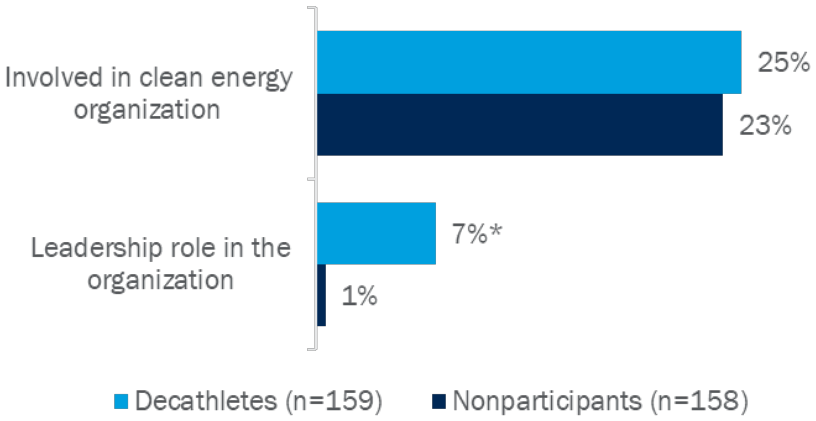
*Statistically significant difference ($p<0.05$).

An intended medium-term outcome of Solar Decathlon participation is involvement in organizations focused on highly efficient buildings or renewable energy due to the increased industry connections Decathletes may form during the competition. The survey gave examples of such organizations and of leadership roles so all respondents could respond to the same prompt: organizations focused on energy efficiency, renewable energy, or sustainability, not including an employer; and roles such as being an officer of the organization, chairing a committee or subcommittee, or leading an ad hoc activity.

We found participation in the Solar Decathlon was linked with greater incidence of leadership roles in extracurricular clean energy industry organizations. Although representing a minority of Decathletes, Decathletes were significantly more likely than nonparticipants to report holding leadership positions in these

organizations (Figure 11). Similar proportions of Decathletes (25%) and nonparticipants (23%) were involved in clean energy, sustainability, or renewable energy organizations outside of their careers (Figure 11).

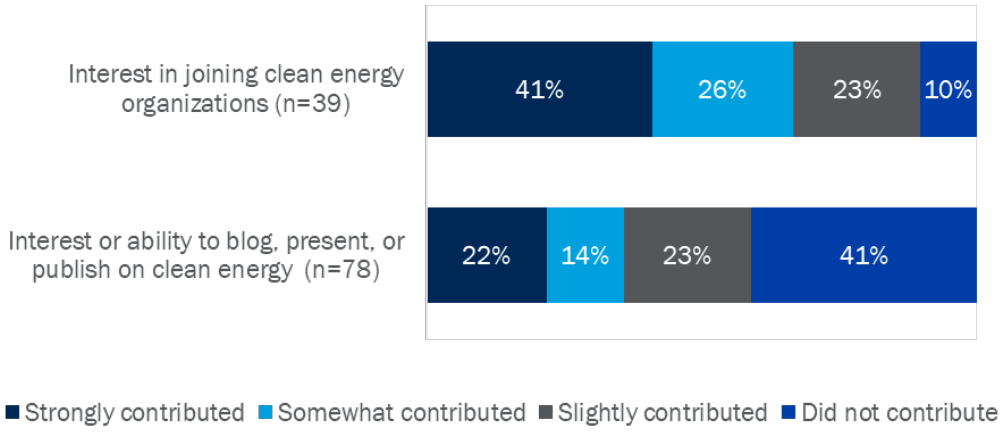
Figure 11. Clean Energy Organization Involvement by Participation Status



*Statistically significant difference ($p<0.05$).

The Solar Decathlon contributed to interest in clean energy industry involvement. Even though Decathletes and nonparticipants were involved in clean energy organizations at about the same rate, Solar Decathlon participation catalyzed interest in joining such an organization. Of Decathletes involved in clean energy organizations beyond their employment, two-thirds (67%) said the program at least somewhat contributed to their interest in joining the organization (Figure 12). About one-third (36%) of Decathletes who blogged, presented, or published on clean energy described their program participation as being at least somewhat influential on their interest or ability to do so.

Figure 12. Influence of Solar Decathlon on Clean Energy Industry Involvement Outside of Employment

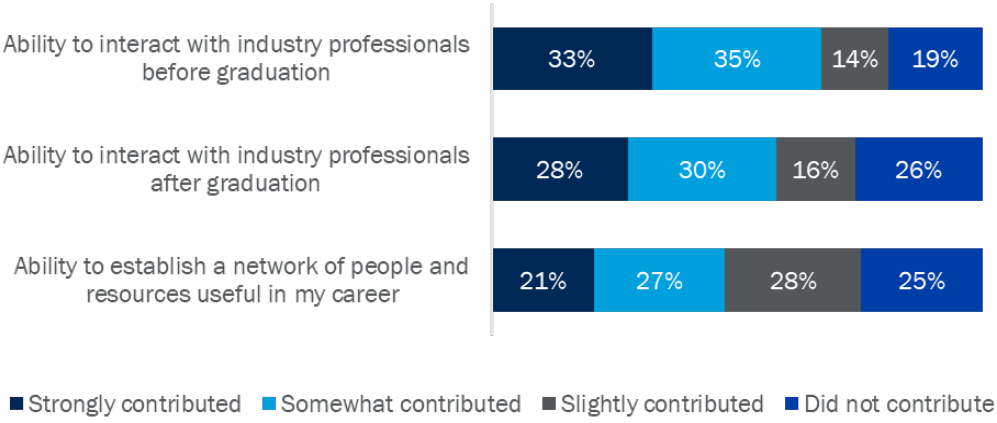


The Decathletes' engagement with their professors and mentors, the juried contests and discussions with judges, along with presentations and engagement with the public are all intended to increase Decathletes' industry connections. **We found that the Solar Decathlon improved clean energy networking opportunities for Decathletes.** Most Decathletes reported their participation at least somewhat contributed to providing

opportunities to interact with industry professionals before graduation (68%) and after graduation (58%) (Figure 13). It seems the program's influence on the ability to network was most influential close to program participation, with less long-term influence. Just under half of participants (48%) found their program experience contributed to establishing a long-term network of contacts in the industry.

In the final comments provided on the survey, one Decathlete mentioned that the competition was a "great way to network and has proved beneficial in my young career with various personal and career opportunities." The Decathletes' improved ability to network with industry professionals during school and soon after graduation may be one reason for their greater employment in the clean energy industry and greater incidence of leadership in organizations compared to nonparticipants.

Figure 13. Influence of Solar Decathlon on Networking (n=159)



3.3 Startups and New Ventures

Decathletes' employment in the clean energy industry is not limited to seeking employment at an established business; they could potentially start their own company. A long-term outcome of participation in the Solar Decathlon competition is business formation in the clean energy or sustainability industry, such as new startups and ventures. **Survey findings indicate that while the formation of startups was infrequent, Decathletes were significantly more likely than nonparticipants to have started one.** Few (5%) Decathletes reported founding a startup, but they did so at a significantly greater rate than nonparticipants (1%) (Table 17).[11] We confirmed that the eight Decathletes who founded a startup did so after program participation (7) or during the program (1), not beforehand.

Table 17. Startup Creation by Participation Status

Response	Decathletes (n=159)	Nonparticipants (n=158)
I have founded a startup	5%*	1%
I have not founded a startup, but was considering it before COVID	7%	11%
I have not founded a startup, and was not considering it before COVID	88%	88%

*Statistically significant difference ($p<0.05$).

[11] If all respondents who were considering creating a startup prior to the COVID-19 pandemic ended up following through, there would not be a significant difference between the number of startups created by Decathletes and nonparticipants.

Of the eight Decathletes who created their own startups, three gave the program high levels of influence, four gave it moderate levels of influence, and one gave it low levels of influence. Half of the eight startups founded by surveyed Decathletes were still running, with three of the four being incorporated. The one startup founded by a surveyed nonparticipant was also still running and incorporated. There were no startups that ended due to COVID-19, but as shown in Table 17, some were never created as a result of the pandemic.

3.4 Final Comments

At the end of the survey, Decathletes were given the option to provide additional comments about their experiences with the Solar Decathlon. Of the 39 Decathletes who provided comments, responses were overwhelmingly positive, with 36 of the 39 describing a positive experience with the program (Table 18). This included gaining "a ton of new skills," kickstarting their careers, and generally enjoying the experience. Fourteen Decathletes felt they gained valuable "soft skills," including public speaking, how to work within a team environment, and self-confidence, while 11 reported gaining technical engineering, architecture, or product development skills.

While Decathletes were generally very positive, a few voiced some negative feelings towards the competition along with some areas for improvement. For instance, four Decathletes said that despite the positive things they gained from the Decathlon, it was very stressful and a large time commitment on top of their academic responsibilities. Another Decathlete felt that while they had learned a lot, "the competition itself was poorly managed, and it all came down to money and which schools could afford to hire installers, and [...] the rubric for points [...] made no sense." The one Decathlete who reported an overall negative experience, said it was a due to team members who got "caught up in personal dynamics and lost focus on the project."

Table 18. Summary of Final Comments by Decathletes (n=39)

Response	Decathletes
Had a good experience	36
Gained soft skills	14
Gained technical skills	11
Influenced career choice in clean energy	7
Was stressful/large time commitment	4
Provided good networking opportunities	3
Had a bad experience	1
Competition was not fairly designed	1

Note: Responses sum up to more than 39 since some Decathletes made multiple points in their comments.

COVID-19 Call-Out Page

The period between Decathletes' participation and our outcomes survey included the COVID-19 pandemic. The pandemic greatly affected the economy including employment, construction, and political attention. Therefore, we included a brief investigation into how the pandemic might have affected the career paths of the former students under study.

We found that a small portion of respondents reported that COVID-19 reduced available job positions, but otherwise the pandemic had minimal effects on respondents' employment. Most Decathletes (80%) and nonparticipants (72%) reported no COVID-19 employment impacts (Table 19). These respondents indicated they had a job prior to the pandemic and maintained that job. A minority of Decathletes (12%) and nonparticipants (16%) reported a slower job market with fewer opportunities; however, a few respondents were laid off, received reduced pay, or changed careers as a result of the pandemic.

