



Opinion **Dynamics**

San Francisco Bay

510 444 5050 tel
510 444 5222 fax

1 Kaiser Plaza
Suite 445
Oakland, CA 94612



PG&E Architecture at Zero Competition Evaluation

Report

June 18, 2018



Contributors

Ellen Steiner, Ph.D.
Vice President

Melanie Munroe
Senior Survey Research Manager

Hilary Polis
Senior Consultant

Table of Contents

1. Executive Summary	1
1.1 Key Research Findings and Recommendations.....	2
2. Introduction	7
2.1 Architecture at Zero Competition	7
2.2 Research Questions	9
3. Research Methods.....	11
4. Summary of Research Findings	14
4.1 Engage Findings	14
4.2 Educate Findings	21
4.3 Motivate Findings	32
4.4 Empower Findings	39
Appendix A. Survey Instruments and Interview Guides	51
Appendix B. Secondary Data Review Sources	66
Appendix C. Case Study Notes.....	67
Student Team #1	67
Student Team #2	68
Professional Team #1.....	69
Professional Team #2.....	70

Table of Tables

Table 1. Key Success Criteria by Research Question and Respondent Type	9
Table 2. Past Registrations and Submissions	12
Table 3. Competition Year Registration Verification	12
Table 4. How did you first learn about PG&E’s Architecture at Zero Competition?	15
Table 5. What challenges, if any, did you experience when designing your Competition submission?	19
Table 6. What are the perceived benefits of ZNE buildings?	24
Table 7. ZNE Principles and Approaches Learned through the Competition	28
Table 8. How has participation in the Competition changed the way you approach design projects?.....	44
Table 9. ZNE Principles and Approaches Past Registrants and Competitors Learned through the Competition Applied after the Competition	45
Table 10. Influence of Competition on Final Site Design and Organizational Approach to Building Design....	47
Table 11. Number of International and Domestic Entries by Students and Professionals	49

Table of Figures

Figure 1. Research Framework.....	2
Figure 2. Engage Key Findings and Recommendations	3
Figure 3. Educate Key Findings and Recommendations	4
Figure 4. Motivate Key Findings and Recommendations	5
Figure 5. Empower Key Findings and Recommendations	6
Figure 6. Growth in Zero Energy Buildings Constructed in North America from 2012-2018.....	8
Figure 7. Research Approach	11
Figure 8. Word Cloud of ZNE Definitions.....	22
Figure 9. Competitor Perceptions of the Definitions of ZNE and Ultra-Low Energy	23
Figure 10. Past Registrant and Competitors' Knowledge and Familiarity with ZNE Principles and Approaches	25
Figure 11. Before entering the Competition, which of the following ways, if any, had you learned about ZNE principles and approaches?.....	26
Figure 12. Why did you decide to register for the Competition?	33
Figure 13. Top Benefits Registrants and Competitors Expected to Realize from the Competition	34
Figure 14. Past Registrant and Competitor Mean Level of Satisfaction with Competition Components	36
Figure 15. How likely are you to recommend the PG&E's Architecture at Zero Competition to a friend or colleague?	37
Figure 16. How has participation in the Competition changed the way you approach design projects? (students vs. professionals).....	45
Figure 17. Number and Share of International vs. Domestic Registrants by Competition Year	48

1. Executive Summary

In 2008, the California Public Utilities Commission (CPUC) set aggressive zero net energy (ZNE) targets for the State of California including goals that all new residential construction in California be ZNE by 2020 and that all new commercial construction be ZNE by 2030.¹ In response, Pacific Gas & Electric (PG&E), along with key partners, formed the Architecture at Zero Competition (Competition) in 2011. The Competition each year is a ZNE design challenge for a pre-selected site in California. Examples of past sites have included an industrial urban infill site in Emeryville, CA and the development of multifamily residential units over a ground floor of retail, community, and support spaces at the University of California, San Francisco's Mission Bay Campus. The Competition is open to students, architects, landscape architects, urban planners, engineers, and designers anywhere in the world. A technical review panel pre-evaluates the technical components of the submission. This review panel then provides the technical evaluation to the jury to determine the winners based on both technical requirements and design considerations. The jury weighs each entry individually, not in competition with the others. The judged criteria include quality of design, innovation, thoughtfulness, and technique. The goal of the Competition is to introduce designers to ZNE design principles and challenges. As a program staff member describes it, the Competition is "an opportunity to wet designer's feet in ZNE."

In June of 2017, PG&E contracted with Opinion Dynamics to conduct an assessment of the Competition. The goal of this assessment is to examine the effectiveness of the Competition. Opinion Dynamics employed seven primary research activities, including:

- Secondary data review;
- Surveys of 48 registrants from 2011-2016 who did not submit a project (past registrants);
- Surveys of 61 registrants from 2011-2016 who did submit a project (past competitors);
- Surveys of 32 registrants from 2017-2018 (current registrants)²;
- Interviews with six Competition challenge site staff from 2011-2018 (site staff);
- Interviews with ten Competition technical reviewers and jury members from 2011-2018; and,
- Four case studies of past competitors.

Research indicates that competitions like this one must achieve four key success criteria in order to stimulate change in thought and behavior that result in short and long-term reductions in energy use.³ The Competition should:

1. Engage (catch attention of and involve the target audience),
2. Educate (communicate information on what, why and how behavior should change),
3. Motivate (enhance desire to change behavior), and

¹ Engage 360. (2011). California's Long -Term Energy Efficiency Strategic Plan. Retrieved from: <http://www.cpuc.ca.gov/General.aspx?id=4125>

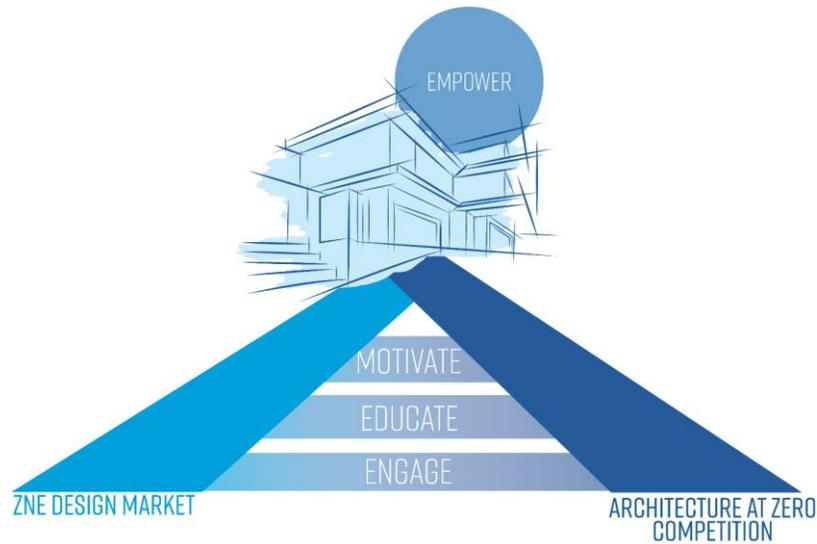
² Note that this survey occurred during the registration period and prior to the submission deadline for the current 2017-2018 Competition year.

³ Vine, E. and Jones, C. (2015). A Review of Energy Reduction Competitions: What Have We Learned? Retrieved from: <https://uc-ciee.org/behavior-decision-making/1/721/99/nested>

4. Empower (increase perception and reality of self-efficacy and suggest concrete and actionable behavior).

In this report, we use these four success criteria as a framework (Figure 1) for the assessment of the Competition.

Figure 1. Research Framework



1.1 Key Research Findings and Recommendations

The key findings identified by each of the four success criteria are triangulated from a combination of interviews with site staff, jurors, technical reviewers, case study teams, and surveys with past registrants, current registrants, and past competitors with insights from the secondary data review presented for background context. We explored both internal Competition processes and how the Competition is influencing the design market. A summary of these key findings and relevant recommendations are presented below. These results are described in detail in the sections that follow.

Figure 2. Engage Key Findings and Recommendations

 ENGAGE	
Findings	Recommendations
<ul style="list-style-type: none"> ▪ Competition marketing strategies are effectively targeting participants but there are additional opportunities to reach potential competitors through industry organizations. ▪ The Competition is raising awareness of ZNE. ▪ There are opportunities to better engage students in the Competition. ▪ Unclear Competition requirements is a barrier to completing Competition submissions. 	<ul style="list-style-type: none"> ▪ Continue to recruit participants through ArchDaily and Bustler. ▪ If growing participation is a goal, consider additional marketing opportunities through reputable organizations such as the Living Buildings Institute and the New Buildings Institute. ▪ Develop partnerships with university architecture programs and studio. ▪ Consider adjusting registration procedures so that students complete their submission as part of an architecture studio program. ▪ Consider offering the technical review service to students on a rolling basis. ▪ Consider making the <ul style="list-style-type: none"> Competition challenge available earlier so that professors have an easier time incorporating the Competition into their curriculum. ▪ Consider developing a sample course curriculum to help professors design courses centered on the Competition. ▪ Consider partnering with an energy modeling software company to offer competitors free trials of energy modeling software during the Competition period. ▪ Work with jurors and technical reviewers to ensure that judging criteria are clearly articulated in the program guidelines. ▪ Refine existing rubric to clearly align with program guidelines.

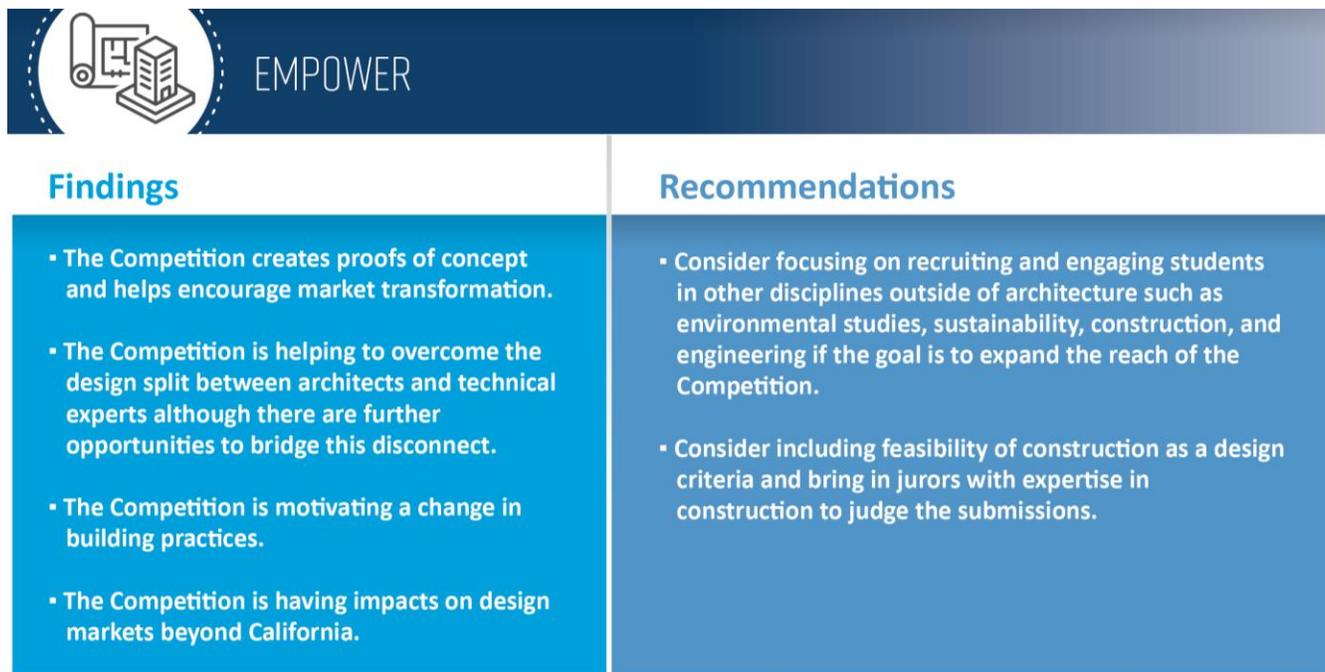
Figure 3. Educate Key Findings and Recommendations

 EDUCATE	
Findings	Recommendations
<ul style="list-style-type: none">▪ Registrants and competitors have varying perceptions of the meaning of ZNE and Ultra low Energy Building Design.▪ Participants understand the benefits of ZNE building design.▪ The Competition is educating all participants about ZNE design techniques.▪ The Competition is helping to educate energy efficient building experts about pain points in the ZNE industry.▪ All groups would like to see improvements in feedback and judging criteria.	<ul style="list-style-type: none">▪ Consider refining and completing a rubric with different design and technical criteria to score the competition submissions.▪ Ensure the technical panel and jury complete the rubric to share with competitors.

Figure 4. Motivate Key Findings and Recommendations



Figure 5. Empower Key Findings and Recommendations



Additional Findings

Capturing registrant information to support evaluation following registration was challenging in this study. For future competitions, we recommend that the current registrant survey questions be included directly in the registration application to capture initial baseline information on all registrants. This approach will ensure survey responses are captured for all registrants which will help establish a strong baseline from which to measure Competition changes over time.

2. Introduction

2.1 Architecture at Zero Competition

Buildings are a primary solution for meeting worldwide energy and climate change goals, as buildings consume almost half of energy produced in the United States and produce 45% of all GHG emissions⁴. While “green buildings” has been a common term in the climate change vernacular for some time, an emerging focus—Zero Net Energy (ZNE) Buildings—is evolving how we think about new construction and existing building retrofits to manage building energy use today and into the future. A ZNE building, also referred to as a zero energy building, is defined as one that produces as much energy as it consumes over the course of a year through combining high levels of efficiency, renewable generation, and effective maintenance and operation procedures. At its most fundamental level, designing a zero net energy building is a balancing act of reducing building loads and increasing efficiency to be able to produce sufficient on-site renewable energy to completely offset the remaining projected energy use over the course of a year.

In 2007, as a part of the Energy Independence and Security Act of 2007 (EISA 2007), the US Department of Energy (DOE) created the Net-Zero Energy Commercial Building Initiative which supported a ZNE goal for all new commercial buildings by 2030, a 50% target for existing commercial buildings by 2030 and a 100% ZNE target for all U.S. commercial buildings by 2050. Many states have been slow to take up these goals. However, the state of California is committed to “the development of a robust and self-sustaining ZNE market” (CEC & CPUC, 2015). Statewide ZNE goals⁵ include;

- By 2020, all residential new construction and 40% of existing homes are ZNE;
- By 2030, all commercial new construction and 50% of existing commercial buildings are ZNE;
- By 2025, state agencies should also take measures toward achieving ZNE for 50% of all existing state-owned building square footage);
- 50% of all new state buildings beginning design after 2020 should be ZNE; and,
- 100% of all new state buildings beginning design after 2025 should be ZNE.

As of January 2018, there were 67 ZNE verified buildings and another 415 ZNE emerging buildings in North America (Figure 6).⁶ This represents an increase of over 700% from 2012, the second year of the Competition. These buildings, however, represent a mere fraction of the new buildings constructed each year and the millions of new buildings already in existence. While this progress is tangible, at the current pace, highly efficient ZNE buildings need to become reality at a much faster pace to reach statewide ZNE goals.

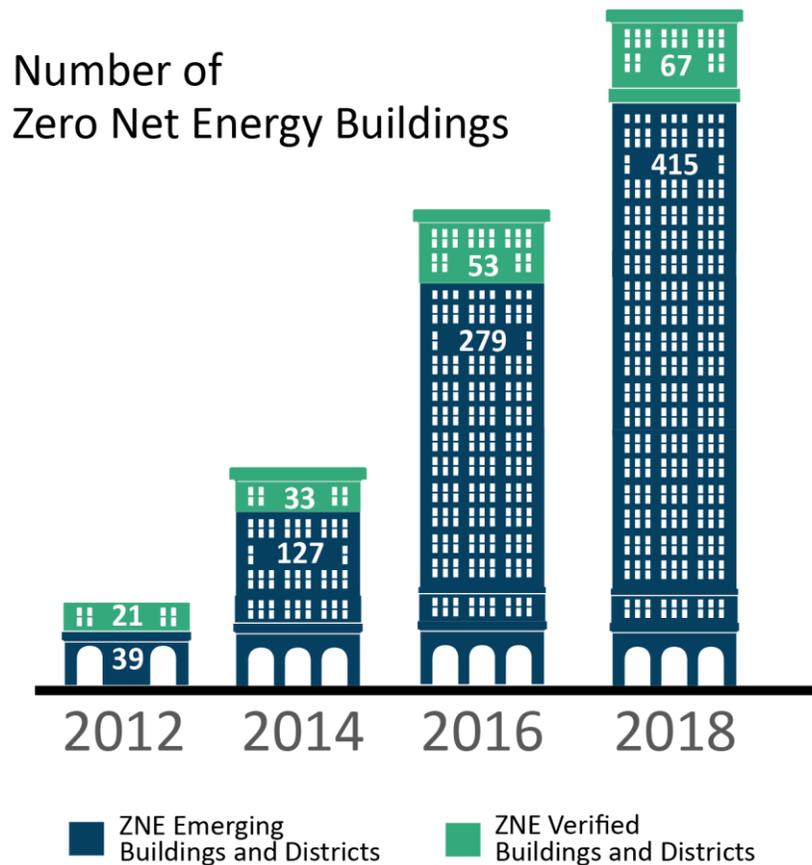
⁴ US Energy Information Administration (2012) / 2030, Inc. / Architecture 2030.

http://architecture2030.org/buildings_problem_why/

⁵ Note: Residential and commercial goals initially established in California’s Long Term Energy Efficiency Strategic Plan, developed by the CPUC in 2008. Original plan and recent updates: <http://www.cpuc.ca.gov/general.aspx?id=4125>

⁶ NBI (2018). 2018 Getting to Zero Status Update and Zero Energy Buildings List. Available at: <https://newbuildings.org/resource/2018-getting-zero-status-update/>

Figure 6. Growth in Zero Energy Buildings Constructed in North America from 2012-2018



There are now 67 ZE Verified and 415 Emerging projects documented by NBI

Source: NBI (2018). 2018 Getting to Zero Status Update and Zero Energy Buildings List. Available at: <https://newbuildings.org/resource/2018-getting-zero-status-update/>

Note: The New Buildings Institute defines ZNE Verified Buildings as buildings that have performed to ZNE standards for at least one full year and NBI has verified the building performance data. Emerging buildings have a specified goal of achieving ZNE but have either not been existence for a full year or have not achieved ZNE standards based on performance data.

In response to this challenge, Pacific Gas & Electric (PG&E), along with key partners, formed the Architecture at Zero Competition (Competition) in 2011. The Competition is a yearly ZNE design challenge for a pre-selected site in California (Competition Challenge Site). The Competition is open to students, architects, landscape architects, urban planners, engineers, and designers anywhere in the world. A technical review panel pre-evaluates the technical components of the submission. This review panel then provides the technical evaluation to the Jury to determine the winners based on both technical requirements and design considerations. The Jury weighs each entry individually, not in competition with the others. The judged criteria includes quality of design, resolution of the program or idea, innovation, thoughtfulness, and technique. The goal of the Competition is to introduce designers to ZNE design principles and challenges.

Results from other design competitions demonstrate these competitions have the potential to change market direction. Research indicates that competitions like this one must achieve four key success criteria in order to stimulate change in thought and behavior that result in short and long-term reductions in energy use. The competition should:

- Engage (catch attention of and involve the target audience),
- Educate (communicate information on what, why and how behavior should change),
- Motivate (enhance desire to change behavior), and
- Empower (increase perception and reality of self-efficacy and suggest concrete and actionable behavior)

We use these four success criteria as a framework for our assessment of the Competition.

2.2 Research Questions

Table 1 provides a crosswalk of the four success criteria, associated research questions, and the groups we engaged with to address each of the research questions.

Table 1. Key Success Criteria by Research Question and Respondent Type

Key Success Criteria	Research Questions	Past Registrants	Past Competitors	Current Registrants	Past and Current Site Staff	Past and Current Technical Reviewers/ Jury Members
		n=48	n=61	n=32	n=5	n=10
Engage	How do registrants, competitors, site staff, technical reviewers, and jury members learn about the Competition?	☑	☑	☑	☑	☑
	Why did participants register but not submit a design to the Competition? What could the Competition have done differently to make it easier for registrants to participate in the Competition?	☑				
	What challenges did participants experience when designing their Competition submission?		☑			
Educate	What were/are participants' level of knowledge about ultra-low energy or ZNE design principles and approaches prior to participating in the Competition?	☑	☑	☑	☑	
	How did participants' learn about ZNE principles and approaches prior to the Competition?	☑	☑	☑	☑	☑
	What were participants experiences utilizing ZNE principles and approaches in design projects prior to participating in the Competition?	☑	☑	☑	☑	

Key Success Criteria	Research Questions	Past Registrants	Past Competitors	Current Registrants	Past and Current Site Staff	Past and Current Technical Reviewers/ Jury Members
	What ZNE principles and approaches have participants learned through participating in the Competition? Has their knowledge and skills increased through the Competition?		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
Motivate	What were/are the motivations for registering/participating in the Competition?	<input checked="" type="checkbox"/>				
	What was/is the perceived value of participating in the Competition?	<input checked="" type="checkbox"/>				
	How satisfied are participants with Competition processes?	<input checked="" type="checkbox"/>				
	How satisfied are participants with the overall Competition experience?		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	What are the perceived benefits of ZNE?	<input checked="" type="checkbox"/>				
Empower	How has participation in the Competition changed the way they approach similar design projects? Have these changes persisted over time?		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
	What elements that participants learned/used in the Competition have they utilized since the Competition?		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
	How have participants used their Competition experience to further their career?		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
	How do participants, site staff, technical reviewers, and jury members perceive the role of ZNE in the design market?	<input checked="" type="checkbox"/>				
	Were the challenge projects influential in changing the eventual design? If so, how did the site utilize the Competition designs? Were there ZNE elements incorporated that likely would not be part of the design had it not been a Competition Challenge site?				<input checked="" type="checkbox"/>	

3. Research Methods

This chapter summarizes the primary data collection activities and the secondary data review conducted as part of this study. Figure 7 illustrates the overall tasks Opinion Dynamics undertook to complete this study. In the remainder of this section, we discuss each method employed in detail.

Figure 7. Research Approach



Secondary Data Review

Opinion Dynamics conducted a brief secondary data review to understand the current state of the ZNE market to provide context to the other data collection activities and insight curation. We reviewed six industry papers and five ZNE industry initiative webpages. A complete list of sources included in this review is available in Appendix B. In addition, we reviewed tracking data from all past competitions and mined it for participation trends and other findings, focusing more extensively on tracking data from the 2015 and 2016 Competitions.

Past Registrants and Competitors Surveys

Opinion Dynamics developed survey instruments for past Competition registrants and competitors to understand their satisfaction with the Competition experience, change in behavior, persistence of behavior change, and perceptions of the ZNE market. The survey sample included all of PG&E's Competition participants from all Competition years regardless of whether or not they entered a submission into the Competition. Table 2 shows the population of past registrants and competitors by competition year.

Table 2. Past Registrations and Submissions

Year	Professional		Student		Total	
	Registrations	Submissions	Registrations	Submissions	Registrations	Submissions
2017-2018	65	10	314	54	379	64
2016	113	24	403	38	546*	62
2015	68	22	23	8	91	30
2014	14	10	28	13	42	23
2013	34	29	30	13	64	42
2012	27	20	23	15	50	35
2011	N/A	12	N/A	5	N/A	17

*There were 29 unclassified.

Note: Because a competitor had to register for the competition before completing a submission the number of registrations includes the number of submissions.

Note: The 2011 to 2016 competitions had registration deadlines in December and the 2017-2018 Competition had a registration deadline in January.

We fielded this survey online from October 10, 2017 to October 24, 2017 attempting a census of all 800 unique contacts with email addresses who participated in the Competition between 2011 and 2016. We sent four reminders during that time to increase participation. We provided as an incentive a \$10 Amazon gift cards for completing the survey, in addition to a chance to win one of four \$50 Amazon gift cards. A total of 109⁷ participants responded to the survey.

Respondents of the survey included individuals from each of the six Competition years. Respondents were fairly evenly split between students (45%) and professionals (54%). In addition 56% of respondents completed submissions, with each Competition year represented.

Table 3. Competition Year Registration Verification

Competition Year (Select all that apply)	Share of Respondents (n=108)
2011	2%
2012	6%
2013	10%
2014	5%
2015	14%
2016	69%

2017-2018 Current Registrants

Opinion Dynamics developed and administered a short survey (17 questions) and deployed it from September 2017-January 2018 during the 2017-2018 Competition registration period. The goal of this survey was to understand registrant knowledge of ZNE principles and approaches, experience designing with ZNE elements, and their motivations for registering for the Competition at the time of registration. This data also provided additional evidence to compare the post-intervention counterfactual collected for past participants. Ideally,

⁷ One survey respondent stated their answers were invalid in the survey, so this respondent was excluded from the analysis and the total number of respondents included in the analysis was 108.

this survey will be utilized in subsequent Competition years for the purposes of longitudinal comparison and to minimize recall issues.

We worked with Competition staff to administer this web-based survey. Competition staff sent email invitations to each registrant inviting them to complete the survey shortly after they completed their registration. A total of 56 respondents partially completed the survey and 32 respondents completed the entire survey⁸. Survey respondents were more likely to be students (88%) than professionals (13%). In addition, most survey respondents replied that 2017 was their first time registering for the competition (93%) and submitting a design in the Competition (96%).

Site Staff Interviews

Opinion Dynamics conducted semi-structured individual interviews with representatives from six out of the seven design sites⁹, with the goal of capturing their perspective on the Competition and understanding how the designs influenced future projects. We worked with the Competition staff to identify the best representatives of the Competition Challenge Sites.

Technical Reviewers and Jury Member Interviews

We conducted ten semi-structured individual interviews with technical reviewers and jury members to understand their experiences in the Competition, specifically:

- Sources of awareness of the Competition;
- Participation drivers;
- Satisfaction with Competition processes and their overall experience;
- Changing trends in ZNE principles and design approaches they observed through the Competition years; and,
- Perceived value of participating in the Competition as a technical reviewer or jury member.

The jurors and technical reviewers we completed interviews with covered all competition years and represented a mix of tenure serving in these roles.

Case Studies

We completed an in-depth analysis of four competitor teams in order to understand the nuances of competitors' experiences, learning, behavior change, and persistence as well as to inform future assessment work. In selecting the four case studies for deeper review, the goal was to more fully develop the self-report counterfactual and broaden understanding of learning and behavior change driven by participation in the Competition.

We developed specific criteria for selecting the four case study teams. We selected teams that were English speakers and had program materials in English. We selected two student teams and two professional teams who entered a submission in the Competition. We also looked at survey responses to maximize the diversity of viewpoints and selected teams with different perspectives on the Competition, including those with both positive opinions and constructive feedback in their open-ended survey responses. In addition, we selected

⁸ For respondents who partially completed the survey, we utilized the answers from the questions they did complete in our analysis.

⁹ One site staff manager transitioned to a different organization and was unable to complete an interview. Another site staff manager did not have time to complete an interview but sent relevant feedback in an email.

respondents with robust responses who we thought were likely to provide us significant detail on their submissions. The four case study teams we selected for the study included a mix of technical and design backgrounds.

For each of the case studies, we interviewed the competitor using the data from their survey response as a foundation. For one student case study team, we also interviewed the professor of the course they completed their competition entry through. In addition, we reviewed the description of this course and syllabus online to provide additional evidence of the counterfactual. We walked through professionals' Competition submissions during the interviews and asked them to consider different design/project options they might offer to the customer without the ZNE mandate. We used the professional interviews to explore decision-making, including specific measures and design tasks which affect design and implementation. In Appendix C, we summarize findings from each case study team.

4. Summary of Research Findings

In this chapter, we summarize the key findings from all research activities completed as part of this study. We identify key findings triangulated from a combination of interviews with site staff, jurors, technical reviewers, and case study teams and surveys with past registrants and competitors with insights from the secondary data review for background context. These key findings are discussed using the engage, educate, motivate, and empower framework. According to this framework, the competition should first catch and hold the attention of registrants and competitors. Once the Competition draws in the attention of Competitors, it should then serve to educate all groups about the design practices they should utilize or technical support they should provide in their design submission. The Competition should then enhance participants' desire to submit a Competition entry and continue to use ZNE design techniques in projects outside of the Competition. Finally, the Competition should empower competitors and the organizations hosting the Competition to continue to incorporate ZNE technologies into their future building designs, thereby helping to stimulate the ZNE design market. In the following sections, we assess Competition processes and results in light of these desired outcomes.

4.1 Engage Findings

In this section, we document how the Competition engaged participants¹⁰ by exploring how the Competition caught the attention of and involved the registrants, competitors, site staff, jurors, and technical reviewers. We assessed the Competition marketing and outreach strategies by exploring participation trends over time and how participants learned about the Competition. Findings from this research revealed Competition marketing strategies are effectively targeting participants and leading to higher levels of ZNE awareness in the design market, but that there are additional opportunities to reach potential competitors through industry organizations. We also explored each group's perception of their involvement with the Competition and identified barriers to engagement. These findings revealed unclear Competition requirements is a barrier to completing submissions and there are opportunities to better engage students in the Competition. These key findings are discussed more fully in this section.

Key finding: Competition marketing strategies are effectively targeting participants but there are additional opportunities to reach potential competitors through industry organizations

We reviewed secondary data to understand how successful the Competition has been at targeting new registrants and competitors through the Competition years. The secondary data review revealed there were

¹⁰ In this report, we use participants to refer to all groups including registrants, competitors, jurors, technical reviewers, and site staff.

546 registrations and 57 submissions in 2016, which is a dramatic increase from 91 registrations and 30 submissions in 2015. While there was a decrease in registrants (379) and a small increase in submissions (64) in 2017, interest still remained high as compared to 2015 and prior competitions. In 2016, the Competition also began a social media outreach campaign through Facebook, and purchased ads on foremost industry websites, Bustler and Arch Daily. The Competition continued to expand outreach efforts in 2017 to attract a wider audience. These efforts included developing a new live website, purchasing digital ads on architecture Competition sites, outreach to past entrants and Deans of California schools of architecture, and continued social media outreach. The Competition's new marketing strategies appear to be effectively targeting potential participants as approximately 60% of all referrals came from Bustler and Facebook. The past registrant and competitor survey revealed that registrants and competitors most frequently learned about the Competition from the Competition website (41%) or another industry-specific website (14%) such as Archdaily.com or Bustler (Table 4). Current registrant survey respondents were most likely to learn about the Competition through their university, which aligns with the fact that a greater percentage of current registrant survey respondents were students.

Table 4. How did you first learn about PG&E's Architecture at Zero Competition?

Channel	Past Registrant and Competitor Survey Respondents (n=108)	Current Registrant Survey Respondents (n= 54)
Competition website	41%	24%
Industry specific website (ArchDaily, Bustler, Competitions.archi)	14%	19%
My university	12%	28%
Word of mouth	12%	9%
Email from the American Institute of Architects (AIA)	6%	0%
American Institute of Architects (AIA) website	6%	6%
Online Search	6%	6%
My employer	5%	4%
Architect's Magazine/Newsletter	0%	4%
Social Media (Facebook, etc.)	0%	2%

Note: Columns may not sum to 100% due to rounding

Case study interviewees suggested the Competition should continue to reach out to potential competitors through ArchDaily and Bustler. These interviewees also suggested the Competition could reach out to competitors through additional sources such as Architizer and the New Buildings Institute. We asked technical reviewers, jurors, and case study participants about the resources they use and trust to keep up to date with the ZNE industry. The sidebar on the following page lists these sources. Partnering with these organizations may provide additional opportunities for the Competition to reach participants. Three out of the four of the case study interviewees specifically mentioned the Living Building Challenge as one of their top resources for

information about ZNE topics. These case study interviewees also believe the mission of the Living Building Challenge is complementary to the Competition, and there might be opportunities for collaboration with the Living Buildings Institute, which manages the Living Building Challenge.

Site staff interviewees learned about the Competition from personal outreach by a Competition representative or from a previous site staff manager. Most site staff interviewees reported having limited interactions with Competition participants. Most jurors became involved with the competition because they were already connected with Competition staff or they were directly asked to be jurors by Competition staff. Technical reviewers were generally comprised of PG&E and Resource Refocus¹¹ staff who were already involved with managing the Competition.

The Competition is raising awareness of ZNE

From a market perspective, juror and technical reviewer interviewees believe the Competition is impacting and changing the ZNE market because it is raising awareness about ZNE in the design community. Furthermore, these interviewees acknowledged that ZNE buildings still makes up a very small fraction of the new construction market which leads them to believe that awareness about ZNE building is currently low among members of the design community. As such, these interviewees believe that registrants and competitors generally have a low level of familiarity with ZNE designs and approaches before they begin the competition. These interviewees believe there is a greater likelihood that the Competition is influencing the design market because it is helping registrants and competitors learn about concepts they wouldn't be aware of otherwise. In contrast, most competitors believe they were somewhat or moderately familiar with ZNE before they entered the Competition. This finding may reflect a difference in understanding of what it takes to produce a technically rigorous ZNE design between jury staff and competitors or a different perception between a general awareness of ZNE as opposed to specific knowledge and application of ZNE principles and techniques.