Table 19. Effect of COVID-19 on Careers by Participation Status

Effects	Decathletes (n=97)	Nonparticipants (n=125)
Slowed down job search	12%	16%
Got laid off	4%	4%
Changed careers	2%	6%
Reduced pay	1%	2%
No impact	80%	72%

4. Conclusions and Recommendations

Overall, we found that participation in the Solar Decathlon was linked with many positive and statistically significant outcomes. We offer the following conclusions and recommendations for the program. As noted earlier, study conclusions are based on data that have several limitations, which may affect the conclusions' validity.

- Conclusion: This study's ability to measure smaller differences between participants and nonparticipants was limited by the sample size, which was a result of the partial student records kept by program administrators. If more complete records had been available, we could have assessed the potential for nonresponse bias and made appropriate adjustments. This data would have also allowed us to determine the representativeness of our sample and the generalizability of the results.
  - Recommendation: For DOE's collegiate competition programs, the program manager should make good faith attempts to keep records of all student participants and their contact information. At a minimum, the contact information should include the student email and, if possible, include a non-university-affiliated email address. If DOE institutes social equity goals for future competition programs related to increasing participation among traditionally underrepresented groups, then it will be important for future evaluators to be able to assess sociodemographic variables. In this case, the program manager should also track socioeconomic characteristics such as age, gender identity, race/ethnicity, first-generation college student status, and household income, among others.
- Conclusion: **The knowledge, skills, and experiences learned in program participation supported Decathletes' ability to enter and advance in the clean energy workforce.** Decathletes were significantly more likely than nonparticipants to still be working in the clean energy industry at the time of the survey, and Decathletes stayed in their clean energy jobs longer than nonparticipants. Decathletes' presence in the clean energy workforce is likely due to (1) their knowledge gained, which they attributed to the Solar Decathlon experience as opposed to coursework or non-coursework activities, and (2) the improved networking ability Decathletes attributed to program participation.
- Conclusion: **The Solar Decathlon is already contributing some of the next generation of leaders to clean energy organizations.** Though the overall number is small (7%), participants are taking on leadership positions (such as being an officer or committee chair) at a greater rate than nonparticipants. Of the Decathletes that have taken on leadership positions in clean energy organizations outside of their job, 90% of them said the Solar Decathlon influenced their interest in doing so.
- Conclusion: **Architects' and engineers' careers, in particular, showed benefits associated with participation in the Solar Decathlon program.** Some program outcomes were more influential for students of certain academic domains, such as architecture and engineering, though program benefits reached Decathletes of all types. For example, Decathletes who majored in architecture exhibited the greatest high-performance home knowledge (such as designing a highly energy-efficient home and siting a PV system), while engineering majors were most likely to report the Solar Decathlon as impactful on their employment in clean energy. Despite these engineering majors reporting the highest program influence on their ability to get a job, they obtained jobs in the clean energy and sustainability fields at rates lower than Decathletes in other majors. Regardless of their academic domain or level of involvement in the program, Decathletes reported similar roles and duties in their jobs (no statistically significant differences in job duties were found).

- Recommendation: To the extent possible, ensure networking opportunities are equally applicable to engineering and non-engineering majors so all Decathletes may take advantage of networking and launch their careers.

- Conclusion: **The COVID-19 pandemic had minimal effects on respondents' employment outcomes, though the effects that occurred were negative.** One might expect potentially greater employment outcomes had the COVID-19 pandemic not occurred, but it is hard to know whether those outcomes would have been the same for participants versus nonparticipants. Respondents noted fewer job opportunities available, and some respondents were laid off or had their pay reduced during the pandemic. Additionally, some respondents were considering founding a startup before COVID but did not, though this was a minority of respondents.

Appendix A. Metrics and Definitions

This study uses terms such as clean energy, jobs, and new ventures. These terms were defined in the survey instruments, so respondents were clear about what they were answering. The following excerpts from the instruments provide terminology definitions.

Clean energy encompasses energy efficiency and renewable energy.

Sustainability describes a reduced environmental impact of economic activity through: reduced resource use (water, raw materials, energy), reduced waste stream, and/or reduced harmful effects or byproducts from the activity lifecycle (extraction, production, and disposal).

Clean energy and sustainability *jobs* encompass:

- Focusing on increasing clean energy/sustainability in your employer's facilities or supply chain
- Designing, manufacturing, selling, installing, or maintaining clean energy/sustainable products, equipment, buildings, processes, or services
- Advising or consulting on clean energy/sustainability
- Developing, implementing, or supporting clean energy/sustainability policies and programs working in governmental or non-governmental offices, energy utilities, consulting firms, or academia
- Providing clean energy/sustainability philanthropy, financing, investment funding, startup accelerators or startup incubators

Jobs:

- Have you ever held a clean energy job? Full-time employee, part-time employee, intern, contractor, or independent consultant all qualify for a "yes" response.

New venture:

- Have you ever started or co-founded a company—or contributed to or facilitated the formation of—a *new* business related to clean energy?

Appendix B. Research Questions

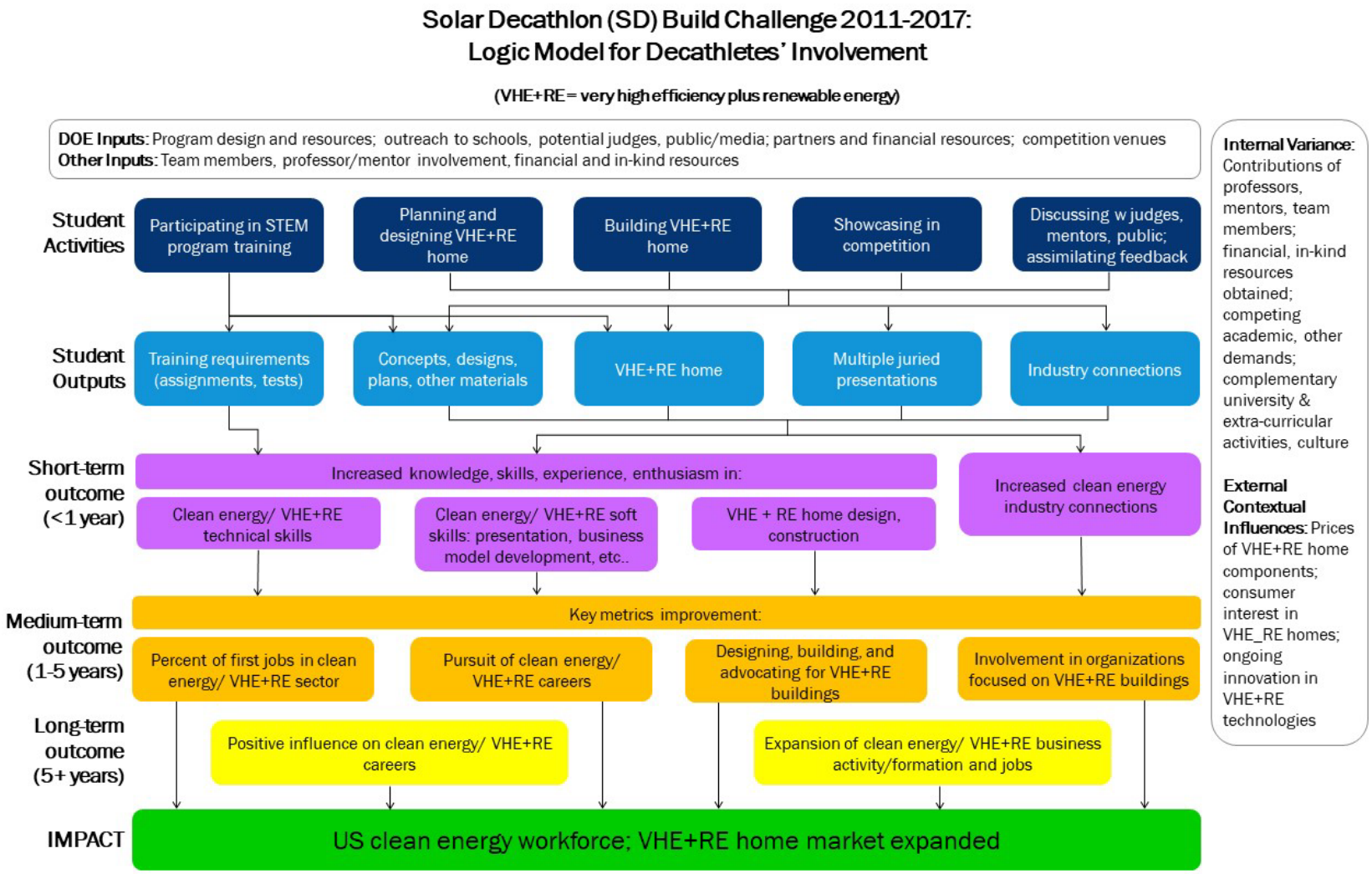
The full list of research questions is below:

1. Measure Decathlete knowledge gains in comparison to non-Decathletes.
    a. Do Decathletes gain greater knowledge than non-Decathletes on such measures as opportunities, cost savings, challenges and markets in sustainability and clean energy?
    b. How much variation is there in the knowledge gains reported by Decathletes from different academic domains?
    c. Among Decathletes, are there any significant differences between cohorts up to 2015 versus 2017 participants (when significant changes were introduced to the program)?
2. Analyze Decathlete participant clean energy job readiness, participation, competitiveness, and persistence in comparison to non-Decathletes.
    a. Are Decathletes better prepared than non-Decathletes to enter and advance in the workplace?
    b. Do Decathletes report that their experiences, knowledge, and skills gained from Solar Decathlon contribute to job readiness?
    c. Upon graduation, are Decathletes more likely than non-Decathletes to pursue career opportunities in sustainability and clean energy fields (broadly construed to span architecture, building materials, engineering, communications, and other domains represented in the Solar Decathlon teams
    d. Are Decathletes more likely than non-Decathletes to stay in the sustainability and clean energy fields?
    e. To what extent does the impact of the Program differ across the Solar Decathlon alumni?
    f. How much variation is there in the experiences of Decathletes from different academic domains and with different commitment levels to the program during their participation?
3. Analyze Decathlete participants contributions to clean energy/sustainability industry in comparison to non-Decathletes comparison groups.
    a. In what settings in the U.S. do former Decathletes have influence, including education, research, policy, and industry?
    b. What kind of influence do they have?
    c. Are Decathletes more likely than non-Decathletes to create their own clean energy startups?
    d. For Decathletes who do create their own startups, how much do they credit their participation in the Solar Decathlon program?