Resources used to keep up with the industry



The Living Building Challenge/The Living Future Institute
The Building Green Report
Greenbuild Conference
US Green Building Institutes
Net Zero Conference
US Department of Energy
Building Sciences Corporation
New Buildings Institute
The American Council for an Energy Efficient Economy (ACEEE)
ASHRAE
International Building Performance Simulation Organization
GreenPoint
American Institute of Architecture Students
ArchDaily
Bustler
Metropolis Magazine
Architectural Record
Architect Magazine
The Sustainable Building Council
The State of California
The Net Zero Conference
The National Institute of Minority Architects (NOMA) and Architect Students
Solar Decathlon
National Architecture Accrediting Board (NAAB)

¹¹ Resource Refocus is a zero net energy consulting and technical research firm hired by PG&E to help implement the Architecture at Zero Competition

Overall, despite perceived low levels of market awareness, jurors and technical reviewers believe that ZNE buildings have gained visibility and the market has expanded since the Competition began in 2011. This is supported by the fact that the number of ZNE buildings in North America has grown by 700% from 2012 to 2018¹². They are also seeing growing interest and awareness in ZNE approaches from the design community in recent years. One juror elaborated that the growth in interest in ZNE is evidenced by the fact that they are seeing more industry conferences dedicated to ZNE and ZNE consistently receives coverage in industry publications. In addition, interviewees believe the Competition contributes to this increase in ZNE market awareness in the design community as competitors spread their knowledge to their clients and others in the design community. One interviewee cited the increasing number of submissions to the Competition each year as evidence that interest is growing in both the Competition and ZNE design.

Juror Interviews



“When you get mainstream practitioners to start thinking about these things, you know you're developing additional expertise and able to grab that and market it for future projects and future clients, and so it helps the breadth of knowledge in some of these new areas, new and emerging areas, like ZNE.”

Key finding: There are opportunities to better engage students in the Competition

To better understand the barriers registrants face when submitting a design in the competition, we asked the 47 Competition registrants who did not complete a submission why they decided not to submit a design. These respondents most frequently said they did not submit a design because they did not have enough time (47%); the Competition didn't fit with their academic schedule (17%); or, the Competition had to be deprioritized due to competing obligations (13%).

Jurors and technical reviewers gave several suggestions for Competition process improvements and these suggestions indicate that jurors and technical reviewers are cognizant of the challenges that registrants and competitors face when they participate in the Competition. Three jurors and technical reviewers suggested the Competition should take steps to make it easier for students to compete, such as adjusting the timing of Competition to match school schedules and integrating the competition into architecture studio courses. In addition, two jurors and technical reviewers also suggested the competition should provide more technical support to students during the Competition to ensure designs are rigorous. Marketing and engagement efforts in 2017-2018 featured a special opportunity for students to receive a technical review of their entries prior to submission to encourage a robust understanding of the metrics and provide students with feedback about areas of their submission that could use improvement. This service was open to all students but not professional registrants and may help students produce more technically rigorous designs. Competition staff learned from previous Competitions that students tended to need more help producing technically rigorous designs as compared with professionals.

Technical Reviewer Interviews



“Basically I think we're moving in the right direction, but I don't think we've gone far enough to like, actually realize our goals of integrating with the student [architecture] studios.”

¹² NBI (2018). 2018 Getting to Zero Status Update and Zero Energy Buildings List. Available at: <https://newbuildings.org/resource/2018-getting-zero-status-update/>

Technical reviewers involved in running the competition indicated they made an effort in recent years to extend the Competition to better coincide with academic calendars; but, they believe there are still opportunities to better align the program with university architecture studio courses. Although accommodating both semester and quarter system schedules can be challenging, one juror suggested that the Competition staff could alter the way that students register for the Competition so that they must register through their school or professor instead of allowing students to register individually. Students would then develop a design submission through their studio course. This juror also suggested making the design challenge available up to a year in advance of the submission date so that students could develop submissions throughout the course of a year in their academic courses and then submit these designs by the January deadline. A technical reviewer also suggested that meeting with architecture professors could be a helpful way of informing future Competition schedules and encouraging professors to incorporate the Competition into their courses.

The two case study student teams provided specific recommendations for making the Competition more accessible to students. One student suggested the Competition offer the technical review service as close as possible to when students complete their final submissions, ideally within a month of when the submission is due. This case study student also advised that professors will need to plan out how to integrate the Competition into their course content and therefore suggested the Competition release the design challenge during the spring or early summer before the Competition to give professors time to plan their courses around the Competition. Another student suggested the Competition should recruit students by continuing to reach out to professors directly. The Competition requires some

advanced modeling and the ability to draw upon multiple different architectural approaches, so the case study interviewee suggested a course built around the Competition would be best suited to students in their final year of undergraduate studies or in graduate school. One case study interviewee completed their Competition submission through an energy modeling class for their Masters of Architecture program. This student case study interviewee reported the Competition submission was the right scope for a group project and felt the Competition challenge would be appropriate for an individual thesis project. In addition, this student enjoyed completing their Competition submission as part of a course and the only challenge they experienced was gaining access to energy modeling software. This student said their professor had to reach out to a modeling software manufacturer directly, which caused delays. To address this challenge, this student recommended the competition provide students with access to a more comprehensive type of energy modeling software that has the capability to model lighting and energy production.

Case Study Course Instructor Interview



“I think the Competition gave [my students] some tools and some concepts that really helped them to give them another layer to their designs from this perspective, because a lot of times there's a big disconnect between what's being taught on their required courses and what's being taught from a design perspective. Any time you can integrate the two, it gives the students an opportunity to learn actually how they learn better which is learning by doing. There's one certain way of learning that they received that knowledge from testing and lectures and reading, but to engage the knowledge from a project and experiential standpoint is kind of how a lot of architects really learn. I think [the Competition] just enriches their experience and knowledge, and in my opinion, is probably more impactful than their typical classes that they learn about sustainability and energy.”

We also interviewed the instructor of the course this case study interviewee completed their submission through. The instructor built an elective course around the Competition focused on energy modeling and energy efficient buildings. The first half of the course was comprised of lectures about net zero energy design and students designed their Competition entry during the second half of the course. Overall, the professor had a positive experience incorporating the Competition into his course. The professor found the Competition to be both well-received and beneficial for students because it gave them an opportunity to learn by doing. Furthermore, the director of the professor’s design program was pleased with how students engaged in the course and asked the instructor to teach the course again.

The professor had several suggestions for ways the Competition can attract more student submissions in the future, including reaching out to students in disciplines outside of architecture, including sustainability and engineering. This may be especially beneficial for students who don’t have the breadth of knowledge needed to develop a submission because they can team up with other students who have complementary areas of expertise. This professor also suggested the scope of the competition was large enough that it warranted dedicating an entire elective course to helping student complete submissions. Furthermore the professor suggested the National Architecture Accrediting Board (NAAB) might be a helpful resource that Competition staff could use to reach out to architecture professors. The instructor reiterated he would like to have the Competition challenge available in June or July so they have time to plan out their course content and find the supporting textbooks to develop the course before school starts at the end of the summer.

Key finding: Unclear Competition requirements is a barrier to completing Competition submissions

Competitors who completed a submission most frequently identified unclear Competition requirements as a challenge they experienced while completing their submission (23%). A few past registrant and competitors and one case study team thought the design elements reviewers and jurors appeared to value in their judging did not match up with the criteria respondents perceived to be important from the Competition submission requirements. To illustrate, two past registrant and competitor survey respondents believed the tower feature of the winning entry in 2016 was taller than the competition regulations allowed. One case study team was surprised their entry was judged on cost, because they didn't find any mention of cost in the Competition guidelines. Another case study interviewee identified examples of winning submissions including design features that were not realistic, such as geothermal heating in areas with no geothermal resources and buildings built on top of existing buildings. Another case study interviewee noticed that the winning entries all had extensive supporting documentation. This interviewee felt the guidelines were not clear about how supporting documentation was utilized in judging and was unsure about how to allocate their time towards this component of their submission. Similar to the subset of registrants who did not complete a submission, competitors who completed a submission also faced challenges related to time constraints as 20% of competitors said they had a lack of time to complete the design and 20% needed to deprioritize the Competition due to competing obligations (n=61).

Table 5. What challenges, if any, did you experience when designing your Competition submission?

Challenges (Multiple Response)	Share of Respondents who Completed a Submission (n=61)
Competition requirements were not clear	23%
Lack of time to complete the design	20%
The Competition had to be deprioritized due to competing obligations	20%
Lack of educational resources or mentors to answer technical questions	16%
Lack of information on the site specifications	13%

Challenges (Multiple Response)	Share of Respondents who Completed a Submission (n=61)
Lack of technical resources available on the Architecture at Zero site	8%
Other	12%
None	25%

Two case study interviewees experienced a lack of information on site specifications as a challenge in the Competition. One interviewee said they would have specifically liked to have access to a survey with the topographic quality of the site and its surroundings and another interviewee would have liked to see clearer setback requirements. Although competitors are given the opportunity to go on a tour of the site before designing their entry, one of the remote case study teams pointed out that many teams are unable to attend this tour because they are located across the country or world. The competition offered video recordings of the site tour and aerial images of the site for the 2017 Competition, which may help address these issues.



Findings

- Competition marketing strategies are effectively targeting participants but there are additional opportunities to reach potential competitors through industry organizations.
- The Competition is raising awareness of ZNE.
- There are opportunities to better engage students in the Competition.
- Unclear Competition requirements is a barrier to completing Competition submissions.

Recommendations

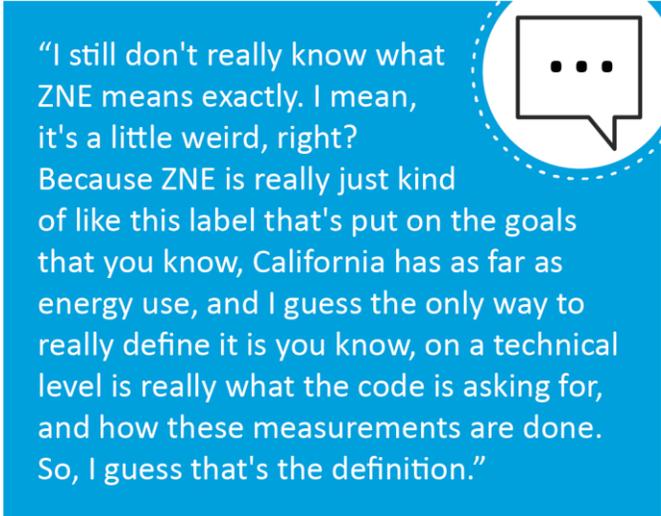
- Continue to recruit participants through ArchDaily and Bustler.
 - If growing participation is a goal, consider additional marketing opportunities through reputable organizations such as the Living Buildings Institute and the New Buildings Institute.
 - Develop partnerships with university architecture programs and studio.
 - Consider adjusting registration procedures so that students complete their submission as part of an architecture studio program.
 - Consider offering the technical review service to students on a rolling basis.
 - Consider making the
- Competition challenge available earlier so that professors have an easier time incorporating the Competition into their curriculum.
 - Consider developing a sample course curriculum to help professors design courses centered on the Competition.
 - Consider partnering with an energy modeling software company to offer competitors free trials of energy modeling software during the Competition period.
 - Work with jurors and technical reviewers to ensure that judging criteria are clearly articulated in the program guidelines.
 - Refine existing rubric to clearly align with program guidelines.

4.2 Educate Findings

Once the Competition has engaged participants, the next step is to educate participants about what ZNE is, why they should design ZNE buildings, and how to incorporate ZNE principles and approaches to achieve ZNE

goals. We assessed how the Competition is educating participants about what ZNE means by asking them to define ZNE and ultra-low building design. Results showed that registrants and competitors have varying perceptions of the meaning of ZNE and Ultra Low Energy Building Design. We evaluated participants' understanding of why they should design ZNE buildings by asking them to identify the perceived benefits of ZNE for the design market and results show that participants understand the purpose of ZNE building design. In addition, we explored how the Competition is educating participants about ZNE design techniques by determining participants' baseline level of knowledge about ZNE and then identifying the specific ZNE concepts and approaches they learned through the Competition. We found the Competition is educating site staff, registrants, and competitors about ZNE design techniques and educating jurors and technical reviewers about pain points in the ZNE industry. We also uncovered that there may be opportunities to further educate all groups by making improvements in feedback and judging criteria. We discuss these findings in more detail in the section below.

Case Study Interview

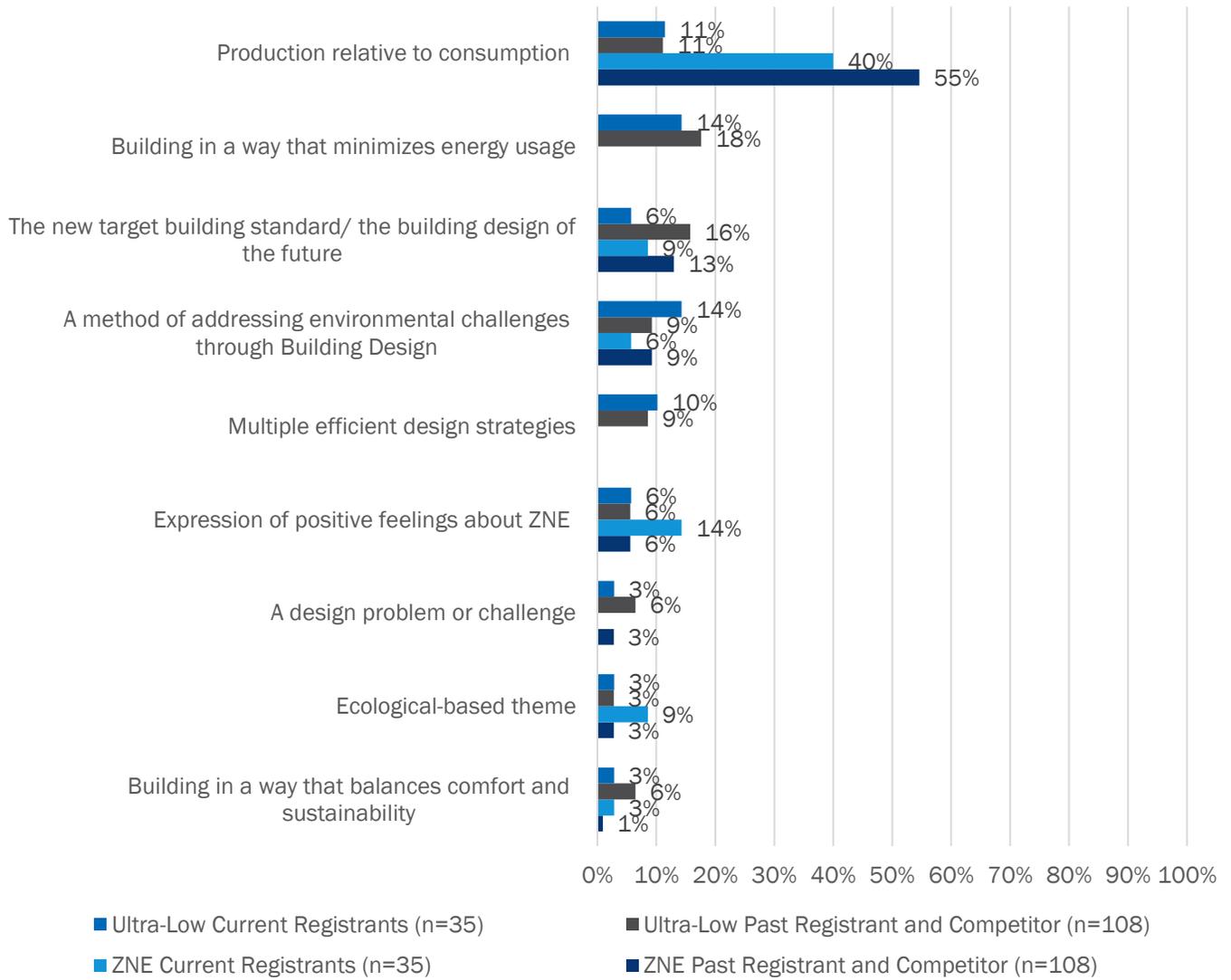


“I still don't really know what ZNE means exactly. I mean, it's a little weird, right? Because ZNE is really just kind of like this label that's put on the goals that you know, California has as far as energy use, and I guess the only way to really define it is you know, on a technical level is really what the code is asking for, and how these measurements are done. So, I guess that's the definition.”

Key finding: Registrants and competitors have varying perceptions of the meaning of ZNE and Ultra low Energy Building Design

One of the key aspects of educating participants about ZNE is helping them to understand what makes this building design approach distinct from other green building design strategies, such as LEED. ZNE currently has varying definitions in both California and nationwide. We asked past registrants, past competitors, and current registrant survey respondents what the terms ultra-low energy building design and ZNE meant to them to get an understanding of how the design industry conceptualizes this topic. We also sought to find convergences and divergences in perceptions of ZNE among respondents. In Figure 8, we visually present the frequency of words associated with ultra-low energy building design and ZNE.

Figure 9. Competitor Perceptions of the Definitions of ZNE and Ultra-Low Energy



Technical Reviewer Interviews



Key finding: Participants understand the benefits of ZNE building design

Another key aspect of educating participants about ZNE is communicating the rationale for designing ZNE buildings to them. We explored registrants' and competitors' understanding of the purpose of ZNE building design by asking them to identify the benefits of ZNE buildings from a list provided—allowing a respondent to select all that applied. Respondents most frequently identified lower greenhouse gas emissions (84%), the use of renewable energy sources (83%), reduced energy bills (81%), the ability to gain control of our energy future (78%), and the ability to optimize the way the building operates and how people use it (70%) as the perceived benefits of ZNE buildings (Table 6). Respondents who gave responses in the other category commonly referred to the benefits of ZNE as promoting cultural changes around resource use and energy consciousness.

“And I think of the people behind the market transformation around ZNE should be more focusing on the non-energy benefits, than we are pitching zero net energy. Because the energy benefits will be there. But, especially with this environment, people make their decisions on what they like. If you talk to any non-architect, when you talk about architecture, they either talk about any building that they felt it was monumental, or they felt good inside and comfortable inside.”

Table 6. What are the perceived benefits of ZNE buildings?

Benefits of ZNE buildings	Share of Respondents (n=108)
Lower greenhouse gas emissions	84%
Use of renewable energy	83%
Reduce energy bills	81%
Help gain control of our energy future	78%
Optimize the way the building operates and how people use it	70%
Spur new product innovation	56%
Help strengthen local economies	43%
Creation of local jobs	32%
Other	9%

We also asked jurors and technical reviewers to identify the perceived benefits of ZNE in the design market. Similar to past registrants and past competitors, these design market experts most frequently identified lower greenhouse gas emissions as a benefit of ZNE buildings. In addition, several interviewees commented that energy benefits, and reduced energy bills are obvious benefits of ZNE buildings, but that there should be more of a focus on marketing the non-energy benefits associated with these buildings such as improved building design, comfort, and building operation.

A few jurors and technical reviewers also commented that being knowledgeable about ZNE design can be a business development benefit for architects because it gives them distinct expertise they can use to differentiate themselves in the market. They also noted that because ZNE is at the cutting edge of green building design, it gives architects the opportunity to show that they are committed to being environmentally conscious. As an example, one technical reviewer described how a previous competitor team used their Competition entry for business pitches to show they have experience with ZNE design. One case study team

Technical Reviewer Interviews

"It sort of reminds me when Priuses were first coming on the market there were also other hybrid cars that looked more like regular cars. So Prius's you look at them and you're like, "That's definitely a Prius." Some of the other hybrids you wouldn't necessarily know that it's a hybrid, and those ones did not succeed as well because people want you to know that they're like, good people, and driving the hybrid. And I think that ZNE is sort of like that, of it's more visible to other people that you're like, doing a good thing for the world if you're ZNE instead of just like, ultra-efficient."



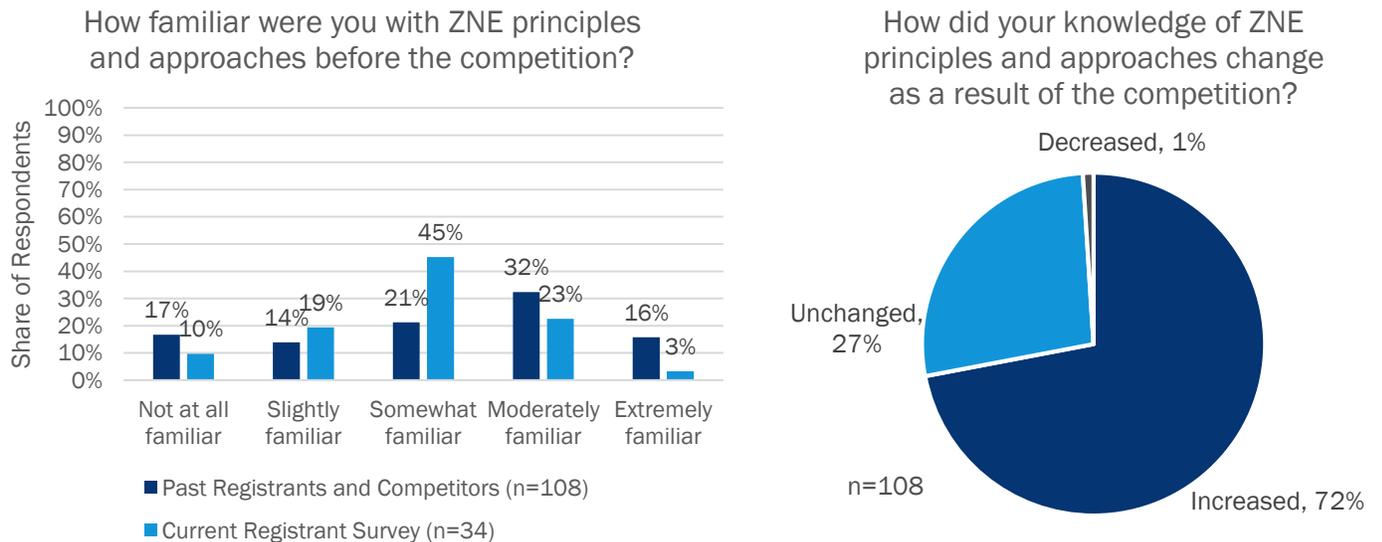
validated this point when they explained their firm is committed to transforming the architecture industry and the Competition gives them a way to demonstrate their commitment to their clients and the rest of the industry.

Key finding: The Competition is educating all participants about ZNE design techniques

Past registrants and competitors, site staff, jurors, and technical reviewers had varying levels of knowledge and exposure to the ZNE concepts and approaches before the competition. As such, the competition educated different groups in different ways. The majority of past registrant and competitor respondents indicated they were either somewhat or moderately familiar with ZNE principles and approaches before entering the Competition (53% of respondents) (Figure 10). In addition current registrants were asked if they had designed or worked on projects that utilize ZNE designs and principles before the Competition and only 28% of current registrant survey respondents had prior experience with applying ZNE. As a result of the

Competition, 72% of past registrants and competitors agree that their knowledge of ZNE principles and approaches increased.

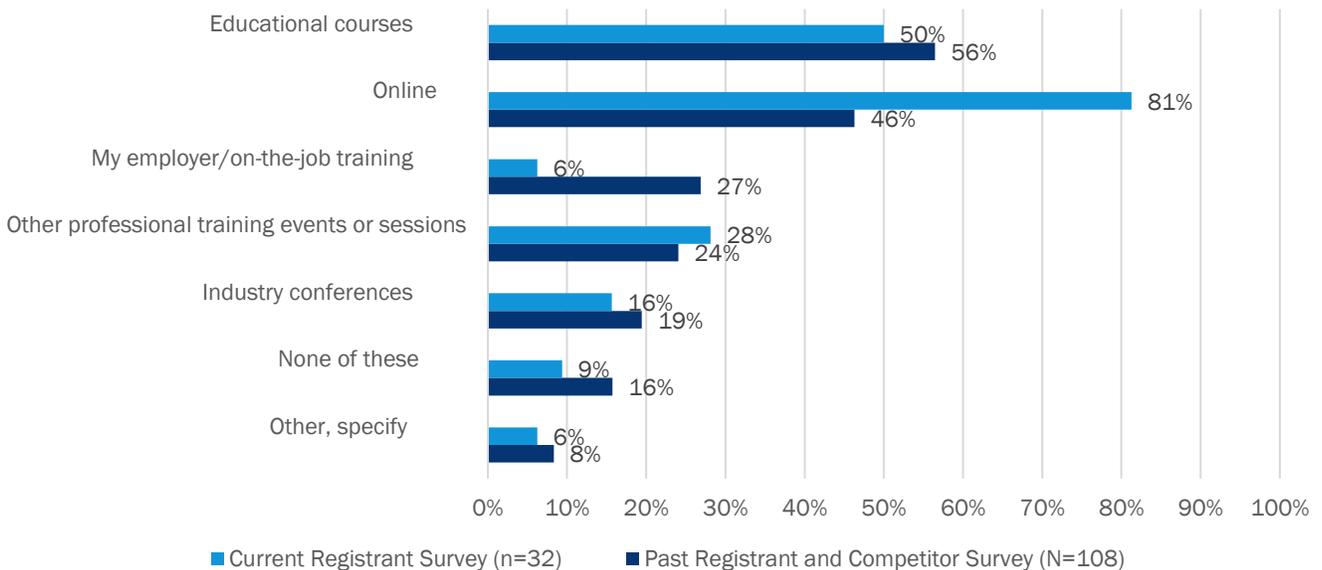
Figure 10. Past Registrant and Competitors' Knowledge and Familiarity with ZNE Principles and Approaches



Past registrants and competitors heard about ZNE principles and approaches from many different sources. Given that about half of respondents were students, it is not surprising that a key source of ZNE information was educational courses (56%). Current registrant survey respondents most frequently learned about ZNE through online sources (81%) (Figure 11). Specifically, case study interviewees felt that their environmental

design, building performance analysis, and energy modeling courses exposed them to ZNE principles and approaches prior to the Competition.

Figure 11. Before entering the Competition, which of the following ways, if any, had you learned about ZNE principles and approaches?



Site staff had varying levels of knowledge about ZNE designs and concepts before the Competition, as some site staff had professional experience as planners and architects, while others had minimal previous experience in these areas. As such, the site staff had varying levels of knowledge gain from the Competition. Overall, several site staff reported the Competition caused them to think differently about overarching building design concepts. One site staff interviewee was impressed by how competitors were able to create dense spaces that still focus on occupant comfort. This interviewee also reported that the Competition caused her to think more holistically about building design and the effects that designs would have on occupant behavior. Another site staff interviewee learned about topics related to combined heat and power.

Site Staff Interviews

"We needed to look at multiple strategies that we can't just get there with one technological move, that it might change the way people live, and you have to socialize that and see if that's going to work"



We asked past registrants and site staff about new ZNE principles and approaches they learned through the Competition. In addition, we asked jurors and technical reviewers about ZNE principles and approaches they believe have been a focus within the competition; and, we reviewed past submissions to understand design trends throughout the Competition years. Table 7 shows

that past registrants and competitors most frequently learned about climate analysis through the Competition. Jurors and technical reviewers commented that the sites selected for the Competition were often located in unique climate zones. For example, the 2016 Competition site at San Francisco State was located within a unique microclimate in San Francisco and this forced competitors to grapple with challenging climatic site characteristics. The Competition submissions revealed many competitors took the site's climate into account

and utilized techniques to make the site's surrounding environment work to increase efficiency. Examples of these efficiencies included optimally siting the building and windows to utilize natural light and ventilation.

Site staff, past registrants, and past competitors indicated that they frequently learned about incorporating renewable energy into building designs. Site staff noted they had given some thought to incorporating renewable energy technologies before the Competition, but the Competition exposed them to different types of renewable energy sources they hadn't through about before, such as marine renewable energy¹³. Jurors explained that the increasing trend of incorporating renewable energy technology into building designs reflects broader changes in the market for renewable energy technologies such as an increase in the acceptability of battery storage technologies.

Site Staff Interviews

"We had considered solar and some solar design, but this went far beyond that and made us aware of technologies that we had no idea about"



Jurors and technical reviewers noted they saw competitors begin to utilize specific design techniques more frequently over the years of the Competition. The tracking data review revealed there was an increase in the utilization of energy modeling software in 2016 compared to 2015. Technical reviewers also commented they saw competitors begin to use energy modeling software more frequently, which they believe is resulting in more technically sound designs. Furthermore, the technical reviewers also saw more competitors focus on Energy Use Intensity (EUI)¹⁴, another important component of designing technically sound buildings. In addition, several jurors and technical reviewers observed registrants and competitors gain an appreciation for integrating daylighting into their designs to reduce lighting loads. Jurors and technical reviewers also noted they have seen competitor teams focus more on integrating non-energy environmental concepts into their building designs including food production and water recycling systems.

Technical Reviewer Interviews

"I would say that people are think a little bit more numerically about them. And some of that is we've improved the guidance that the teams get, and that that they need to do some kind of energy modeling. That's been forced by the competition a little bit, but at least people are thinking about that, and proposing a lot of analyses."



¹³ Marine renewable energy is a blanket designation generally taken to refer to power generation from waves, currents (ocean, tidal, and river), thermal gradients, and salinity gradients.

¹⁴ Energy Use Intensity (EUI) is a metric that is used to compare the energy consumption of different buildings by accounting for conditioned floor area. It is defined as annual energy consumption divided by conditioned floor area and is most commonly expressed in the units of kBtu/sf/yr.

Table 7. ZNE Principles and Approaches Learned through the Competition

	ZNE Principles and Approaches Past Registrant and Competitors Learned through the Competition	New Concepts Introduced to Site Staff through the Competition	Trends in Competition Designs observed by Jurors and Tech Reviewers
Climate analysis	54%	X	X
Shading studies	49%		
Passive system strategies	47%		
Lighting considerations	44%		
Strategies to reduce energy loads	44%		X
Building envelope considerations	42%	X	X
Integration of solar power into design	39%	X	X
Whole building energy modeling software	37%		X
Occupant behavior considerations	35%	X	
Integration of wind power into design	33%	X	X
Water heater considerations	33%		
Energy Use Intensity (EUI) metrics	31%		X
Space conditioning considerations	31%	X	
Increased knowledge regarding specific equipment/measures (e.g. insulation, lighting controls, energy star appliances, smart strips, etc.)	31%		
Specific definitions of ZNE (such as site vs. source definitions)	27%		
Plug load considerations	26%		
Controls and related strategies (e.g. Ensuring that systems talk to one another and work together)	25%	X	
Integration of biomass/biofuel into design	20%		
Appliance considerations	20%		
Shared vehicles		X	
HVAC systems		X	
Integration of other sustainable design aspects			X

The Competition is helping to educate energy efficient building experts about pain points in the ZNE industry

In addition to revealing how the Competition is directly educating participants, our research also uncovered findings about how the Competition is providing participants with key background knowledge about the current state of the ZNE industry. All jurors and technical reviewer interviewees came into the Competition with a high level of knowledge about ZNE and ultra-low energy designs and were selected for their specialized expertise in these topics. Juror and technical reviewer interviewees tended to have expertise in either architecture or energy modeling. As such, no jurors or technical reviewers felt their ZNE or efficient building knowledge and skills directly grew through their involvement with the competition.

Most juror and technical reviewer respondents said their most valuable takeaway from the Competition was learning how professionals and students grapple with the challenges of ZNE and ultra-low energy design techniques in a realistic scenario. Competition submissions revealed competitors often failed to think about the design holistically; how energy efficiency systems work together; and, competitors often lacked a general understanding of building science concepts. Competition submissions also show many competitors also missed the mark when it came to estimating reasonable plug loads and breaking down end uses. This information is valuable for jurors and technical reviewers who help lead and educate the design community, but may not have the chance to learn how practitioners implement ZNE design concepts on a regular basis. These interviewees reported that the Competition provided them with an opportunity to identify the concepts that are most challenging for competitors to implement. This helps jurors and technical reviewers determine where to focus their efforts in developing education materials and providing industry leadership in the future.

One of the more technically-focused case study interviewees explained the Competition helped her realize the rest of the industry is having a difficult time developing designs that are technically feasible. As such, this interviewee elaborated that participating in the Competition gave her an understanding of how her skillset fits within the greater context of industry.

Key finding: All groups would like to see improvements in feedback and judging criteria

Our research also revealed there are key opportunities to enhance how the Competition is educating participants.

Juror Interviews

“I think any interaction that I have with people in the field doing this every day gets reflected back into the types of research we do, the types of questions we try to answer, you know to make us better researchers that ultimately are trying to transform the energy industry.”



Juror Interviews

“I don't remember if there was much feedback. If you're a firm responding, so you put in whatever it is. Maybe it's a couple hundred hours of work, and you built your submittal and you turn it in, and then if you're a firm that submitted and you didn't win, I don't know if you get any feedback from that process, and that would be interesting to maybe be able to do that. That would take extra work on the part of the jurors. It may not be feasible if there's lots and lots of submissions, but that feedback loop could be valuable if it was in place.”