Appendix C. Program Theory Logic Model

The student-centered PTLM for Decathletes is in Figure 14.

Figure 14. Solar Decathlon Logic Model



Appendix D. Summary of Program Data

Opinion Dynamics received program data from DOE representatives covering Cohorts 5–8 and competition years 2011–2017. Table 20 provides a summary of the data received.

The "role in Solar Decathlon" field varied substantially among universities, with some providing more descriptive roles than others. There were 547 unique roles included in the data. The most common role was "Student Member," which accounted for 40% of students in the dataset (968 of 2,451). Examples of other roles included: technology management, renewable energy engineering, building science, urban planning, graphic design, industrial design, environmental design, interior design, geology and physics, chief electrical designer, drawings, health and safety, home automation lead, and energy modeling.

Table 20. Summary of Solar Decathlon Program Data Records

Data Field	Number of Records
First and last name	2,458
Competition year	2,458
University name	2,458
Role in Solar Decathlon	2,451
Email addresses	1,043 (589 .edu and 454 .com or .org)
Degree title earned upon Solar Decathlon involvement	201

Appendix E. Survey Instrument

Instrument Information

Table 21. Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Web survey
Estimated Time to Complete	Participants: 20 minutes on average; nonparticipants: 10 minutes on average
Population Description	See Table 22 for participants cohort groups We will generate a similar group of nonparticipants: former college students that attended and, likely but not necessary, graduated from the same schools as the participants at the time of the competitions and that have similar majors as the participants
Sampling Strata Definitions	See Table 22 for participants cohort groups We will generate similar cohorts of nonparticipants
Population Size	Participants: ~1,775 from program tracking database Nonparticipants: ~2,000 to target
Completion Goal(s)	Participants: ~390 Nonparticipants: ~120
Type of Sampling	Census of participants and of targeted nonparticipants
Contact Sought	Former student who participated in program and similar nonparticipants
Fielding Firm	Opinion Dynamics

Table 22: Program Cohorts

Evaluation	Program	Cohort	Competition Performance Period
Solar Decathlon	SD with upfront payments to universities	Cohort 5	2010 to 2011
		Cohort 6	2012 to 2013
		Cohort 7	2014 to 2015
	SD without upfront payments	Cohort 8	2016 to 2017
Race to Zero	RTZ	Cohort 1	2014
		Cohort 3	2016
		Cohort 4	2017
		Cohort 5	2018

Table 23: Research Objectives and Associated Questions

SOW RQ#	Question	Section of Instrument
1a, 1b	Knowledge outcomes: CE opportunities, CE cost savings, CE challenges, CE markets; by academic domains	Knowledge Outcomes
2a, b, c, d, f, g	CE jobs held? CE careers pursued? Stay in CE field? Better prepared to enter and advance; contributes to job readiness; by academic domains; pre/post 2017 participation	Job Trajectory
3b, c	Where do they have influence in the US, if any;* What kind of influence;* Influence of program on industry connections	Industry Influence
3d, e	CE startup; to what extent do they credit program	Startups and Sales

*The survey questions get at the spirit of this research question, but do not literally address the question.
B. Instrument does not explore influence on employers' decisions. Objective influence questions defy conceptualization. Self-reported influence questions subject to bias stemming from respondents' personal characteristics (naivete, hubris, modesty, etc.)

Programmer Information

Table 24: Database Inputs

Variable Name	Variable Description	Purpose
PROGRAM	"SD" (Solar Decathlon) or "RTZ" (Race to Zero)	Question phrasing
PGM_DESCRIPTION	For Solar Decathlon: "design and build" For Race to Zero: "design"	Question phrasing
YEAR_PART	Year participant participated	To drive display logic and for use in analysis
TRACKED_NAME	Program participant name per program tracking records	For use in analysis, comparing program tracking participation data (TRACKED_NAME) with participant self-report (PARTICIPANT; see Table 5)
TIME_TO_COMPLETE	"20 minutes" if participant (TRACKED_ NAME <> EMPTY) "10 minutes" if nonparticipant (NONPART_NAME <> EMPTY)	For use in introduction
NONPART_NAME	Nonparticipant name identified by evaluation team	For use in analysis
TEAM COMPLETE	0 = Team list provided by DOE assumed incomplete based on number of team members 1 = Team list assumed complete	To drive display logic for question asking for names of team members
EMAIL	Email address to which survey was sent	To inform incentive logic

Table 25: System Variable Creation

Variable Name	Variable Description	Purpose
PGM_AWARE	Respondent aware of program	To inform display logic throughout instrument
PARTICIPANT	Participated in program per respondent report	To inform display logic throughout instrument
NONPARTICIPANT	Did not participate in program per respondent report	To inform display logic throughout instrument
P_2020_ONLY	Respondent participated only in 2020 SD competition	To inform display logic for Knowledge Outcomes
AWARE_NP	Nonparticipant aware of program	To inform display logic for selected Qs
PURSUED_GRAD	Respondent pursued grad school	To inform display logic for selected Qs
HAD_KNOWLEDGE	Respondent reported knowledge of one or more program evaluation knowledge metrics	To inform display logic for selected Qs
STARTUP	Respondent reported a startup	To inform display logic for selected Qs
GOT_JOB	Respondent reported having held a job in clean energy	To inform display logic for selected Qs
STARTUP_JOB	Respondent reported having a startup, a CE job, or both	To inform display logic for selected Qs
ASK_KNOWLEDGE	Respondent meets criteria to be asked the knowledge questions	To inform display logic for selected Qs
HAD_KNOWLEDGE	Respondent reported knowledge of one or more program evaluation knowledge metrics	To inform display logic for selected Qs
PUBLICATIONS	Respondent reported having publications/presentations	To inform display logic for selected Qs

Programming note style conventions in this document:

[PROGRAMMING] Programming instructions are in bracketed CAPS.

For each multiple response question, create separate binary variables for each response option.

Email Invitations

Email Invitation for Decathletes

Subject Line: Solar Decathletes: Your opinions matter!

Hi [FIRST NAME],

The U.S. Department of Energy (DOE) wants to hear about what former Solar Decathletes are doing. **As a former Solar Decathlete, you can provide DOE with valuable feedback to improve future competitions and provide insight into the participation experience.** DOE is sponsoring this survey to learn about what knowledge and career positions former Decathletes hold. **We'll send you a $25 e-gift card as a thank you for completing the survey, which will only take about 20 minutes.**

<<LINK: Take the survey>>

Your participation is voluntary, and your responses will remain confidential. If you have questions about this survey, or have any technical problems, please contact Taylor Williams. Opinion Dynamics is conducting this survey on behalf of the U.S. Department of Energy.

Thank you in advance. We look forward to your response.

Sincerely,

Follow-Up Email for Decathletes

Subject line: We still want to hear from you, Solar Decathlete

Hi [FIRST NAME],

Recently, we asked you to complete a survey on what you've been doing since participating in the Solar Decathlon, as part of the U.S. Department of Energy's efforts to improve future competitions and understand participants' experiences. We've not yet reached our goal for survey responses. **Can you be one of the people to get us to that goal?**

20 minutes of your time can really help DOE understand the Solar Decathlon's impacts and how to best improve the program. **Plus, we'll send you a $25 e-gift card as a thank you for completing the survey.**

<<LINK: Take the survey>>

Your participation is voluntary, and your responses will remain confidential. If you have questions about this survey, or have any technical problems, please contact [OPINION DYNAMICS STAFF PERSON]. Opinion Dynamics is conducting this survey on behalf of the U.S. Department of Energy.

Thank you in advance. We look forward to your response.

Sincerely,

Email Invitation for Race to Zero Participants

Subject Line: Race to Zero Competitors: Your opinions matter!

Hi [FIRST NAME],

The US Department of Energy (DOE) wants to hear about what former Race to Zero competitors are doing. **As a former Race to Zero competitor, you can provide DOE with valuable feedback to improve future competitions and provide insight into the participation experience.** The DOE is sponsoring this survey to learn about what knowledge and career positions former Race to Zero competitors hold. **We'll send you a $25 e-gift card as a thank you for completing the survey, which will only take about 20 minutes.**

<<LINK: Take the survey>>

Your participation is voluntary, and your responses will remain confidential. If you have questions about this survey, or have any technical problems, please contact Taylor Williams. Opinion Dynamics is conducting this survey on behalf of the U.S. Department of Energy.

Thank you in advance. We look forward to your response.

Sincerely,

Follow-Up Email for Race to Zero Participants

Subject line: We still want to hear from you, Race to Zero competitor

Hi [FIRST NAME],

Recently, we asked you to complete a survey on what you've been doing since participating in the Race to Zero competition, as part of the U.S. Department of Energy's efforts to improve future competitions and understand participants' experiences. We've not yet reached our goal for survey responses. **Can you be one of the people to get us to that goal?**

20 minutes of your time can really help DOE understand Race to Zero's impacts and how to best improve the program. **Plus, we'll send you a $25 e-gift card as a thank you for completing the survey.**

<<LINK: Take the survey>>

Your participation is voluntary, and your responses will remain confidential. If you have questions about this survey, or have any technical problems, please contact Taylor Williams. Opinion Dynamics is conducting this survey on behalf of the U.S. Department of Energy.

Thank you in advance. We look forward to your response.

Sincerely,

Email Invitation for Nonparticipants

Subject line: U.S. Department of Energy wants to hear from you

Hi [FIRST NAME],

The U.S. Department of Energy (DOE) is assessing its programs offered to college students with a goal of learning their impacts and improving them. **You have been selected to take a survey based on the college you attended and the major you chose. We'll send you a $50 e-gift card as a thank you for completing the survey, which will only take about 15 minutes.** Your responses are instrumental in helping DOE improve the programs it sponsors on college campuses.