Some of the past registrants and competitors reported they would like to see changes to the judging process including better feedback, transparency, and changes to the judging criteria (28%, n=15). Three survey respondents did not understand why the winning entry was selected given the Competition criteria. Other survey respondents did not understand why their design was not selected and would like clearer feedback from jurors about how to improve their designs in the future. Requests for more feedback were true of teams that received awards and did not receive awards alike. One case study group that received an award reported they would have liked to receive more feedback about what made their design stand out and why it was selected as a winning design. The three other case study teams had higher levels of satisfaction with other competitions they participated in which they attributed to the rigorous feedback they received through these other Competitions. Examples of these other competitions that respondents felt gave thorough feedback included a Competition to build a new music hall in Hungary sponsored by Archtalent, The Living Building Challenge, the Solar Decathlon, and the Tiny Home Design Challenge. One team elaborated that in a previous competition, the jury used an algorithm based on several different categories including cost, site analysis, sustainability, and quality of spaces to score the entries. The team received information about how their design ranked according to the specified criteria which helped them recognize the relative strengths and weaknesses of their design and understand how to improve their design for the future.

One site staff interview reported that it would be helpful if they received a summary of jurors' and technical reviewers' critiques of each design. As the Competition now receives many entries, having a summary of juror and technical reviewer feedback would be valuable to site staff to refer to when they go to make decisions about the actual building design at the site. This site staff interviewee said they had some visibility into the judging process during the Competition, but they would also like to receive summary information they can refer back to.

Participants also expressed frustration with the judging criteria as three past registrant and competitors specifically felt like the Competition judging valued innovative design concepts over technical documentation. One technically-skilled case study participant felt that technical aspects were undervalued in the Competition and specifically noted that the Competition published the design boards but not the technical documentation for the winning entries. This interviewee recalled it was difficult to learn from the technical designs of other competitors. In recent

Site Staff Interviews

“It would be really, really interesting if we got something that was a consolidation of these are the really impressive, key ideas that seem the strongest and most viable. Then, here's where people were pushing the boundaries that might be worth further investigation, both from a calculations standpoint, but also from that design side. It would be nice to have something other than the entries themselves, something that was explanatory about the best thinking that was brought in from the jury and the review side.”



Case Study Interview

“So, we had spent probably \$100,000 and a month of effort, and pretty in-depth study and design, and I know that folks looked at it carefully, but we didn't really ... we didn't get ... Four bullet points just was not really all that useful...You would probably want them to say, "These were the things that were striking about the project. These are the potential shortcomings of the project, or concerns that we would have about this specific project... I mean, just tell us a more in-depth analysis of what made the decisions, what was striking about the project...”



years, the Competition has evolved to require more technical information on the design boards and has begun publishing the technical portion of Competition entries on the website. Another case study respondent who participated in the Competition more recently felt the competition was more focused on technical data and therefore more objective than other design competitions he previously participated in.

This disconnect in perspectives is likely reflective of an industry-wide challenge, as the technically-skilled case study respondent sees architects frequently struggle with technical documentation. One juror who specializes in industry-leading ZNE research echoes that he often sees architects struggle with incorporating ZNE concepts that are technically feasible. For example, architects often adopt concepts from ZNE buildings in other locations without regard for changes in climactic context. Nevertheless, the case study respondent believes it is important for the Competition to lead the industry in the right direction by enforcing technical requirements and ensuring competitors have a chance to learn how to meet technical requirements through the Competition. Technical reviewers reported their role is to check the technical feasibility of the design and then pass this information to the jurors. One case study interviewee believes the Competition should strive towards balancing technical and design criteria, which would mean that these criteria are weighted similarly. A juror also agreed the two types of criteria should both be included in the final judging.

One juror also suggested the Competition move towards giving competitors standardized feedback that helps educate the competitors about the strengths and weaknesses of their designs. This juror noted that it was challenging to review all of the submissions in a short period time and giving the jury a simple rubric with criteria they could use to evaluate all the submissions could help the jury review the submissions in an efficient and standardized way. Another juror suggested the Competition should send jurors and technical reviewers as much information as possible about the design challenge and submittals ahead of the competition so they can maximize their allotted judging time. One technical reviewer suggested selecting a smaller site for the design challenge which would allow the jurors and technical reviewers to complete more rigorous and accurate evaluations of the submissions. A few respondents also suggested the Competition should consider incorporating different design focuses. Given California's climate goals, several jurors and technical reviewers said they would like the Competition to focus on Zero Net Carbon instead of Zero Net Energy. One juror interviewee would specifically like to see resilience to climate impacts incorporated into designs. Another case study team suggested the Competition could focus on a type of design known as "well-building" and include the health and well-being of occupants as a judging criteria in the future. In addition, past registrants and competitors suggested the Competition should focus on a variety of new topics including experimental housing solutions, wellness, carbon emissions considerations, and retrofits.

Site Staff Interviews

"90% of what people implemented was probably all the same, but we'd have to really dig to find the 10% of new ideas that were brought out and hopefully we ran across them during the final presentation, but in truth as I'm reflecting on it, I'm realizing that we may have missed some real jewels in the rough because there wasn't this sort of post-review analysis or summary to capture all those ideas and then disseminate them to the field."



Case Study Interview

"I mean, I think that the (ZNE) program that California started and implementing this into their code, it's important. I think it's important for our industry to treat it that way, and for the focus in our industry to really want to understand this and you know, train themselves, and you know, have the ability to because if nobody understands it, then the (ZNE) program's useless... "





EDUCATE

Findings

- Registrants and competitors have varying perceptions of the meaning of ZNE and Ultra low Energy Building Design.
- Participants understand the benefits of ZNE building design.
- The Competition is educating all participants about ZNE design techniques.
- The Competition is helping to educate energy efficient building experts about pain points in the ZNE industry.
- All groups would like to see improvements in feedback and judging criteria.

Recommendations

- Consider refining and completing a rubric with different design and technical criteria to score the competition submissions.
- Ensure the technical panel and jury complete the rubric to share with competitors.

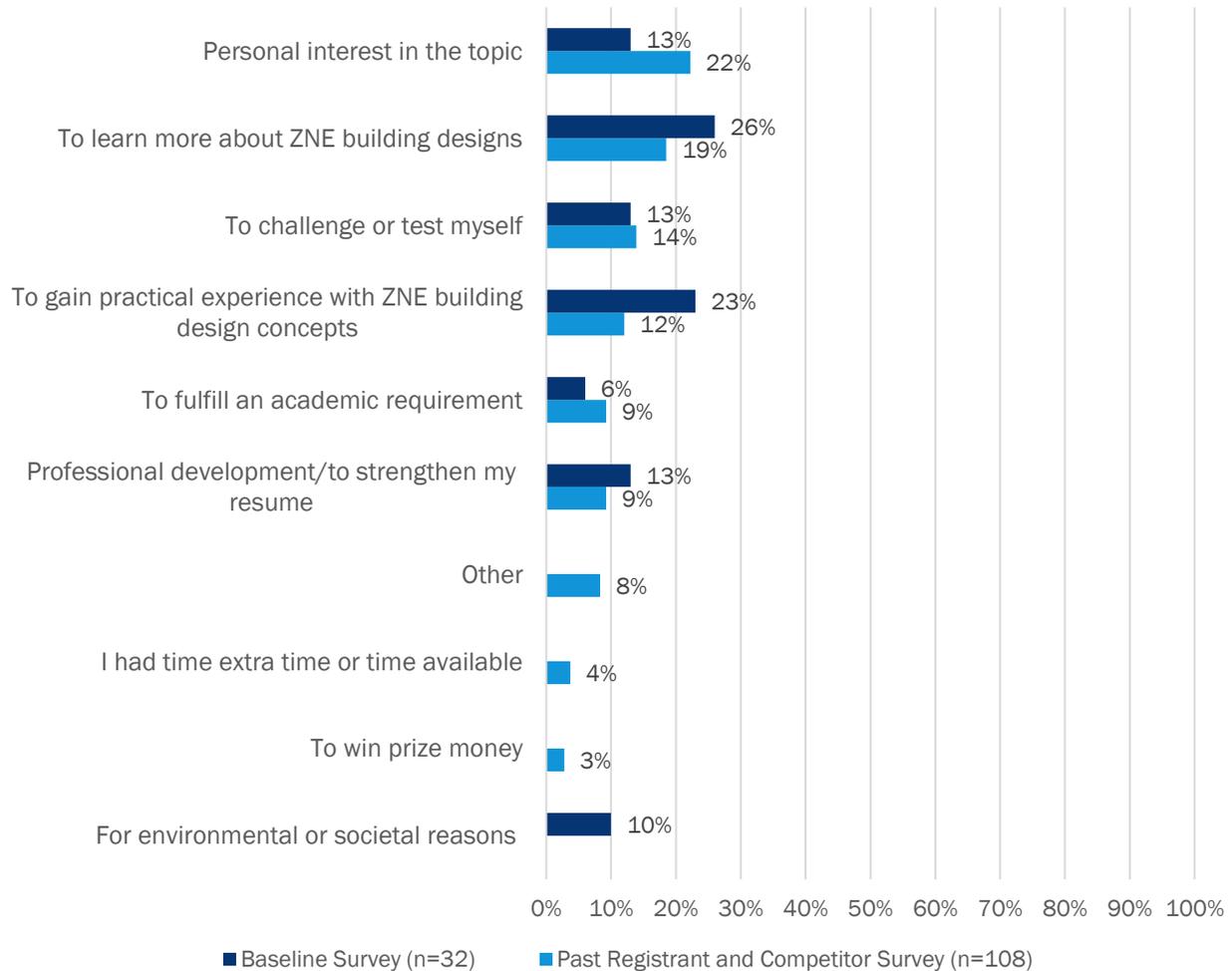
4.3 Motivate Findings

Just as the Competition is meant to educate participants about how their design techniques should change to achieve ZNE, the Competition is also designed to enhance participants' desire to pursue ZNE building designs. To better understand the drivers of participants' motivation to design ZNE buildings we asked participants about why they originally decided to register for the Competition. We found that participants were motivated to participate by personal interest in ZNE and the opportunity to gain experience and learn more about ZNE designs and concepts. In addition, we explored the role the Competition is playing in motivating participants to pursue ZNE designs outside of the competition and found that participants feel positively about their experience with developing a ZNE design through the Competition. In addition, multiple groups suggest the Competition could further motivate both competitors and the design community by making an effort to expand post-Competition promotional efforts and knowledge transfer.

Key finding: Personal interest in ZNE and the opportunity to gain experience and learn more about ZNE designs and concepts were key motivators of Competition participation

We asked all groups why they decided to participate in the Competition either as a competitor, judge, technical reviewer, or site host. Current registrant survey respondents, past registrants, and past competitors identified a variety of factors that motivated their participation in the Competition with the most frequent being personal interest in the topic and the opportunity to learn more about ZNE building designs and concepts (Figure 12).

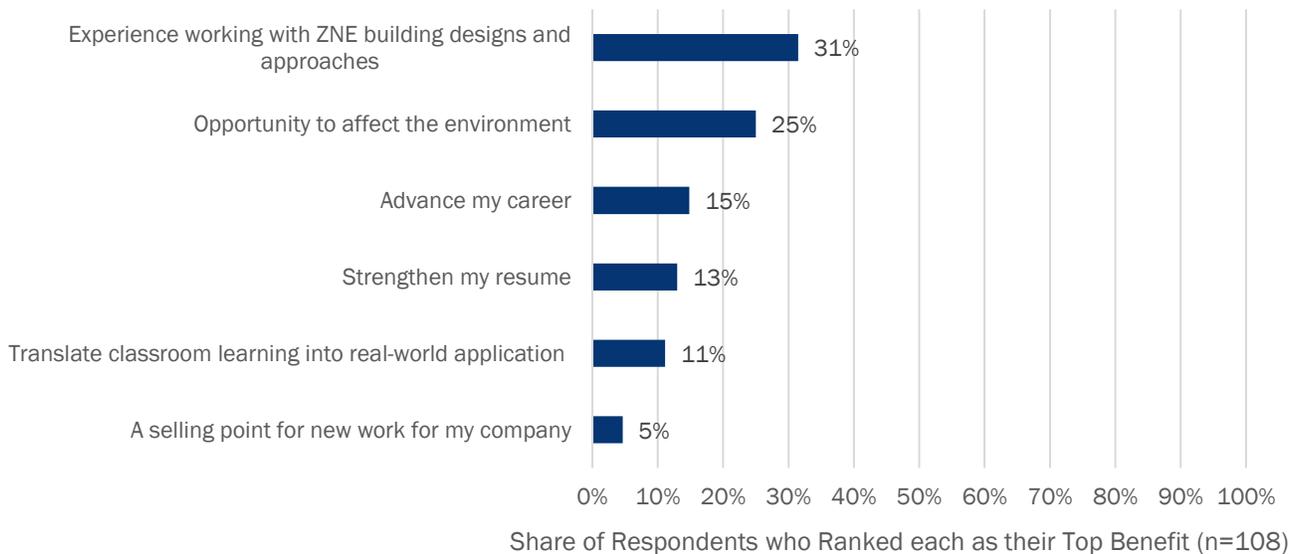
Figure 12. Why did you decide to register for the Competition?



Site staff were most frequently motivated to take part in the Competition because the mission and timing of the Competition fit with the design goals and timeline for development of their site. Several interviewees had goals of incorporating sustainable design concepts into their buildings and were hoping to get ideas for specific design techniques and elements for minimizing energy use from the Competition. Some interviewees were motivated to serve as jurors or technical reviewers for the Competition because they see value in the opportunities the Competition provides to engage with other leaders in the industry. Juror and technical reviewers also decided to participate, because they believe in the mission of the Competition and the Competition helps them stay up-to-date with the latest developments in the efficient design industry. One interviewee sees their contribution to the Competition as a worthwhile use of their time and as something that will help move the design market forward.

We also asked past registrants and past competitors about the benefits they expected would result from participating in the Competition. We provided past registrants and past competitors with a list of potential benefits, and asked them to select the applicable benefits they expected to realize from the competition, and rank them (Figure 13).

Figure 13. Top Benefits Registrants and Competitors Expected to Realize from the Competition



Respondents' rankings of the benefits they expected to see from the Competition aligned with their motivations for registering in the Competition as respondents most frequently ranked experience working with ZNE building designs and approaches as their top benefit. Registrants and competitors may value experience working with ZNE designs and approaches because they don't have an opportunity to gain this experience through architecture school or traditional design projects. To illustrate this point, one case study participant explained that architecture graduate schools tend to focus on "blobitecture" or more dramatic designs and this participant felt the Competition would help their team transition to the type of work they planned to do after graduate school by giving them the opportunity to design realistic and functional buildings. We also gave respondents the opportunity to write in additional benefits they realized through the Competition and these benefits included the opportunity to collaborate with other experts in the field; access to networking opportunities; and, opportunities to develop time management skills.

Case study teams, jurors, and technical reviewers had suggestions for motivating competitor interest in the Competition in future program years. One case study participant believes that more unique building types and sites, such as the marine science visitor's center facility that is the focus of the 2017 Competition draw more interest in the competition. Similarly, another case study team appreciated that the sites selected for the Competition have had unique characteristics that present interesting design challenges. In addition, case study teams, jurors, and technical reviewers reported that selecting a site where there are official plans to construct a building in the future also helps to generate interest in the Competition. One case study team reported they would like to see more of a realistic opportunity to have their firm bid and work on the final project. Case study participants also identified the low cost of registration and the fact that designs can be submitted digitally as factors that encouraged them to enter the Competition.

Key finding: All participants were very satisfied with their Competition experience

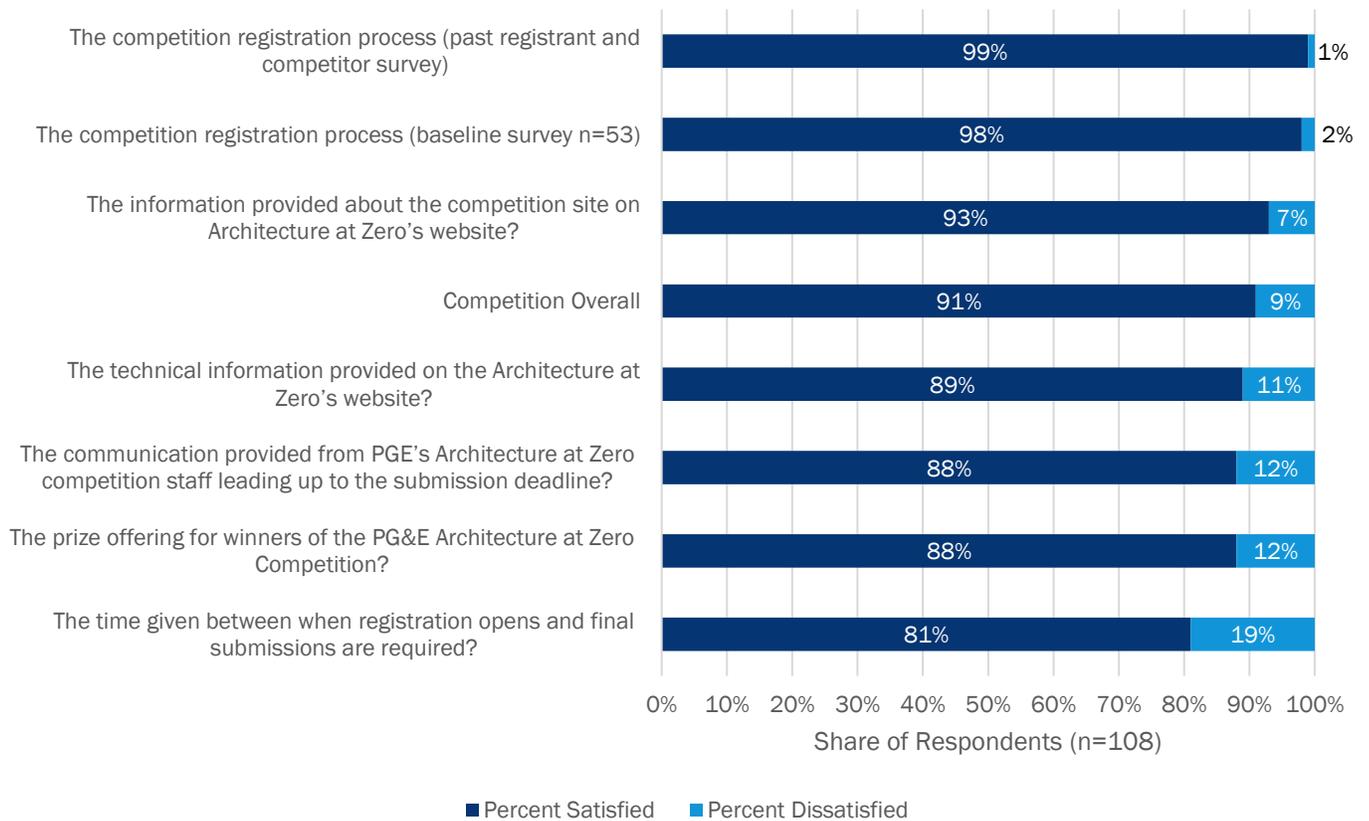
Participants' perception of their experience with the Competition can influence their motivation to pursue ZNE design after the Competition ends. Overall, most past registrant and competitor respondents were satisfied with their Competition experience (91% of registrants and competitors were somewhat satisfied, satisfied or very satisfied) (Figure 14). Past registrants and competitors were most satisfied with the Competition registration process and their communication with Competition staff. Two case study interviewees explained that the Competition staff members were very prompt to answer their questions. These interviewees appreciated that the Competition staff posted answers to competitors' frequently asked questions on the website so that all competitors received the same information. While satisfaction was high for all program elements, participants were least satisfied with the technical information provided on the Competition website and the time given between when registration opened and when final submissions were due.

Site Staff Interviews



“I think it tends to be focused on informing the design community, which is a good thing. I think you might also think about trying to get it out to public institutions that build buildings with a longer view, so cities, counties, community colleges, find a way to get it out to the presidents or the facilities directors in those venues might be something that the PG&E thinks about. How do you get it out to your customer base who are building new buildings? Then the other one would be the development community, whether it's through the Urban Land Institute or through the real estate press, to educate the development community that it is not landing a man on the moon to build the ZNE building.”

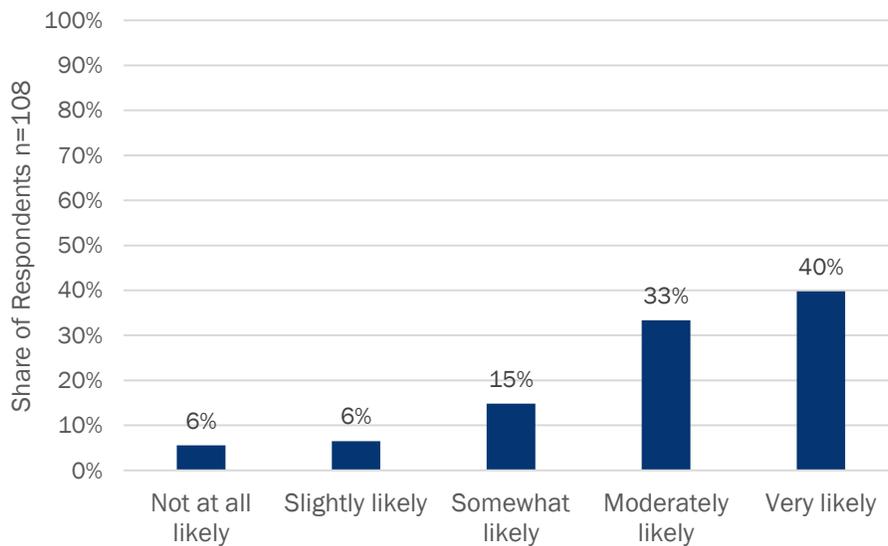
Figure 14. Past Registrant and Competitor Mean Level of Satisfaction with Competition Components



Notes: Percent satisfied represents respondents who said they were somewhat satisfied, satisfied or very satisfied. Likewise percent dissatisfied represents respondents who said they were somewhat dissatisfied, dissatisfied, or very dissatisfied

Eighty-eight percent of respondents were somewhat likely, moderately likely, or very likely to recommend PG&E's Competition to a friend or colleague. Of those likely to recommend, 65% had already recommended the Competition to a friend or colleague (n=79) (Figure 15).

Figure 15. How likely are you to recommend the PG&E's Architecture at Zero Competition to a friend or colleague?



All site staff managers were also very satisfied with their interactions with Competition staff and their overall experience with the Competition (n=6). Site staff interviewees also felt that Competition staff were very well-organized, worked well as a team, and did an excellent job of managing the Competition. A few site staff specifically appreciated that Competition staff managed the competition in such a way that the amount of time site staff were required to commit was minimal.

All juror and technical reviewer interviewees were also very satisfied with their overall Competition experience (n=10). Similar to the site staff, jurors and technical reviewers expressed that the Competition staff was well-organized and had good communication skills. Most jurors acknowledged that they had been involved with other competitions and appreciated the fact that the Competition ran smoothly without a hitch.

Key finding: Multiple groups suggest the Competition could further motivate participants by making an effort to expand post-Competition promotional efforts and knowledge transfer

Site staff, past registrants, and past competitors believe the competition submissions are valuable and efforts should be made to draw attention to submissions after the competition ends.

Site Staff Interviews

"We basically told them what we were thinking in terms of the site and what our hopes were and the PG&E staff and consultants just ran with it and made it really a pleasure for us to work with, not at all a distraction to our day-to-day work"



Juror Interviews

"For juries that I've been on, that one was one of the best ever, and it's because the staff ran it really, really well, and very firmly with good understanding of the issues."



"The communication was excellent, the organization was outstanding. So it made it very easy for us to come in."

One site staff manager suggested Competition staff should expand efforts to publicize the Competition results after the Competition concludes. This site staff interviewee suggested that Competition should expand publicity efforts to groups outside the design community that have a stake in new building construction. Examples of these stakeholders include planners from cities, counties, and community colleges.

One student case study participant, who received an award through the Competition, said they would have valued exposure and PR regarding their success in the Competition over a monetary award. This respondent had several suggestions for increasing the visibility of winners and raising awareness of the Competition within the design community, including hosting a networking reception for the winners and pushing more publications about the Competition to industry news outlets. Similarly, one site staff interviewee said they wished winning teams had an opportunity to give a more in-depth presentation of their designs to help site staff better understand how to integrate competitors' submissions in the final building design. These presentations could be recorded and made available on the Competition website. The site staff interviewee believes this type of marketing opportunity might motivate more teams to complete submissions.

Another case study interviewee acknowledged the Competition may have some influence on the design community through influencing how individual competitors think about ZNE design. However, this interviewee believes the development of hundreds of submissions featuring innovative designs over the years are what really hold the potential to advance the design profession. As such, this interviewee believes the Competition should put more effort into disseminating these submissions to the design community.

Site staff echoed the importance of disseminating results as one site manager suggested it would be helpful if site staff managers received copies of the presentations and other Competition materials in a digital format so they could refer back to competitors' designs as a resource over time.

Case Study Interview



“After the competition, I just try to see how much influence has this had just on architecture websites. I only found, maybe, one or two websites with an article on it. Every now and then, ArchDaily will pick up on it and then they'll make a post on it. I think if Architecture at Zero goes to ArchDaily and say, “Hey, we want you to write a post about the winners that just won...” That has a lot of visibility within the design community.”



MOTIVATE

Findings

- Personal interest in ZNE and the opportunity to gain experience and learn more about ZNE designs and concepts were key motivators of Competition participation.
- All participants were very satisfied with their Competition experience.
- Multiple groups suggest the Competition could further motivate participants by making an effort to expand Post-Competition promotional efforts and knowledge transfer.

Recommendations

- Develop a summary of Competition submissions and disseminate this summary to site staff and the design community to drive increased learning.
- Consider sponsoring a post-competition event where the winners have the opportunity to present—either in person or through web means—their designs to site staff and the general public. Record these presentations for the future.
- Consider increasing the exposure of the competition and winners through industry publications, media outlets, and planners with an interest in developing ZNE buildings.

4.4 Empower Findings

After participants are equipped with new knowledge of ZNE approaches and motivated to change their building practices the last step in the Competition is to (1) increase participants' perception and reality of self-efficacy and (2) empower participants to start incorporating ZNE designs and approaches into buildings, thereby helping to stimulate the ZNE design market. We assessed how the competition is impacting respondents' perception of their own ability to design ZNE buildings and found that the Competition helps all groups develop proofs of concept which aids in proving the feasibility of ZNE to themselves as well as the design community. Furthermore, the Competition is helping to address the barrier of participants' ability to develop technically feasible ZNE designs by encouraging participants to overcome the gap between architects and technical experts. There are further opportunities for the Competition to help bridge this disconnect between architects, and builders. We also explored how the Competition is empowering participants to incorporate ZNE designs and approaches into buildings as well as developing full-scale ZNE buildings by asking competitors and site staff about how they applied concepts learned through their Competition experience to future buildings designs. The results demonstrated that the Competition is empowering a change in building practices and that the Competition is having impacts on design markets beyond California. These findings are further discussed in the section below.

Key Finding: The Competition creates proofs of concept and helps encourage market transformation

We assessed how the Competition is impacting respondents' perception of their own ability to design ZNE buildings by first identifying perceived challenges to developing ZNE and then evaluating how the Competition is addressing these challenges. We asked juror and technical reviewer interviewees about the perceived drawbacks of ZNE buildings and interviewees said that there is a perception that ZNE buildings are too costly to design and construct because they can involve extra modeling and cutting-edge technology. These interviewees believe that concerns about cost-effectiveness are debunked when practitioners have the opportunity to gain practical experience with ZNE design concepts and approaches. As such, several respondents said they believe there are no drawbacks associated with ZNE buildings. These interviewees hope that the design community will begin to realize that ZNE buildings can be cost-competitive as more ZNE projects are completed. Similarly, other interviewees identified the fact that ZNE buildings currently comprise a small fraction of the total market share of new construction buildings as another perceived drawback to ZNE development. These same interviewees believe this challenge will be addressed as ZNE buildings begin to gain traction in the market and the industry capitalizes on economies of scale as new ZNE and new design standards are realized. One interviewee compared the current stage of the ZNE industry to the state of the solar industry before the widespread adoption of solar panels.

Some jurors and technical reviewers referred to the Competition as a type of market transformation because ZNE is still considered early stage and "futuristic" by the design community. These interviewees believe the Competition is a type of market intervention because it can help shift the prevailing opinion about ZNE in the design community from futuristic to realistic.

Both case study teams and site staff alike reported that the Competition helped to create a proof of concept that demonstrates ZNE building is feasible and eliminates perceptions of cost and complexity as barriers to ZNE development.

A few site staff managers went into the Competition with the goal of using the experience as a way of showcasing their building as a proof of concept for sustainable design techniques to build support for integrating high efficiency standards into future building designs. Depending on the stage of the project, these interviewees were specifically looking to gain support from potential project funders, architecture firms, other

Juror Interviews

"The market is slowly changing, but the building I think is just highly complicated so it takes a long time for things to happen, and [the Competition] is one of those things that help socialize the benefits and develop the skill sets to put these kind of packages together."



Juror Interviews

"What all the competitions do and all the PR and all the discussion and anybody entering the competition, what it does is it creates momentum. It just adds to the information base and to moving the market, moving us away from fossil fuels and creating solutions to the climate crisis. Everything that's done from the competition to the work that people do, all that stuff, everything that's done and the information that goes out from that, all works together to move us in a better direction on addressing this issue."



members of site planning and leadership teams, and the general public. Three site staff reported the competition helped prove to their target audiences that ZNE designs were feasible at their sites. One site staff interviewee who hosted the Competition during the early years when the ZNE industry was at a more nascent stage said they were able to use the design submissions as leverage to prove to the design community that ZNE design concepts could be completed at their site, which ultimately resulted in the construction of a ZNE building on the site. Another interviewee said they were hoping the submissions would encourage their partners to consider ZNE building designs, but their partners ultimately went in a different direction.

Key finding: The Competition is helping to overcome the design split between architects and technical experts although there are further opportunities to bridge this disconnect

Our research revealed that an additional challenge to developing the ZNE design industry is interdisciplinary communication and systems thinking. Multiple participants believe that moving the ZNE industry forward requires multiple industry groups interacting and working together. These participants specifically highlighted that designers, technical experts, and builders all need to be able to iterate and agree upon a design in order for ZNE standards to be realized. Participants noted the Competition is helping to address this challenge by bringing individuals with different types of expertise together to explore ZNE design concepts.

Case Study Interview



“I think there's a myth ... People hear net zero and they think it's mysterious and complicated, and maybe it's a little intimidating, but I think once we dove into it and really started to study and explore it, it's not as intimidating and mysterious as maybe people think, and I think that's a good thing, because I think clients get scared when they don't know what something is, so if we could help educate folks that this is not that ... it's not rocket science. There's things that can be done that are pretty straightforward to accomplish these goals”

Juror Interviews



“The Competition is more geared toward moving the, providing education opportunities, moving academia toward addressing these issues, rather than the people I work with. We're all there already, so it doesn't impact me or us that way. But what it does is, it helps to move the people who enter the competition, the schools, and that's where the impact is.”

Jurors and technical reviewers also believe the Competition plays an especially important role in shifting perspectives in academia. Technical reviewers commented that professors tend to specialize in either visual architectural design or more technical engineering concepts, leaving a gap between these two important components of building design. This phenomenon is known as the "design split." The design split makes it difficult for students to develop a balanced understanding of energy efficient design. ZNE building requires the integration of both technical and design techniques and the Competition helps expose students and academics to both of these building design approaches. Juror interviewees reported professional firms are ahead of academia in terms of recognizing the importance of this integration. As such, educating both professors and students about these topics is particularly important.

Furthermore, some jurors reported that the Competition brought together jurors, technical reviewers, and competitors from different backgrounds in the industry including design experts, technical energy modeling experts, professionals, and students. These interviewees reported that gaining exposure to this diversity of backgrounds helped them learn about cutting edge topics in other parts of the industry and the challenges associated with designing ZNE buildings from a more holistic perspective.

Juror Interviews

"...The design split, I'm sure you've heard of it before where the designers are on one side of the thing, and the technology people are on the other side of the equation. So that's how it is in many, many schools of architecture, but some schools are, and actually many firms now are recognizing and value that interaction, and that collaboration between the design, and the actual function and performance."



Technical Reviewer Interviews

"It's nice for me, as a technical person, to have the balance to see what it is that architects are thinking about when they're trying to communicate a design to their clients."



One case study team also reported that the Competition brought together people with different types of expertise from within their organization to collaborate on their submission. The Competition encouraged internal collaboration within this company in a manner than is not typical in their organizational structure.