<<LINK: Take the survey>>

Your participation is voluntary, and your responses will remain confidential. If you have questions about this survey, or have any technical problems, please contact Taylor Williams by replying to this email. Opinion Dynamics is conducting this survey on behalf of the U.S. Department of Energy.

Thank you in advance. We look forward to your response.

Sincerely,

Follow-Up Email for Nonparticipants

Subject line: U.S. Department of Energy still wants to hear from you

Hi [FIRST NAME],

Recently, we asked you to complete a survey on what you've been doing since college, as part of DOE's assessment of its programs for college students. We've not yet reached our goal for survey responses. **Can you be one of the people to get us to that goal?**

10 minutes of your time can really help DOE improve its programming to benefit college students like you once were. **Plus, we'll send you a $50 e-gift card as a thank you for completing the survey.**

<<LINK: Take the survey>>

Your participation is voluntary, and your responses will remain confidential. If you have questions about this survey, or have any technical problems, please contact [OPINION DYNAMICS STAFF PERSON]. Opinion Dynamics is conducting this survey on behalf of the U.S. Department of Energy.

Thank you in advance. We look forward to your response.

Sincerely,

Instrument

Introduction

Thank you for taking our survey!

The U.S. Department of Energy is assessing its clean energy competition programs for college students. Lawrence Berkeley National Laboratory, with Dr. Christopher Payne as the Principal Investigator, has been

selected to provide management oversight for this evaluation study. To ensure a fair and objective study, a third-party entity, Opinion Dynamics, led by Dr. Ellen Steiner, is conducting the evaluation. Your responses to this survey will be used to assess the impacts of the programs and to improve them.

Your participation in this survey is completely voluntary, and your responses will remain confidential. The email used to send this message will be disassociated from your responses as soon as you use the link to fill out the survey. Whatever email address you provide in order to receive the incentive will be held strictly confidential, and used to send your e-gift card, if you choose to receive it, but will not be linked back to your responses. Every effort will be made to ensure that your email is protected and kept confidential. This will include keeping all responses in password-protected files/laptops and locked file cabinets. Data published will only be in aggregate where individual responses cannot be identified.

You may stop or withdraw from the study at any time without it being held against you. Your decision to participate or not to participate will have no effect on your current or future connection with anyone from your former college, or on any future endeavor.

For issues related to your rights as a research participant in this study, please contact Lawrence Berkeley National Laboratory's Human & Animal Research Committee (HARC) at 510-486-5399 or send email to harc@lbl.gov. You may also contact Dr. Christopher Payne at 510-495-2577 or send him an email at CTPayne@lbl.gov.

For any questions not specifically related to your rights as a human subject, please contact Dr. Ellen Steiner at esteiner@opiniondynamics.com.

Please click on CONTINUE to consent and begin the survey.

Program Block[12]

[USE OF PROGRAM BLOCK QUESTIONS
(1) TO CREATE SYSTEM VARIABLES THAT WILL DRIVE PROGRAM LOGIC, INCLUDING SCREENING OUT SOME RESPONDENTS.
(2) IN ANALYSIS: TO COMPARE PARTICIPANTS AND NONPARTICIPANTS.
(3) IN ANALYSIS: TO COMPARE SUBGROUPS OF PARTICIPANTS BY PARTICIPATION YEAR AND BY LEVEL OF INVOLVEMENT.
(4) IN ANALYSIS, TO COMPARE SUBGROUPS OF NONPARTICIPANTS BY AWARE AND UNAWARE.]

[ASK ALL]

[12] Research questions associated with this section: **1c:** Among Decathletes, are there any significant differences between cohorts up to 2015 and post-2017 (when significant changes were introduced to the SD program)? **2f:** To what extent does the impact of the Program differ across the program alumni? **2g:** How much variation is there in the experiences of participants from different academic domains and with different commitment levels to the Program during their participation? Note: To be addressed to the extent sample sizes permit. Reporting will only identify significant and meaningful differences and will not show all comparisons.

Q1. Have you heard of the U.S. Department of Energy's Solar Decathlon (SD) or Race to Zero (RTZ) competitions for university or college students? *In these competitions, student teams design or design and build highly efficient and innovative buildings powered by renewable energy.*

[SINGLE RESPONSE; FORCE RESPONSE]

1. Yes
2. No
3. Not sure

[IF Q1 = 1 (YES) CODE PGM_AWARE = 1]
[IF Q1 = 2 OR 3 (NOT AWARE, NOT SURE) CODE NONPARTICIPANT = 1]

…Program Involvement

[ASK IF PGM_AWARE = 1]

Q2. Have you participated in any of the SD or RTZ competitions? If you participated in both competitions, please select the one you had greater involvement in and/or know the most about.

[SINGLE RESPONSE; FORCE RESPONSE]

1. Yes, I have participated in the SD competition
2. Yes, I have participated in the RTZ competition
3. No, I have not participated in either

[IF Q2 = 3 THEN NONPARTICIPANT = 1]

[CODE PROGRAM = SD IF Q2 = 1, PROGRAM = RTZ IF Q2 = 2]

[ASK IF Q1 = 2 OR 3, OR IF Q2 = 3]

Q2A. What university(ies) or college(s) did you attend between the years 2010 and 2018? *Please spell out the full name of the university(ies) or college(s) and list all that you attended as an undergraduate and/or graduate student, regardless of whether you received a degree, certificate, etc.*

1. [OPEN-END]

[ASK IF Q2 = 1 OR 2]

[SINGLE RESPONSE; FORCE RESPONSE]

Please select the option that best describes your participation, if any, in each competition.

	1. Participated as an undergraduate student	2. Participated as a graduate student	3. Participated as a non-student advisor/ mentor/ etc.	4. Did not participate
Q3. [IF PROGRAM = SD] 2011 competition in Washington, D.C.	□	□	□	□

Q4. [IF PROGRAM = SD] 2013 competition in Irvine, California	□	□	□	□
Q5. [IF PROGRAM = SD] 2015 competition in Irvine, California	□	□	□	□
Q6. [IF PROGRAM = SD] 2017 competition in Denver, Colorado	□	□	□	□
Q7. [IF PROGRAM = SD] 2020 competition in Washington, D.C.	□	□	□	□
Q8. [IF PROGRAM = RTZ] 2014 RTZ competition	□	□	□	□
Q9. [IF PROGRAM = RTZ] 2015 RTZ competition	□	□	□	□
Q10. [IF PROGRAM = RTZ] 2016 RTZ competition	□	□	□	□
Q11. [IF PROGRAM = RTZ] 2017 RTZ competition	□	□	□	□
Q12. [IF PROGRAM = RTZ] 2018 RTZ competition	□	□	□	□

[CODE PARTICIPANT = 1 AND NONPARTICIPANT = 0 IF
Q3 = 1 OR 2 (2011 STUDENT SD PARTICIPANT)
OR Q4 = 1 OR 2 (2013 STUDENT SD PARTICIPANT)
OR Q5 = 1 OR 2 (2015 STUDENT SD PARTICIPANT)
OR Q6 = 1 OR 2 (2017 STUDENT SD PARTICIPANT)
OR Q8 = 1 OR 2 (2014 STUDENT RTZ PARTICIPANT)
OR Q9 = 1 OR 2 (2015 STUDENT RTZ PARTICIPANT)
OR Q10 = 1 OR 2 (2016 STUDENT RTZ PARTICIPANT)
OR Q11 = 1 OR 2 (2017 STUDENT RTZ PARTICIPANT)
OR Q12 = 1 OR 2 (2018 STUDENT RTZ PARTICIPANT)]
[CODE AS NONPARTICIPANT IF
Q3 = 4

AND Q4 = 4
AND Q5 = 4
AND Q6 = 4
AND Q7 = 4
AND Q8 = 4
AND Q9 = 4
AND Q10 = 4
AND Q11 = 4
AND Q12 = 4 (PARTICIPATED IN NONE OF THE COMPETITIONS]
[CODE AS P_2020_ONLY IF PARTICIPANT = 0 AND NONPARTICIPANT = 0 AND Q7 = 1 OR 2 (2020 STUDENT PARTICIPANT)]
[IF PARTICIPANT = 0 (NOT CODED AS PARTICIPANT) AND NONPARTICIPANT = 0 (NOT CODED AS NONPARTICIPANT) AND P_2020_ONLY = 0, **THANK AND TERMINATE**. WOULD INCLUDE ONLY RESPONDENTS THAT WERE ADVISORS FOR EVERY COMPETITION IN WHICH THEY PARTICIPATED]

… … Thank and Terminate for Disqualified

[SHOW ALL THAT SATISFY THANK AND TERMINATE CRITERIA]

Q13. Thank you for your time. We are interested in the experiences of people that participated as students in [PROGRAM] between 2011 and 2017. Please accept a $5 gift card for clicking into the survey. To receive the $5 e-gift card, provide your email address in the space below. Be assured that your email address will be held in confidence and used only to send you a gift card. Please allow 2 to 6 weeks to process and deliver your gift card. It will come from Tango, our gift card company that allows you to select from dozens of retailers and restaurants like Amazon, Target, Starbucks, Home Depot, and many others. If you don't want to receive the gift card, please leave the space blank.

[SINGLE RESPONSE; NO RESPONSE REQUIRED; VALIDATE FOR VALID EMAIL]

[OPEN_END EMAIL]

CLOSING: That's it! Thank you for helping the U.S. Department of Energy in its program planning.

Please click on SUBMIT to record your answers and start the processing of your gift card.