Another case study participant explained why the design split is a crucial challenge for the ZNE industry to address. In practice, this respondent observes disconnects between technical specialists, the construction community, and the design community in regards to the development of ZNE buildings. This respondent elaborated that small details in ZNE building design plans can have a large impact on the actual performance of the building. As such, if designers create designs that are not technically feasible or contractors and technical specialists are unsuccessful at translating these designs into reality, then the building will not perform to ZNE standards from the very start of building construction. This case study participant reported that this is an ongoing challenge in the industry, because constructing these buildings requires ongoing feedback between the construction and design community. This interviewee feels this communication isn't happening frequently enough and believes the Competition can help address this challenge by altering judging criteria to motivate competitors to really think through the technical details and real-world feasibility of their designs. Technical reviewers added that one of the objectives of the competition is to encourage competitors to start thinking about both the technical and design components of ZNE building from a systems perspective.

The design course instructor we interviewed as part of one of the case studies, who had incorporated the Competition into one of his courses, suggested the Competition can further help address the design split by encouraging students from multiple different disciplines to enter the Competition. This interviewee specifically suggested the competition should reach out to students in mechanical engineering, electrical engineering, construction, and sustainability. Furthermore, this instructor suggested that he would like to open up their Architecture at Zero Course to students in different majors to build teams that foster interdisciplinary collaboration. This instructor identified the Solar Decathlon Competition, sponsored by the U.S. Department of Energy, as an example of a competition that encourages students to focus on interdisciplinary design. In 2017, the judging criteria for the solar decathlon focused on architecture, market potential, engineering, communications, innovation, and water

Case Study Interview



“At the end of the day like, if contractors keep looking at details that don't work, or don't perform, and just doing their own thing instead then they're just gonna stop looking at our details entirely... They could get ignored, or changed, and you know, most of the time I feel like the contractor understands what they're doing, but they might not, you know?... I mean, the way that design, and construction should work is they should be checks on each other, right? And the way it is working now is that there is no checks on each other.”

Case Study Interview



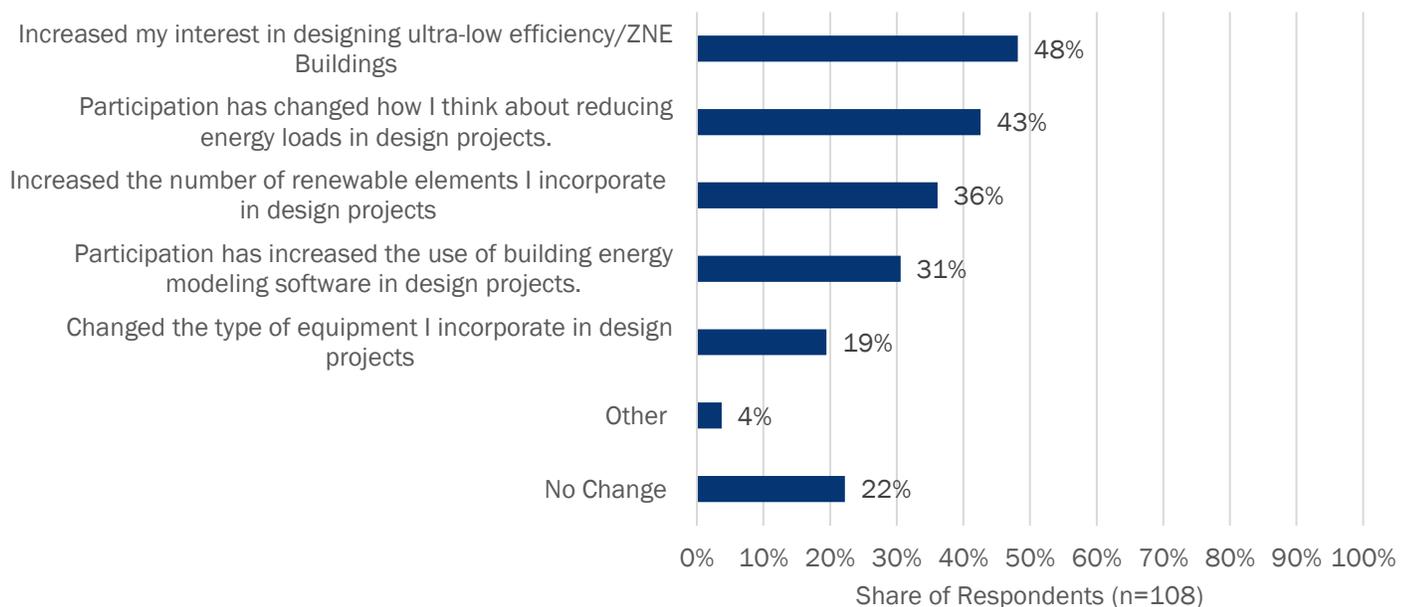
“It offered us an opportunity to work in a truly integrated manner. We talk a lot about it but sometimes we don't really deliver on projects, but this one offered us an opportunity to really design this with the engineers in the room and begin to think more holistically.”

and featured technical experts from each of these disciplines as jurors¹⁵. This instructor would like to see the Competition have similar criteria.

Key finding: The Competition is motivating a change in building practices

We explored how the Competition is empowering participants to apply the concepts they learned through the Competition to buildings they design after the Competition. Most site staff, past registrants, and competitors reported the Competition has had at least some influence on the way they design buildings since the Competition ended. The Competition successfully empowered past registrants and competitors to change the way they approach design projects, as 78% of respondents reported the Competition changed their thinking about at least one design aspect. Respondents most frequently reported the Competition increased their interest in designing ultra-low efficiency/ZNE buildings (48%) and changed how they think about reducing energy loads in design projects (43%).

Table 8. How has participation in the Competition changed the way you approach design projects?

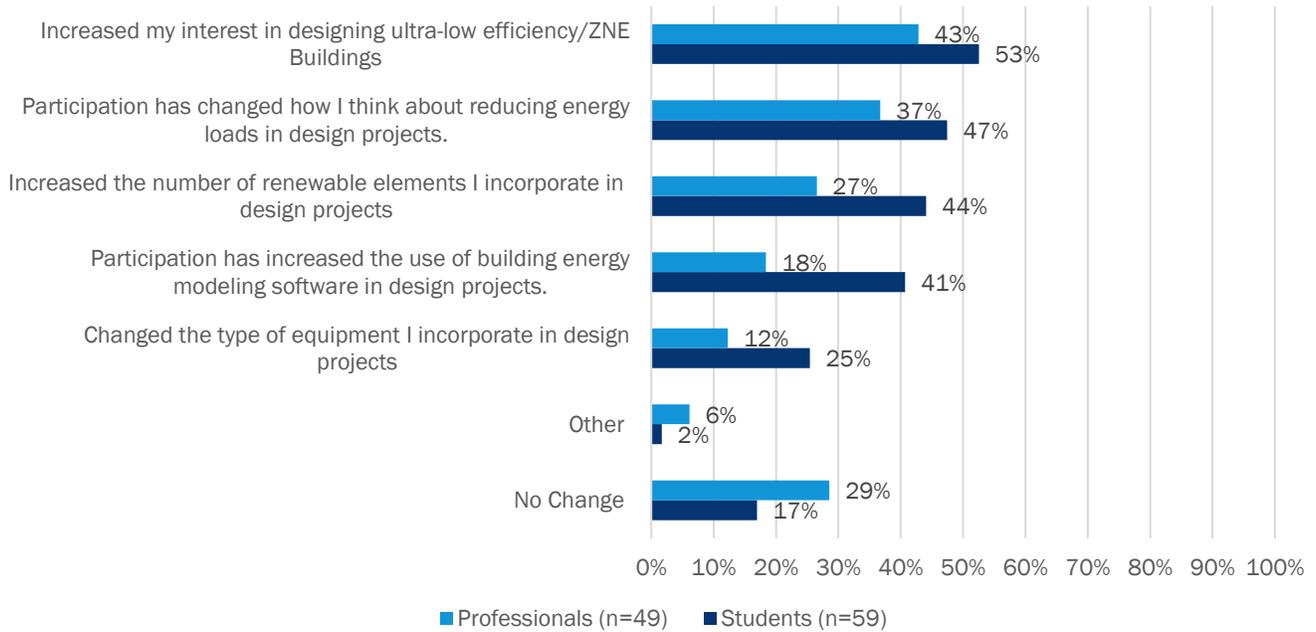


The Competition motivated lasting changes as 83% of respondents said the changes they made to the way they approach design projects persisted over time. Forty percent of respondents also indicated that they used their Competition experience to further their career. Over half of Competition participants (53%) indicated that they designed or worked on projects that use ZNE principles outside of the Competition (n=108). In addition, students were more frequently motivated to apply the lessons they learned through the Competition in other contexts. Figure 16 shows students reported the Competition empowered them to change how they approach design projects at higher rates than professionals for each of the five aspects of ZNE and ultra-low efficiency building design they were asked about. At the same time, professionals were more likely than students to report they used their Competition experience to further their career as 45% of professionals reported using the Competition to further their career, while 36% of students reported using their Competition experience to further their career. These results suggest that students and professionals may be realizing different benefits

¹⁵U.S. Department of Energy. "Solar Decathlon 2017". Retrieved from: <https://www.solardecathlon.gov/2017/competition-juries.html>

from their experiences with Competition as the students were more likely to realize educational benefits and professionals were more likely to realize career benefits.

Figure 16. How has participation in the Competition changed the way you approach design projects? (students vs. professionals)



The most common approaches competitors learned through the Competition and later applied after the Competition included shading studies (54%), climate analysis (50%), strategies to reduce energy loads (47%), building envelope considerations (47%), passive system strategies (46%) and lighting considerations (45%) (Table 9).

Table 9. ZNE Principles and Approaches Past Registrants and Competitors Learned through the Competition Applied after the Competition

ZNE Principles and Approaches	Share of Respondents who Used Principle or Approach After Competition (n=108)
Shading studies	54%
Climate analysis	50%
Strategies to reduce energy loads	47%
Building envelope considerations	47%
Passive system strategies (e.g. natural ventilation)	46%
Lighting considerations	45%
Integration of solar power into design	38%
Occupant behavior considerations	33%
Space conditioning considerations	31%
Water heater considerations	29%

ZNE Principles and Approaches	Share of Respondents who Used Principle or Approach After Competition (n=108)
Energy Use Intensity (EUI) metrics	28%
Appliance considerations	26%
Increased knowledge regarding specific equipment/measures (e.g. insulation, lighting controls, energy star appliances, smart strips, etc.)	26%
Integration of wind power into design	25%
Whole building energy modeling software	23%
Controls and related strategies	20%
Plug load considerations	19%
Integration of biomass/biofuel into design	15%
Other, specify	9%

Case study teams reported having varied experiences with incorporating the design concepts they learned through the Competition into projects after the Competition. Two case study team highlighted that the Competition allowed them to test out more innovative designs they wouldn't have had an opportunity to use in traditional design scenarios, specifically building envelope improvements and occupant behavioral techniques. Another team wanted to include more innovative design components, such as occupant behavioral approaches, in their submission but they felt there wasn't room on their submission design board to communicate these design aspects. Another case study interview applied the shading and climate analysis techniques they learned through the Competition to their current projects and also think more about applying glazing to windows in their designs.

We asked case study interviewees who are design professionals to describe how they would modify their design if their Competition submission was a real project they were developing for a client and there was no ZNE mandate. These two interviewee teams explained that they currently suggest several design components in their submission to their clients. This by default includes LED lighting and occupant behavioral techniques. At the same time, these interviewees said they probably would not include the less-proven and more expensive components of their submissions in their real-world designs. However, they indicated that the Competition provided a great opportunity for these participants to think more about emerging technologies that they may want to incorporate in their designs in the future. Examples of these technologies include emerging energy generation technologies and new construction materials.

Case Study Interview



“Yeah, we want to dream through competitions, at the same time, we want to make them achievable so that they are true, they can become a true project, really, in a way, so it's not just a drawing but it's something that has potential for it to be an actual project, so that drives us, really, that innovation that is achievable.”

Table 10 shows the Competition is also motivating changes in design practices within the organizations that host the competition sites. Overall, site staff reported that the Competition has had limited influence on the final designs developed at the actual Competition sites to date and a significant influence on how their organizations approach new projects after the Competition. Several site staff interviewees reported that the

Competition shifted the way these organizations think about building designs, provided them with proofs of concept, and given them new ideas for concepts and approaches to incorporate into future building designs.

One case study team acknowledged that site staff did not secure the level of funding required to design a ZNE building on site by the time the Competition concluded. This could be one of the reasons why Competition designs are not being incorporated into the final building design at the site, but incorporated into later building designs as site staff has more time to secure funding for ZNE developments that begin after the Competition ends. This team elaborated that structuring financing for ZNE buildings is a common challenge in the industry as buildings often have separate maintenance and capital budgets, and ZNE buildings generally result in higher capital costs but the savings are realized through reduced maintenance costs. This team elaborated that currently green loan programs are not available to help developers overcome financing challenges specific to ZNE. As such, this team recommended the Competition focus on securing funding for a ZNE building at the site before the Competition begins so that competitors might have a more realistic opportunity to contribute to the final building design.

Examples of fundamental changes that site organizations have made to their building design processes after the Competition include shifting the way their organization hires architects to work on projects. One site staff interviewee appreciated how they were able to learn about design concepts from multiple teams with different types of expertise through the Competition. This experience motivated this site staff interviewee to hire multiple different teams with different areas of expertise to plan and collaborate on their site design instead of hiring one firm which is customary. Some organizations reported the Competition has had an influence far beyond the site selected for the Competition, as one site staff manager reported their organization began having internal meetings to discuss opportunities to incorporate ZNE design across their entire university campus. In addition, the Competition exposed the staff at another site to new building design concepts—such as shared vehicles, using electric end-uses instead of gas, and green roofs—that they plan to incorporate into new construction projects moving forward.

Table 10. Influence of Competition on Final Site Design and Organizational Approach to Building Design

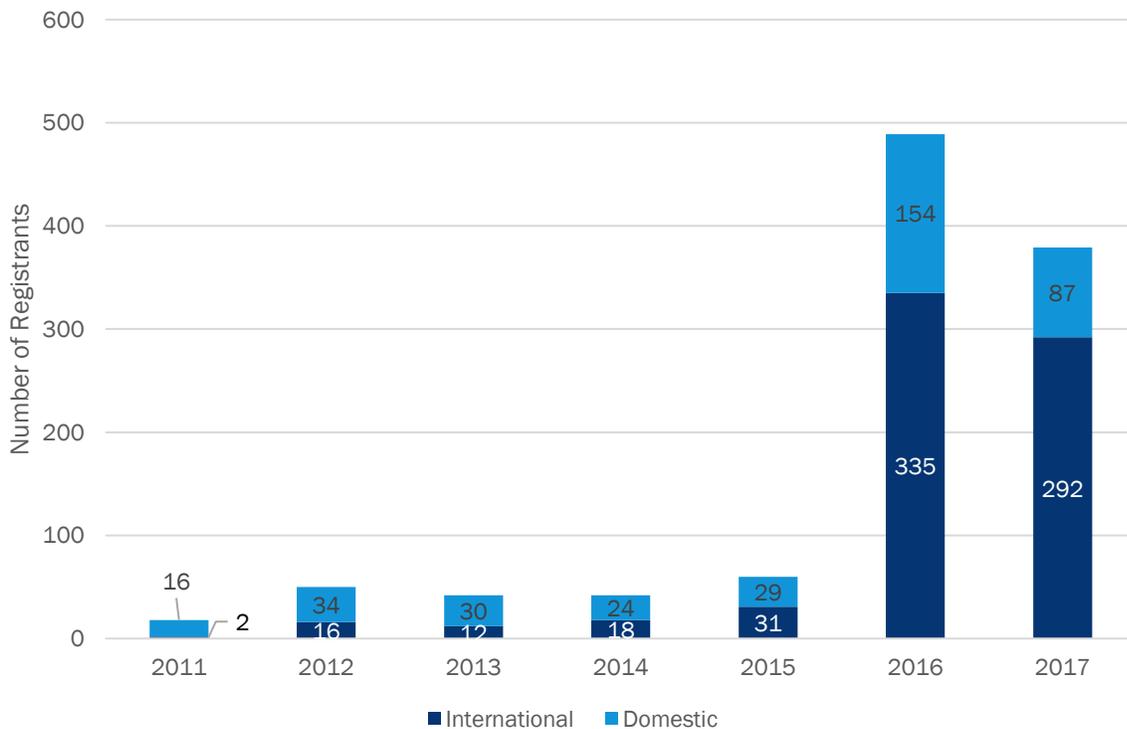
	Status of Site	Incorporation of Submissions in Final Site Design	Additional Influences of Competition
2011	Planned development	N/A	N/A
2012	Construction Phase	Final submission was not incorporated in final design, but submissions influenced the design of other buildings near the Competition site.	The Competition provided ZNE proofs of concept for planning the construction and design of other buildings in the "district" around the site. The Competition is influencing conversations about planning at the site.
2013	Construction Phase	Submissions had no influence on final design	Increased public awareness around the site
2014	No project currently being developed on site	Foresee using submissions at the site in the future	Incorporating concepts learned through the Competition in other building designs
2015	Developing plans for student housing onsite	Submissions are being incorporate into the final building design	Organization has had meetings to discuss incorporating ZNE designs in across the entire campus

	Status of Site	Incorporation of Submissions in Final Site Design	Additional Influences of Competition
2016	Scoping project on site	Site staff plan to incorporate submissions in project design	Shared submissions with design consultants, hired multiple design teams with different backgrounds after experience with the Competition
2017	Fundraising for project on site	Site staff plan to incorporate submissions in project design	N/A

Key finding: The Competition is having impacts on design markets beyond California

Participant data and survey results also showed that the Competition’s influence on building design practice changes extends beyond California. This is evidenced by the fact that the number and share of international registrants grew year over year over the Competition’s existence with a dramatic increase in entries from 2015 to 2016 (Figure 17).