[SHOW A SUBMIT BUTTON TO RECORD ANSWERS AND END THE SURVEY]

… End of Thank and Terminate subroutine

[ASK IF PARTICIPANT = 1 OR IF P_2020_ONLY = 1]
What was your role on your [PROGRAM] team(s)?
[SINGLE RESPONSE; FORCE RESPONSE]

	1. I acted as a team leader (either formally or informally)	2. I was not a team leader, but I substantially contributed	3. I participated in a supporting role	4. None of these

		to the project		
Q14. [SHOW IF Q3 = 1 OR 2] 2011 competition in Washington, D.C.	☐	☐	☐	☐
Q15. [SHOW IF Q4 = 1 OR 2] 2013 competition in Irvine, California	☐	☐	☐	☐
Q16. [SHOW IF Q5 = 1 OR 2] 2015 competition in Irvine, California	☐	☐	☐	☐
Q17. [SHOW IF Q6 = 1 OR 2] 2017 competition in Denver, Colorado	☐	☐	☐	☐
Q18. [SHOW IF Q7 = 1 OR 2] 2020 competition in Washington DC	☐	☐	☐	☐
Q19. [SHOW IF Q8 = 1 OR 2] 2014 RTZ competition	☐	☐	☐	☐
Q20. [SHOW IF Q9 = 1 OR 2] 2015 RTZ competition	☐	☐	☐	☐
Q21. [SHOW IF Q10 = 1 OR 2] 2016 RTZ competition	☐	☐	☐	☐
Q22. [SHOW IF Q11 = 1 OR 2] 2017 RTZ competition	☐	☐	☐	☐
Q23. [SHOW IF Q12 = 1 OR 2] 2018 RTZ competition	☐	☐	☐	☐

[ASK IF PARTICIPANT = 1 OR IF P_2020_ONLY = 1]
Q23A. What university(ies) or college(s) were you attending when you competed in the [PROGRAM] competition(s)? *If you competed in more than one competition at different universities, please specify which university you attended for each competition and spell out the full name of the university(ies) or college(s).*

1. [OPEN-END]

Academic Majors[13]

[USE OF ACADEMIC MAJORS Qs:
(1) TO INFORM SKIP LOGIC FOR SUBSEQUENT TAILORED Qs.
(2) FOR ANALYSIS: COMPARABILITY OF PARTICIPANTS AND NONPARTICIPANTS IN DEGREE OBTAINED.
(3) FOR ANALYSIS: DO PROGRAM IMPACTS VARY ACCORDING TO PARTICIPATION AS AN UNDERGRADUATE VS PARTICIPATION AS A GRADUATE?
(4) TEST HYPOTHESIS: PARTICIPANTS ATTRIBUTE PROGRAM INFLUENCE FOR GRAD SCHOOL.]

[ASK ALL]

Q24. What year did you begin your undergraduate studies? *Please enter year as YYYY.*

[SINGLE RESPONSE; FORCE RESPONSE]
[OPEN-ENDED NUMERIC TEXT BOX YYYY]
[ASK ALL]

Q25. Please select the subject(s) you majored in as an undergraduate student. *Please respond even if you were not awarded a degree and select all that apply.* [MULTIPLE RESPONSES; FORCE RESPONSE]

1. Building & Energy (building science, building energy, energy systems, energy performance, etc.)
2. Construction (building construction, construction management, facilities management, etc.)
3. Design (architectural, environmental, interior design, landscape design, urban design, sustainable design, etc.)
4. Engineering (architectural, biosystems, chemical, civil, electrical, energy, engineering physics, environmental, industrial, mechanical, etc.)
5. Management (business administration, management of business, energy, engineering, sustainable systems, or technical systems, etc.)
6. Sustainability (sustainable built environment, technology, systems, development, etc.)
7. Some other subject(s)

[ASK ALL]

Q26. What undergraduate degree(s) have you received, if any? *Please select all that apply.*

[MULTIPLE RESPONSE; FORCE RESPONSE]

1. Associates degree
2. BA – Bachelor of Art
3. BS – Bachelor of Science
4. Other, please describe [OPEN-ENDED TEXT BOX]
5. None, did not complete a degree [MAKE EXCLUSIVE ANSWER]

[13] Research questions associated with this section: **1b:** How much variation is there in the knowledge gains reported by Decathletes from different academic domains? **2g:** How much variation is there in the experiences of Decathletes from different academic domains and with different commitment levels to the Program during their participation?

[ASK IF Q26= 1, 2, 3, OR 4]

Q26A. What was your undergraduate degree(s) in? *Please specify the actual major(s) of your degree(s).*

1. [OPEN-END]

[ASK ALL]

Q27. Did you attend graduate school (whether or not you attained a graduate or professional degree)?

[SINGLE RESPONSE; FORCE RESPONSE]

1. Yes
2. No

[CODE VARIABLE PURSUED_GRAD = 1 IF Q27=1]

[ASK IF PURSUED_GRAD = 1]

Q28. What year did you begin your graduate studies? *Please enter year as YYYY.*

[SINGLE RESPONSE; FORCE RESPONSE]

1. [OPEN-ENDED TEXT BOX]

[ASK IF PURSUED_GRAD = 1]

Q29. Please select the subject(s) you majored in as a graduate student. *Please respond even if you were not awarded a graduate or professional degree and select all that apply.*

[MULTIPLE RESPONSES; FORCE RESPONSE]

1. Building & Energy (building science, building energy, energy systems, energy performance, etc.)
2. Construction (building construction, construction management, facilities management, etc.)
3. Design (architectural, environmental, interior design, landscape design, urban design, sustainable design, etc.)
4. Engineering (architectural, biosystems, chemical, civil, electrical, energy, engineering physics, environmental, industrial, mechanical, etc.)
5. Management (business administration, management of business, energy, engineering, sustainable systems, or technical systems, etc.)
6. Sustainability (sustainable built environment, technology, systems, development, etc.)
7. Some other subject(s)

[ASK IF PURSUED_GRAD = 1]

Q30. What graduate degree(s) have you received, if any? *Please select all that apply.*

[MULTIPLE RESPONSE; FORCE RESPONSE]

1. MA – Master of Art
2. MS – Master of Science

3. PhD – Doctor of Philosophy
4. JD – Doctor of Jurisprudence
5. Other, please describe: [OPEN-ENDED TEXT BOX]
6. None, did not complete a graduate degree [MAKE EXCLUSIVE ANSWER]

[ASK IF Q30= 1, 2, 3, OR 5]

Q30A. What was your graduate degree(s) in? *Please specify the actual major(s) of your degree(s).*

1. [OPEN-END]

… Attribution grad school

[ASK IF PURSUED_GRAD = 1 AND IF (Q3 = 1 OR Q4 = 1 OR Q5 = 1 OR Q6 = 1 OR Q8 = 1 OR Q9 = 1 OR Q10 = 1 OR Q11 = 1 OR Q12 = 1 (PURSED GRAD SCHOOL AND PARTICIPATED IN PROGRAM AS AN UNDERGRADUATE)]

Q31. Please rate the influence you think your [PROGRAM] experience had on your acceptance into graduate school?

[SINGLE RESPONSE; REQUEST RESPONSE]

1. No influence
2. Low influence
3. Moderate influence
4. High influence
5. Not sure (please explain): [OPEN-ENDED TEXT BOX]

[IF P_2020_ONLY = 1, SKIP TO KNOWLEDGE OUTCOMES]

Startups[14]

[USE OF STARTUPS AND SALES OUTCOMES QUESTIONS:
(1) TO CREATE SKIP PATTERNS FOR THIS SECTION
(2) IN ANALYSIS: TO CHARACTERIZE THE CE STARTUPS OF PARTICIPANTS AND NPs.[15]
(3) TEST HYPOTHESIS: PARTICIPANTS MORE FREQUENTLY STARTED BUSINESSES THAN DID NPs.
(4) TEST HYPOTHESES: PARTICIPANTS ATTRIBUTE PROGRAM INFLUENCE IN STARTUP]

[DISPLAY TO ALL]

For the rest of the survey, please note the following terms and definitions.

Clean energy encompasses energy efficiency and renewable energy.

[14] Research questions addressed in this section: **3d:** Are Decathletes more likely than non-Decathletes to create their own clean energy startups? **3e:** For Decathletes who do create their own startups, how much do they credit their participation in the SD Program?

[15] Note: Startup characteristics simply inform an understanding of participant and NP careers. There is no assumption that a clean energy startup of one type is preferable over another.

Sustainability describes a reduced environmental impact of economic activity through: reduced resource use (water, raw materials, energy), reduced waste stream, and/or reduced harmful effects or byproducts from the activity lifecycle (extraction, production, and disposal).

Clean energy and sustainability *jobs* encompass:

- Focus on increasing clean energy / sustainability in your employer's facilities or supply chain
- Designing, manufacturing, selling, installing, or maintaining clean energy / sustainable products, equipment, buildings, processes, or services
- Advising or consulting on clean energy /sustainability
- Developing, implementing, or supporting clean energy / sustainability policies and programs working in governmental or non-governmental offices, energy utilities, consulting firms, or academia
- Providing clean energy / sustainability philanthropy, financing, investment funding, startup accelerators or startup incubators

… Startups

[ASK ALL]

Q32. Have you ever started or co-founded a *new* clean energy or sustainability business?

[SINGLE RESPONSE; FORCE RESPONSE]

1. Yes
2. No, but I was seriously considering it before the COVID-19 pandemic occurred
3. No, and I was not seriously considering it before the COVID-19 pandemic occurred

[CODE STARTUP = 1 IF Q32 = 1]
[ASK IF STARTUP = 1; IF STARTUP = 0, GO TO NEXT SECTION (JOB TRAJECTORY]

Q33. Which of the following **best** describes the clean energy or sustainability activities of this startup business?

[SINGLE RESPONSE; FORCE RESPONSE; OPEN-ENDED RESPONSE UNFORCED]

1. Designing, manufacturing, selling, installing, or maintaining clean energy/sustainable products, equipment, buildings, processes, or services
2. Advising or consulting on clean energy/sustainability
3. Developing, implementing, or supporting clean energy/sustainability policies and programs while working in governmental or non-governmental offices, energy utilities, or academia
4. Something else related to clean energy/sustainability work (please describe): [OPEN ENDED]

[ASK IF STARTUP = 1]

Q34. Is (or was) the startup incorporated?

[SINGLE RESPONSE; FORCE RESPONSE]

1. Yes
2. No
98. Not sure

[ASK IF PARTICIPANT = 1 AND Q34 = 1 (INCORPORATED)]

Q35. When was the startup incorporated?

[SINGLE RESPONSE; FORCE RESPONSE]

1. Before I learned about the [PROGRAM] competition
2. During or leading up to my involvement in the [PROGRAM] competition
3. After the [PROGRAM] competition
98. Not sure

… … Startup Longevity

[ASK IF STARTUP = 1]

Please indicate the year your involvement with the startup began and ended. If you are still involved with the business, please select "Ongoing" for "Year Ended."
[SINGLE RESPONSE; FORCE RESPONSE]

Q36. Year Started	Q37. Year Ended
	1. Ongoing
1. 2021	2. 2021
2. 2020	3. 2020
3. 2019	4. 2019
4. 2018	5. 2018
5. 2017	6. 2017
6. 2016	7. 2016
7. 2015	8. 2015
8. 2014	9. 2014
9. 2013	10. 2013
10. 2012	11. 2012
11. 2011	12. 2011
12. 2010	13. 2010
13. prior to 2010	14. prior to 2010

[ASK IF Q37 <> 1 (INVOLVEMENT HAS ENDED))

Q38. Please indicate whether the startup is ongoing or – if not – indicate its last operating year.

[SINGLE RESPONSE; FORCED RESPONSE]

Startup Ongoing or End Date
1. Ongoing (includes startups sold to other ongoing firms)
2. 2021
3. 2020
4. 2019
5. 2018
6. 2017

7. 2016
8. 2015
9. 2014
10. prior to 2014

[ASK IF Q38 = 2021 OR 2020; FORCED RESPONSE]
Q38A. Did the COVID-19 pandemic contribute to the startup company ending?
[SINGLE RESPONSE]

1. Yes
2. No
0. Other, please specify: [OPEN-ENDED RESPONSE]

… Attribution startup

[ASK IF PARTICIPANT = 1 AND STARTUP = 1]

Q39. Please rate the influence your [PROGRAM] experience had on your ability to start/co-found the startup business?

[SINGLE RESPONSE; FORCE RESPONSE; OPEN-ENDED RESPONSE UNFORCED]

1. No influence
2. Low influence
3. Moderate influence
4. High influence
5. Not sure (please explain) [OPEN-ENDED TEXT BOX]

Job Trajectory[16]

[USE OF JOB TRAJECTORY QUESTIONS:
(1) TO CREATE SKIP PATTERNS FOR THIS SECTION
(2) IN ANALYSIS: TO CHARACTERIZE THE CE JOBS OF PARTICIPANTS AND NPs.[17]
(3) TEST HYPOTHESIS: PARTICIPANTS MORE FREQUENTLY SOUGHT CLEAN ENERGY (CE) JOBS THAN DID NPs.
(4) TEST HYPOTHESIS: PARTICIPANTS MORE FREQUENTLY LANDED ONE OR MORE JOBS IN CE THAN DID NPs.
(5) TEST HYPOTHESIS: PARTICIPANTS MORE FREQUENTLY ARE CURRENTLY IN A CE JOB THAN NPs.[18]
(6) TEST HYPOTHESIS: PARTICIPANTS HAVE MORE YEARS IN CE JOB THAN NPs.
(7) TEST HYPOTHESIS: PARTICIPANTS ATTRIBUTE PROGRAM INFLUENCE IN CAREER TRAJECTORY]

[16] Research questions associated with this section: **SD 2a:** Are Decathletes better prepared than non-Decathletes to enter and advance in the workplace? **SD 2b:** Do Decathletes report that their experiences, knowledge and skills gained from SD contribute to job readiness? **SD 2c:** Upon graduation, are Decathletes more likely than non-Decathletes to pursue career opportunities in sustainability and clean energy fields (broadly construed to span architecture, building materials, engineering, communications and other domains represented in the SD teams [described in O*Net as the Green Sector]) **SD 2d:** Are Decathletes more likely than non-Decathletes to stay in the sustainability and clean energy fields? **SD 3b:** In what settings in the U.S. do former Decathletes have influence, including education, research, policy, and industry? (Bi-variate analysis with variables from Industry Influence section.)
[17] Note: Job characteristics simply inform an understanding of participant and NP careers. There is no assumption that a clean energy job for one type of employer or in one type of field is preferable over another.
[18] Note: Total number of CE jobs is not a relevant metric. It "rewards" people who change jobs frequently, a characteristic independent of the research questions.

[SHOW IF STARTUP = 1]
The following questions ask about your employers associated with clean energy or sustainability jobs. Please do not include your job with the new business that you started/co-founded.
[SHOW IF STARTUP = 0]

The following questions ask about your employers associated with clean energy or sustainability jobs.

[SHOW ALL]
A *clean energy job* relates to energy efficiency or renewable energy and a *sustainability job* relates to reducing the environmental impact of economic activity. The job could be *partially* or *fully* focused on clean energy or sustainability.
[PROGRAMMER – ADD A POP-OUT BOX THAT RESPONDENT CAN ACCESS BY CLICKING TO SEE EXAMPLES OF CLEAN ENERGY/SUSTAINABILITY JOB (EXAMPLES FOUND AT OUTSET OF STARTUPS SECTION).]
[ASK ALL]

Q40. Have you ever held a clean energy or sustainability-related job? Full-time employee, part-time employee, intern, contractor, or independent consultant all qualify for a "yes" response.

[SINGLE RESPONSE; FORCE RESPONSE]

1. Yes
2. No
3. Not sure

[CODE GOT_JOB IF ☐ = 1]
[ASK IF GOT_JOB = 0]

Q41. Have you ever actively sought a clean energy or sustainability-related job?

[SINGLE RESPONSE; FORCE RESPONSE]

1. Yes
2. No
3. Not sure

[ASK IF GOT_JOB = 0. SINGLE RESPONSE]
Q41A. Please briefly explain how the COVID-19 pandemic impacted your job search or employment outcomes, if it all.

1. COVID impacts on job search or employment outcomes: [OPEN-ENDED TEXT BOX]
2. COVID did not impact my job search or employment outcomes to the best of my knowledge

[IF GOT_JOB = 0, SKIP TO INDUSTRY INFLUENCE/CONNECTIONS]
[ASK IF GOT_JOB = 1]

Q42. Congratulations on your employment relating to clean energy or sustainability. How many clean energy or sustainability jobs with distinct employers have you held?

[SINGLE RESPONSE; FORCE RESPONSE]

1. One employer
2. Two employers
3. Three or more employers

… First Job

[DISPLAY IF Q42 = 1 (ONE EMPLOYER)]

Please tell us about your job with that employer.

[DISPLAY IF Q42 = 2 OR 3 (TWO OR MORE EMPLOYERS)]
Please tell us about your *first* clean energy/sustainability job.
[ASK IF GOT_JOB = 1]

Q43. Which of the following **best** describes the clean energy or sustainability activities you conducted for this employer?

[SINGLE RESPONSE; FORCE RESPONSE; OPEN-ENDED RESPONSE UNFORCED]

1. Focus on increasing clean energy/sustainability in your employer's facilities or supply chain
2. Designing, manufacturing, selling, installing, or maintaining clean energy/sustainable products, equipment, buildings, processes, or services
3. Advising or consulting on clean energy/sustainability
4. Developing, implementing, or supporting clean energy/sustainability policies and programs working in governmental or non-governmental offices, energy utilities, consulting firms, or academia
5. Providing clean energy/sustainability philanthropy, financing, investment funding, or support to startup accelerators or startup incubators
6. Something else related to clean energy/sustainability work (please describe): [OPEN ENDED]

[ASK IF GOT_JOB = 1]

Q44. What was your job title or role with this employer?

[SINGLE RESPONSE; UNFORCED RESPONSE]

1. [OPEN-ENDED]

[ASK IF GOT_JOB = 1]
When did your involvement with this employer start and end? Please select "ongoing" if you are still working for this employer.
[SINGLE RESPONSE; FORCE RESPONSE]

Q45. Year Started	Q46. Year Ended
	1. Ongoing
1. 2021	2. 2021
2. 2020	3. 2020
3. 2019	4. 2019
4. 2018	5. 2018
5. 2017	6. 2017
6. 2016	7. 2016
7. 2015	8. 2015
8. 2014	9. 2014
9. 2013	10. 2013
10. 2012	11. 2012
11. 2011	12. 2011
12. 2010	13. 2010

13. prior to 2010	14. prior to 2010

… Second Job

[ASK IF Q42 = 2 OR 3 (TWO OR MORE EMPLOYERS)]

Q47. Which of the following **best** describes the clean energy or sustainability activities you conducted for the *second* employer?

[SINGLE RESPONSE; FORCE RESPONSE; OPEN-ENDED RESPONSE UNFORCED]

1. Focus on increasing clean energy/sustainability in your employer's facilities or supply chain
2. Designing, manufacturing, selling, installing, or maintaining clean energy/sustainable products, equipment, buildings, processes, or services
3. Advising or consulting on clean energy/sustainability
4. Developing, implementing, or supporting clean energy/sustainability policies and programs working in governmental or non-governmental offices, energy utilities, consulting firms, or academia
5. Providing clean energy/sustainability philanthropy, financing, investment funding, or support to startup accelerators or startup incubators
6. Something else related to clean energy/sustainability work (please describe): [OPEN ENDED]

[ASK IF Q42 = 2 OR 3 (TWO OR MORE EMPLOYERS)]

Q48. What was your job title or role with this second employer?

[SINGLE RESPONSE; UNFORCED RESPONSE]

1. [OPEN-ENDED]

[ASK IF Q42 = 2 OR 3 (TWO OR MORE EMPLOYERS)]
When did your involvement with this second employer start and end? Please select "ongoing" if you are still working for this employer.
[SINGLE RESPONSE; FORCE RESPONSE]

Q49. Year Started	Q50. Year Ended
	1. Ongoing
1. 2021	2. 2021
2. 2020	3. 2020
3. 2019	4. 2019
4. 2018	5. 2018
5. 2017	6. 2017
6. 2016	7. 2016
7. 2015	8. 2015
8. 2014	9. 2014
9. 2013	10. 2013
10. 2012	11. 2012
11. 2011	12. 2011
12. 2010	13. 2010

13. prior to 2010	14. prior to 2010

… Third Job

[ASK IF Q42 = 3 (MORE THAN TWO EMPLOYERS)

Q51. Which of the following **best** describes the clean energy/sustainability activities you conducted for the *third or current* employer?

[SINGLE RESPONSE; FORCE RESPONSE; OPEN-ENDED RESPONSE UNFORCED]

1. Focus on increasing clean energy /sustainability in your employer's facilities or supply chain
2. Designing, manufacturing, selling, installing, or maintaining clean energy/sustainable products, equipment, buildings, processes, or services
3. Advising or consulting on clean energy/sustainability
4. Developing, implementing, or supporting clean energy/sustainability policies and programs working in governmental or non-governmental offices, energy utilities, consulting firms, or academia
5. Providing clean energy/sustainability philanthropy, financing, investment funding, or support to startup accelerators or startup incubators
6. Something else related to clean energy/sustainability work (please describe): [OPEN ENDED]

[ASK IF Q42 = 3 (MORE THAN TWO EMPLOYERS)

Q52. What was your job title or role with this employer?

[SINGLE RESPONSE; UNFORCED RESPONSE]

1. [OPEN-ENDED]

[ASK IF Q42 = 3 (MORE THAN TWO EMPLOYERS)
When did your involvement with this employer start and end? Please select "ongoing" if you are still working for this employer.
[SINGLE RESPONSE; FORCE RESPONSE]

Q53. Year Started	Q54. Year Ended
	1. Ongoing
1. 2021	2. 2021
2. 2020	3. 2020
3. 2019	4. 2019
4. 2018	5. 2018
5. 2017	6. 2017
6. 2016	7. 2016
7. 2015	8. 2015
8. 2014	9. 2014
9. 2013	10. 2013
10. 2012	11. 2012
11. 2011	12. 2011
12. 2010	13. 2010

13. prior to 2010	14. prior to 2010

… Job Attribution

[ASK IF GOT_JOB=1 AND IF PARTICIPANT]

Q55. Did your experience in [PROGRAM] help you to obtain clean energy/sustainability employment?

[SINGLE RESPONSE; FORCE RESPONSE]

1. Yes
2. No
98. Not sure

[SHOW IF Q55 = 1 AND Q42 = 2 OR 3]
For the next question, please think of the clean energy/sustainability job for which your [PROGRAM] experience was *most* influential.

[ASK IF Q55 = 1]

Q56. Please rate the influence you think your [PROGRAM] experience had in obtaining clean energy/sustainability employment.

[SINGLE RESPONSE; FORCE RESPONSE; OPEN-ENDED RESPONSE UNFORCED]

1. Low influence
2. Moderate influence
3. High influence
4. Not sure (please explain): [OPEN-ENDED TEXT BOX]

Industry Influence/ Connections[19]

[USE OF INDUSTRY INFLUENCE QUESTIONS:
(1) TO CREATE SKIP PATTERNS FOR THIS SECTION
(2) TEST HYPOTHESIS: PARTICIPANTS MORE FREQUENTLY HAVE PUBLICATIONS/PRESENTATIONS THAN NPs.
(3) TEST HYPOTHESIS: PARTICIPANTS ATTRIBUTE PROGRAM INFLUENCE IN INDUSTRY INFLUENCE/ CONNECTIONS]

[ASK ALL]
Please identify the number of publications, presentations, or blogs you have done on clean energy (energy efficiency, renewable energy) or sustainability during or after college.
[SINGLE RESPONSE; FORCE RESPONSE]

Topic	1. One	2. Two	3. Three	4. Four	5. Five or more	6. None
Q57. Blog on clean energy/sustainability						

[19] Research questions addressed in this section: **3b:** In what settings in the U.S. do former Decathletes have influence, including education, research, policy, and industry? (Bi-variate analysis with variables from Job Trajectory section.) **3c:** What kind of influence do they have?

Q58. Conference presentation on clean energy/sustainability						
Q59. Conference paper on clean energy/sustainability						
Q60. Published journal article on clean energy/sustainability						

[CODE PUBLICATIONS = 1 IF Q57 = 1 OR 2 OR 3 OR 4 OR 5, OR Q58 = 1 OR 2 OR 3 OR 4 OR 5, OR Q59 = 1 OR 2 OR 3 OR 4 OR 5, OR Q60 = 1 OR 2 OR 3 OR 4 OR 5 (HAVE ONE OR MORE OF BLOG OR PRESENTATION OR CONF PAPER OR ARTICLE]

[ASK ALL]

Q61. Are you involved in any organizations focused on energy efficiency, renewable energy, or sustainability, not including an employer?

[SINGLE RESPONSE; FORCE RESPONSE]

1. Yes
2. No
3. Not sure

Q62. [ASK IF Q61 = 1] Do you have a leadership role in the organization(s), such as being an officer of the organization, chairing a committee or subcommittee, or leading an ad hoc activity?

[SINGLE RESPONSE; FORCE RESPONSE]

1. Yes
2. No
3. Not sure

...Industry Attribution

[ASK IF PARTICIPANT]

Please rate the degree to which your [PROGRAM] experience contributed to the following:
[RANDOMIZE; SINGLE RESPONSE; FORCE RESPONSE]

	1. Strongly contributed	2. Somewhat contributed	3. Slightly contributed	4. Did not contribute	5. Not sure
Q63. [ASK IF PUBLICATIONS = 1] My interest in or	□	□	□	□	□

	ability to blog, publish or present on clean energy or sustainability					
Q64.	[ASK IF Q61 = 1 OR 2 OR 3] My interest in joining organizations focused on clean energy or sustainability	☐	☐	☐	☐	☐
Q65.	[ASK IF Q62 = 1] My ability to take a leadership role in organizations focused on clean energy or sustainability	☐	☐	☐	☐	☐
Q66.	My ability to interact with industry professionals prior to graduating	☐	☐	☐	☐	☐
Q67.	My ability to interact with industry professionals since leaving school	☐	☐	☐		
Q68.	My ability to establish a network of people and resources useful in my career	☐	☐	☐	☐	☐

Knowledge Outcomes[20]

[USE OF KNOWLEDGE OUTCOMES QUESTIONS:
(1) TO CREATE SKIP PATTERNS FOR THIS SECTION
(2) TEST HYPOTHESIS: PARTICIPANTS MORE FREQUENTLY LEARNED ABOUT TOPICS OF INTEREST THAN DID NPs.
(3) TEST HYPOTHESIS: MANY (POSSIBLY MORE THAN HALF) PARTICIPANTS AND PGM_AWARE NPs ENDORSE PROGRAM AS MOST/MID IMPORTANT SOURCE OF INFORMATION, SUGGESTING ATTRIBUTION.
(4) TEST HYPOTHESIS: PARTICIPANTS ATTRIBUTE KNOWLEDGE GAIN TO PROGRAM.

[20] Research questions associated with this section: **1a:** Do Decathletes gain greater knowledge than non-Decathletes on such measures as opportunities, cost savings, challenges and markets in sustainability and clean energy?

(5) EXPLORE USE OF SOURCE OF KNOWLEDGE (COURSEWORK AND OTHER ACTIVITIES) AS PART OF SEGMENTATION SCHEME TO CONTROL FOR PRE-DISPOSITION (I.E., PROGRAM SELF-SELECTION BIAS).]

[ASK ALL]

Did you learn anything during school about the following topics – either in your coursework or non-coursework activities?

[SINGLE RESPONSE; FORCE RESPONSE][21]

	1. Yes	2. No	3. Not sure
Q69. Sizing a photovoltaic (PV) system for a home	□	□	□
Q70. Siting a PV system - factors affecting appropriate siting	□	□	□
Q71. Modeling a home's energy use	□	□	□
Q72. Designing a highly energy-efficient home	□	□	□
Q73. Identifying "win point" or "sell points" for marketing a solar home (a home with a PV system)	□	□	□

[CODE HAD_KNOWLEDGE IF Q69 = 1 OR Q70 = 1 OR Q71 = 1 OR Q72 = 1 OR Q73 = 1]

… Program aware subroutine

[ASK IF HAD_KNOWLEDGE = 1]

Q74 – Q83. What was the **main** source of how you learned about that topic?

[SINGLE RESPONSE]

	School Coursework	[SHOW IF PGM_AWARE = 1] The Solar Decathlon or Race to Zero competition	Other non-coursework activities
Q74. [SHOW IF Q69 = 1] Sizing a PV system for a home			
Q75. [SHOW IF Q70 = 1] Siting a PV system			
Q76. [SHOW IF Q71 = 1] Modeling a home's energy use			
Q77. [SHOW IF Q72 = 1] Designing a highly energy-efficient home			

[21] Not randomized since answers drive subsequent matrix questions and order should be the same across matrices.

Q78. [SHOW IFQ73 = 1] Identifying "win point" or "sell points" for marketing a solar home			

…Attribution of Knowledge

[ASK IF (PGM_AWARE = 1) AND (HAD_KNOWLEDGE = 1)]
Please rate the importance of the Solar Decathlon (SD) or Race to Zero (RTZ) Competition in increasing your level of knowledge of the following topics.
[SINGLE RESPONSE; FORCE RESPONSE]

[MATRIX QUESTION]

	1. No importance	2. Low importance	3. Some importance	4. High importance	5. Not sure
Q84. [SHOW IF Q69 = 1] Sizing a PV system for a home					
Q85. [SHOW IF Q70 = 1] Siting a PV system					
Q86. [SHOW IF Q71 = 1] Modeling a home's energy use					
Q87. [SHOW IF Q72 = 1] Designing a highly energy-efficient home					
Q88. [SHOW IF Q73 = 1] Identifying "win point" or "sell points" for marketing a solar home					

… True/False Knowledge Questions

[USE OF TRUE/FALSE OUTCOMES QUESTIONS: IN ANALYSIS:
(1) TEST HYPOTHESIS: PARTICIPANTS MORE FREQUENTLY ENDORSE CORRECT ANSWERS ACROSS THE TRUE/FALSE BATTERY THAN NPs.]

Please indicate whether you believe the following statements are true or false. If you are not sure whether the statement is true or false, select "Not sure."

[ASK ALL]

[MATRIX QUESTION; FORCE RESPONSE; RANDOMIZE ITEMS]

		1. True	2. False	3. Not sure
Q89.	To reduce the size of heating and cooling equipment needed, architects and other designers can take advantage of thermal bridging, which describes the transfer of heat through building materials.			
Q90.	Although most states have enough sunshine for households to take advantage of PV systems, the weather in a few states just doesn't make PV systems worthwhile.			
Q91.	Thermal bridging is a very important consideration when air sealing a home.			
Q92.	It is important that a house not be sealed too tightly in order to avoid mold and moisture issues.			
Q93.	Sizing and placement of PV systems on a home's roof is challenging and needs to consider many factors, including the size and orientation of the roof, the building's structural integrity, fire codes, historic building laws, and rules issued by the Federal Aviation Administration (FAA) and the U.S. Department of Energy (DOE).			

Segmentation Questions

[USE OF SEGMENTATION QUESTIONS: IN ANALYSIS:
(1) ASSESS COMPARABILITY OF PARTICIPANTS AND NPs
(2) DEVELOP VIA SEGMENTATION ANALYSIS A SUBSET OF NPs WITH SIMILAR PREDISPOSITION TO CE AS PARTICIPANTS, TO MITIGATE PROGRAM SELF SELECTION BIAS]

[ASK ALL]

Q94. Did you ever participate in Science Olympiad?

[SINGLE RESPONSE; FORCE RESPONSE]

1. Yes
2. No
3. Don't recall

[SHOW IF PARTICIPANT OR P_2020_ONLY = 1]
During your time in junior high, high school, or college, did you write about energy efficiency, renewable energy, sustainability, or the environment in any of the these *prior to participating* in [PROGRAM]?
[SHOW IF NONPARTICIPANT]

During your time in junior high, high school, or college, did you write about clean energy (energy efficiency, renewable energy), sustainability, or the environment in any of these?
[ASK ALL]

[SINGLE RESPONSE; FORCE RESPONSE]	Yes	No	Don't recall
Q95. A school newspaper	□	□	□
Q96. The local newspaper (example: a letter to the editor)	□	□	□
Q97. A blog or Facebook post	□	□	□
Q98. A tweet	□	□	□
Q99. A journal publication	□	□	□
Q100. A conference presentation or paper	□	□	□

[SHOW IF PARTICIPANT OR P_2020_ONLY = 1]
During your time in junior high, high school, or college, and *prior to participating* in [PROGRAM], …
[SHOW IF NONPARTICIPANT]
During your time in junior high, high school, or college……
[ASK ALL]

Q101. Had you volunteered with a group focused on energy efficiency, renewable energy, sustainability, or the environment?

[SINGLE RESPONSE; FORCE RESPONSE]

1. Yes
2. No
3. Don't recall

[SHOW IF PARTICIPANT OR P_2020_ONLY = 1]
During your time in junior high, high school, or college, and *prior to participating* in [PROGRAM], had you…?
[SHOW IF NONPARTICIPANT]
During your time in junior high, high school, or college had you…?
[ASK ALL]

[SINGLE RESPONSE; FORCE RESPONSE]	Yes	No	Don't recall
Q102. Thought up ideas for possible new inventions or ways of making things	□	□	□
Q103. Developed a working model of a possible new invention or ways of making things	□	□	□

Q104. Employed yourself by selling things or providing services to family, friends, and acquaintances	□	□	□
Q105. Employed yourself by selling things or offering services to multiple people you didn't know	□	□	□

[ASK ALL]

Q106. Which of the following, if any, did you participate in that supported the development of a new business or product idea? *Please select all that apply.*

[MULTIPLE RESPONSE; FORCE RESPONSE; REQUEST OPEN-ENDED RESPONSE AS RELEVANT]

1. College coursework
2. Non-coursework activity while a college student
3. Training sometime after completing your college degree(s)
4. Incubator or accelerator
5. Something else; please describe [OPEN-ENDED TEXT BOX]
6. None of the above [MAKE EXCLUSIVE ANSWER]
7. Not applicable, did not develop a new business or product idea [MAKE EXCLUSIVE]

[SHOW ALL]

The last three questions will be used only to group answers from all respondents. Your answers will not be identified with you personally and all data will be held confidentially.

[ASK ALL]

Q107. Please select the range that includes your age.

[SINGLE RESPONSE; FORCE RESPONSE]

1. Less than 25 years
2. 25 to 29 years
3. 30 to 34 years
4. 35 to 39 years
5. 40 or older
6. Prefer not to answer

[ASK ALL]

Q108. Please select the range that includes your income during the past 12 months.

[SINGLE RESPONSE; FORCE RESPONSE]

1. Less than $40,000
2. $40,000 to $59,999
3. $60,000 to $79,999
4. $80,000 to $99,999
5. $100,000 to $149,999
6. $150,000 or more

7. Don't know
8. Prefer not to answer

[ASK ALL]

Q109. With what gender do you identify?

[SINGLE RESPONSE; FORCE RESPONSE]

1. Male
2. Female
3. Other
4. Prefer not to answer

[ASK IF PARTICIPANT = 1 OR P_2020_ONLY=1]

Q110. If you would like to provide any comments about your [PROGRAM] experience, please type them in the box below.

[UNFORCED]

1. [OPEN-END RESPONSE BOX]

[ASK IF PARTICIPANT = 1 OR P_2020_ONLY=1]

Q111. Your participation in this study will be more valuable if you can help us reach as many former [PROGRAM] participants as possible. Please provide the names and, if possible, the contact information of your former teammates or other [PROGRAM] participants you know. We will send them the same survey and not identify that you provided their information.

1. [OPEN-END RESPONSE BOX #1]
2. [OPEN-END RESPONSE BOX #2]
3. [OPEN-END RESPONSE BOX #3]
4. [OPEN-END RESPONSE BOX #4]

Thank and Terminate

Whew! You made it! Thank you for participating in this survey.

[SINGLE RESPONSE; NO RESPONSE REQUIRED; VALIDATE FOR VALID EMAIL]

Q112. To receive your gift card, please enter your preferred email address below and we will send it to you in the next 2 to 6 weeks. It will come from our gift card company, Tango, that allows you to select from dozens of retailers and restaurants like Amazon, Starbucks, Target, Lowe's, and many others. If you do not want to receive the gift card, please leave the space below blank.

1. [OPEN-END EMAIL]

That's it! Thank you for helping the U.S. Department of Energy in its program planning.

Please click on SUBMIT to record your answers and start the processing of your gift card.

SHOW A SUBMIT BUTTON TO RECORD ANSWERS AND END THE SURVEY.

Appendix F. Evaluation Nonparticipant Recruitment

We recruited nonparticipants from universities that participated in the Solar Decathlon at some point but only from a period in which the school sent no team to the Solar Decathlon. We refer to these years as "gap years," meaning the school either had a lapse in participation or had yet to participate. We chose this approach because it would reduce self-selection bias. We also believed the threat to validity from potentially poor comparison schools is greater than the threat to validity from potentially obtaining nonparticipant responses from students who attended the school when a team participated. Table 26 shows the participating schools and which periods there were no participating teams from that school. The checkmarks represent the eligible attendance years of recruited nonparticipants. The blank boxes represent years the school sent a team to the Solar Decathlon, and those would be attendance years of participants.

Table 26. Universities and Years from Which Nonparticipants Were Recruited

School	Gap years	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Alfred State University	2010–2014	✓	✓	✓	✓	✓					
Appalachian State University	2014–2019					✓	✓	✓	✓	✓	✓
Ball State University	2014–2019					✓	✓	✓	✓	✓	✓
California Institute of Technology	2014–2019					✓	✓	✓	✓	✓	✓
California Polytechnic State University	2014–2019					✓	✓	✓	✓	✓	✓
California State University Sacramento	2010–2014	✓	✓	✓	✓	✓					
Daytona State College	2010–2014	✓	✓	✓	✓	✓					
Florida International University	2012–2019			✓	✓	✓	✓	✓	✓	✓	✓
Hampton University	2014–2019					✓	✓	✓	✓	✓	✓
Middlebury College	2014–2019					✓	✓	✓	✓	✓	✓
New Jersey Institute of Technology	2012–2019			✓	✓	✓	✓	✓	✓	✓	✓
Northwestern University	2010–2016	✓	✓	✓	✓	✓	✓	✓			
Old Dominion University	2014–2019					✓	✓	✓	✓	✓	✓
Purdue University	2014–2019					✓	✓	✓	✓	✓	✓
Rutgers University	2014–2019					✓	✓	✓	✓	✓	✓
Santa Clara University	2014–2019					✓	✓	✓	✓	✓	✓
Spitzer School of Architecture	2012–2019			✓	✓	✓	✓	✓	✓	✓	✓
University at Buffalo	2010–2014	✓	✓	✓	✓	✓					
University of Alabama	2010–2016	✓	✓	✓	✓	✓	✓	✓			
University of California Berkeley	2010–2016	✓	✓	✓	✓	✓	✓	✓			

School	Gap years	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
University of California Davis	2010–2014	✓	✓	✓	✓	✓					
University of Denver	2010–2016	✓	✓	✓	✓	✓	✓	✓			
University of Hawaii	2012–2019			✓	✓	✓	✓	✓	✓	✓	✓
University of Illinois at Urbana-Champaign	2014–2019					✓	✓	✓	✓	✓	✓
University of Louisville	2014–2019					✓	✓	✓	✓	✓	✓
University of Maryland	2012–2016			✓	✓	✓	✓	✓			
University of Massachusetts Lowell	2012–2019			✓	✓	✓	✓	✓	✓	✓	✓
University of North Carolina at Charlotte	2014–2019					✓	✓	✓	✓	✓	✓
University of Texas at Austin	2010–2014	✓	✓	✓	✓	✓					
Washington State University	2010–2016	✓	✓	✓	✓	✓	✓	✓			
Washington University	2010–2016	✓	✓	✓	✓	✓	✓	✓			
Yale University	2010–2014	✓	✓	✓	✓	✓					

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