Figure 17. Number and Share of International vs. Domestic Registrants by Competition Year



Most of the growth in entries between the 2015 and 2016 Competition years came in the student category. The number of student entries grew from 24 to 389 from 2015 to 2016, while the number of professional entries grew at a slower rate from 35 to 100 (Table 11). In addition, from 2015 to 2016 the number of international student submissions increased more than the number of domestic student submissions.

Table 11. Number of International and Domestic Entries by Students and Professionals

Competition Year	Number of Entries				Total ¹⁶
	Domestic Students	International Students	Domestic Professionals	International Professionals	
2011	4	1	12	1	18
2012	16	7	18	9	50
2013	14	4	16	8	42
2014	14	14	10	4	42
2015	10	14	19	16	59
2016	100	289	54	46	489
2017	64	250	23	42	379
Total	222	579	152	126	

California is at the forefront of pushing efficient building design and past registrant and competitor survey results indicate the Competition may be helping to educate competitors from areas where efficient building designs and technologies are less developed. For example, one past registrant and competitor team from Russia explained that ZNE technology is still at an early stage and they were motivated to participate in the Competition because they wanted to help move Russia’s progress towards developing ZNE building technology forward. Another past competitor was asked to participate in a conference to discuss the potential of completing ZNE buildings in Montreal, Quebec as a result of their participation in the Competition. Similarly, one case study team was from Florida, and they noted that ZNE in Florida is just beginning to gain interest, but they hope to be able to draw on their Competition experience to take advantage of new ZNE opportunities in Florida as they arise.

¹⁶ In some cases, the total does not match the total in Figure 17 because some submissions were missing a student or professional designation.



EMPOWER

Findings

- The Competition creates proofs of concept and helps encourage market transformation.
- The Competition is helping to overcome the design split between architects and technical experts although there are further opportunities to bridge this disconnect.
- The Competition is motivating a change in building practices.
- The Competition is having impacts on design markets beyond California.

Recommendations

- Consider focusing on recruiting and engaging students in other disciplines outside of architecture such as environmental studies, sustainability, construction, and engineering if the goal is to expand the reach of the Competition.
- Consider including feasibility of construction as a design criteria and bring in jurors with expertise in construction to judge the submissions.

Appendix A. Survey Instruments and Interview Guides



September 2017

Introduction

The evaluation team will conduct ten semi-structured individual interviews with technical reviewers or jury members to understand their experiences in the Competition. The goal of the interviews is to understand how they became aware of the Competition; what drove them to participate; their satisfaction with Competition processes and the overall experience; observed changing trends in ZNE principles and design approaches through Competition years; and, the perceived value of participating in the Competition as a technical reviewer or jury member. The interview guides will be catered to the juror/technical reviewer (past, present, reoccurring).

Roles/Responsibilities

1. What is your current occupation? What kind of work do you do?
2. Please briefly describe your role as a [technical reviewer/juror] for PG&E's Architecture at Zero Competition.
3. My understanding is that you were involved in the Competition in [YEAR(s)]. Is this correct?

Engage

4. How did you first get involved with the Architecture at Zero Competition?
5. How would you describe your experience working with the Competition Staff and your satisfaction with the Competition process and participation as a [Reviewer/Juror]? [PROBE: Is there anything you would improve? Do differently? Why?]

Education and Behavior

Now I'd like to talk more broadly about ultra-low energy or Zero Net Energy (ZNE).

6. Please describe your involvement and familiarity with ultra-low energy and ZNE building design and approaches before participating as a [Reviewer/Juror] in the Competition. What industry resources do you use to keep up to date with ZNE principles and approaches and market changes?

7. What ZNE principles and approaches have been a focus within the Competition? Has your knowledge and skills increased through your involvement with the Competition? Through reviewing and evaluating submission designs?
8. What is the impact of participating as a [Reviewer/Juror] in the Competition on your [Day Job]?
9. How has your perception of ZNE building design changed over the course of the Competition?

Motivations

Thinking about your motivations for participating in the competition as a [Reviewer/Juror]...

10. Why did you decide to participate as a [Reviewer/Juror] in Competition?
11. What value has there been for you personally and/or professionally in participating in the Competition as a [technical reviewer/jury member]?
12. What are the perceived benefits and drawbacks of ZNE and the Architecture at Zero Competition on the design market?

Empowerment

13. How do you feel the Competition is impacting and changing the ZNE market?
14. Have you observed changing trends in ZNE principles and design approaches through Competition years?
15. Is there any additional information you would you like to provide?



September 2017

Introduction

Opinion Dynamics will conduct an in-depth interview with site staff representatives from each of the seven challenge sites, with the goal of capturing their perspective on the competition and understanding how the designs influenced the eventual site design and future projects. The interview guides will be catered to the organization/company of the site, past vs present sites, and the stage of building development at the site.

Roles/Responsibilities

1. Please briefly describe your role in [Organization].
2. How did you get involved with the Architecture at Zero Competition?
3. My understanding is that your site was the focus of the [Year] Competition. Is this correct?

Engage

4. How did you first learn about the Competition? How did the site get involved and selected for the competition?
5. What information did you provide on the site and what interactions did you have with Competition staff? With Participants?
6. How would you describe your experience working with the Competition Staff and your satisfaction with competition processes? [PROBE: Is there anything you would improve? Do differently? Why?]
7. Please describe your satisfaction with the overall competition experience? [PROBE: Is there anything you would improve? Do differently? Why?]

Education and Behavior

Now I'd like to talk about the idea of ultra-low energy or Zero Net Energy (ZNE) more broadly.

8. How familiar were you with ultra-low energy and ZNE building design and approaches before participating in the competition? Was your [organization] considering ultra-low energy design for this project prior to it being the focus of the [Year] Architecture at Zero Competition? How about ZNE? Renewable energy?

9. What ZNE design principles and approaches have you learned through lending the site for the Competition?

10. Was a project developed on the competition site?

[If yes] How many design submissions did you look at to pull ideas for your site? Were ZNE elements and designs from the Competition utilized at the site in the eventual design? If so, how did the site utilize the Competition designs?

- a. Were all the competition entries taken into consideration during the final design or were only the winning entries looked at for ideas? Were there any specific design aspects or specific entry that stood out?
- b. Were there ZNE elements incorporated that likely would not be part of the design had it not been a Competition Challenge site?
- c. How influential were the challenge projects in changing the eventual design?

[If no,] Was it ever intended to develop the site as presented in the Competition? Are there plans to develop the site in the future? Do you foresee the competition entries being utilized as a source for developing the site?

Motivations

Thinking about [ORGANIZATION]...

11. Why did [ORGANIZATION] decide to lend this site for the Competition? What were your goals going in to the competition? What were you hoping to get out of the design submissions and suggestions?
12. What are the different benefits you experienced by participating as a competition site? Challenges?

Empowerment

13. How has participation in the Competition changed the way you approach projects within your [ORGANIZATION]?
14. Did the Competition design entries influence future projects? If so how?



**PG&E Architecture at Zero
Registrant Web Survey
Final – August 2017**

Survey Overview

The goal of this survey is to understand satisfaction with the competition experience, change in behavior, persistence of behavior change, and perceptions of the ZNE market of past competition entrants (including those who enter a submission). These surveys will be fielded via the web. We will send out surveys to a census of registrants and participants from the inception of the program (2011 – 2016 Competitions), with a target length of 10 minutes per survey. To incentivize survey participation, a sweepstakes of four \$50 Amazon gift cards will be offered for those who complete the surveys.

Outreach Approach

Past registrants and competitors will be invited to take the survey via an email invitation and two email reminders, as needed.

E-mail Invitation

From: Melanie Munroe, Senior Survey Research Manager	[ArchatZero@opiniondynamics.com]
Subject:	PG&E Needs Your Input

E-mail Text:

Dear [Name],

Thank you for your involvement in Pacific Gas & Electric (PG&E)'s Architecture at Zero Competition.

PG&E is working with Opinion Dynamics to get your feedback regarding this Competition. Your input is very important to us and will help improve our future competition communications.

Your responses are strictly confidential.

Please select the link below before DATE to take this important survey:

[INSERT UNIQUE URL TO SURVEY]

Your time and feedback is very much appreciated!

Melanie Munroe
Senior Survey Research Manager
Opinion Dynamics

Survey Instrument

[SAMPLE VARIABLES

TYPE:

1=Past Entrant/Registrant Only

2=Past Submission

YEAR: (Competition years from sample)]

Introduction/Screener

Thank you for taking this survey. Your input is very important to PG&E and will help to improve future Architecture at Competition communications. Your responses will be combined with all other responses and will be kept strictly confidential.

S1. Our records show that you registered for PG&E's Architecture at Zero Competition in [YEAR], is that correct?

1. Yes
2. No

[ASK IF QS1=1]

S2. Did you register for the Architecture at Zero Competition in any additional years?

1. Yes
2. No

[ASK IF QS1=2 OR QS2=1]

S3. In which years did you register for the Architecture at Zero Competition?

Please select all that apply.

1. 2017
2. 2016
3. 2015
4. 2014
5. 2013
6. 2012
7. 2011
8. Unsure
9. None (SHOW IF QS1=2) THANK AND TERMINATE

[CALCULATE <YEAR_PARTICIPATE> FOR S4]

S4. To confirm, please let us know whether or not you submitted a proposed design for each year you entered the competition. Did you enter a proposed design submission for... [1=Yes, 2=No]

- a. [SHOW IF YEAR_PARTICIPATE=2016] The 2016 competition?
- b. [SHOW IF YEAR_PARTICIPATE=2015] The 2015 competition?
- c. [SHOW IF YEAR_PARTICIPATE=2014] The 2014 competition?
- d. [SHOW IF YEAR_PARTICIPATE=2013] The 2013 competition?
- e. [SHOW IF YEAR_PARTICIPATE=2012] The 2012 competition?
- f. [SHOW IF YEAR_PARTICIPATE=2011] The 2011 competition?

[CALCULATE VERIFIED YEARS VARIABLE FOR EACH YEAR]

[CALCULATE FLAG CALLED <MULT_YEAR> IF THEY REGISTERED IN MULTIPLE YEARS]

[IF MULTIPLE YEARS SELECT MOST RECENT YEAR AND IF THEY SUBMITTED THEN THE MOST RECENT SUBMISSION YEAR FOR THE SURVEY]

[CALCULATE VERIFIED VARIABLE

V_TYPE:

1=Past Entrant/Registrant Only

2=Past Submission]

S5. Thinking about the competition in [VERIFIED YEAR], how many people did you register with on your team for PG&E’s Architecture at Zero Competition? (If you only registered for yourself, please enter “1”.)

[NUMERIC OPEN END]

S6. Thinking about the competition in [VERIFIED YEAR], did you register for the competition as a student or professional?

1. Student
2. Professional

Engage

EN1. How did you first learn about the Architecture at Zero Competition?

1. Email from the American Institute of Architects (AIA)
2. Postcard from the American Institute of Architects (AIA)
3. American Institute of Architects (AIA) website
4. Architecture at Zero Competition website
5. My employer
6. My university
7. Word of mouth
00. Other, please specify

EN2. How satisfied were you with the competition registration process?

○ 1	○ 2	○ 3	○ 4	○ 5	○ 6
Very Dissatisfied	Dissatisfied	Somewhat Dissatisfied	Somewhat Satisfied	Satisfied	Very Satisfied

[ASK IF EN2=1,2,3]

EN2a. Why were you dissatisfied with the registration process? [OPEN END]

[ASK IF V_TYPE=1]

EN3. Why did you decide to register for the Architecture at Zero Competition, but not submit a design to the competition? [OPEN END]

[ASK IF V_TYPE=1]

EN4. What could the competition have done differently to make it easier for entrants to submit their design in the competition? [OPEN END]

[ASK IF V_TYPE=2]

EN5. What challenges did you experience when designing your competition submission?

1. Lack of information on the site specifications
2. Lack of technical resources available on the Architecture at Zero site
3. Lack of time to complete the design
4. The competition had to be deprioritized due to competing obligations
5. Lack of educational resources or mentors to answer technical questions
6. Competition requirements not clear
0. Other, specify

Education and Behavior

EB1a. What does ultra-low energy building design mean to you? [OPEN END]

EB1b. What does Zero Net Energy (ZNE) building design mean to you? [OPEN END]

EB2. Before entering the competition, which of the following ways, if any, had you learned about ZNE principles and approaches? Select all that apply. [ROTATE]

1. Educational courses
2. My employer – on-the-job training
3. Industry conferences
4. Other professional training events or sessions
5. Online
00. Other, specify
96. None of these

EB3. Before entering the competition, how familiar were you with ZNE principles and approaches?

○ 1	○ 2	○ 3	○ 4	○ 5
Not at all familiar	Slightly familiar	Somewhat familiar	Moderately familiar	Extremely familiar

EB3a. Why did you give that rating? [OPEN END]

EB4. As a result of the Architecture at Zero Competition, do you feel that your knowledge of ZNE principles and approaches, increased, decreased, or remained unchanged because of the competition?

1. Increased
2. Decreased
3. Unchanged

EB5. Have you designed or worked on projects that utilize ZNE principles outside of the competition?

1. Yes
2. No

[ASK IF EB5=1]

EB6. Please describe your experiences utilizing ZNE principles and approaches in design projects. [OPEN END]

EB7. What ZNE principles and approaches did you learn about through participating in the competition?

1. Specific definitions of ZNE (such as site vs. source definitions)
2. Energy Use Intensity (EUI) metrics
3. Integration of wind power into design
4. Integration of solar power into design
5. Integration of biomass/biofuel into design
6. Whole building energy modeling software (e.g. OpenStudio, eQUEST, NREL PVWatts Grid Data calculator, etc.)
7. Strategies to reduce energy loads
8. Building envelope considerations
9. Space conditioning considerations
10. Water heater considerations
11. Lighting considerations
12. Appliance considerations
13. Plug load considerations
14. Occupant behavior considerations
15. Shading studies
16. Climate analysis
17. Passive system strategies (e.g. natural ventilation)
18. Controls and related strategies (e.g. Ensuring that systems talk to one another and work together)
19. Increased knowledge regarding specific equipment/measures (e.g. insulation, lighting controls, energy star appliances, smart strips, etc.)
00. Other, specify

Motivations

M1. Why did you decide to register for the Competition? [OPEN END]

M2. Please select and rank the benefits on the right that you expected would come from participating in the competition. Please rank up to 6 benefits. [ROTATE] (NOTE: This will display as an interactive ranking question where respondents can drag and drop the items in order to rank them from 1 to 6 depending on the number of benefits they select. 1 = most important, 6 = least important)_

1. Experience working with ZNE building principles and approaches
2. Advance my career
3. Strengthen my resume
4. A selling point for new work for my company
5. Translate classroom learning into real-world application
6. Opportunity to affect the environment

M2b. What additional benefits, if any, came from participating in the Competition? [OPEN END, 96 – None]

M3. What are the perceived benefits of ZNE buildings? Select all that apply. [ROTATE]

1. Reduce energy bills

2. Lower greenhouse gas emissions
3. Optimize the way the building operates and how people use it
4. Use of renewable energy sources
5. Creation of local jobs
6. Spur new product innovation
7. Help strengthen local economies
8. Help gain control of our energy future
00. Other, please specify:

M4. What additional feedback, if any, would you like to provide? [OPEN END, 96 – None]

Empower

EM1. How has participation in the competition changed the way you approach design projects? Select all that apply. [ROTATE]

1. Participation has increased my interest in designing ultra-low efficiency/ZNE buildings.
2. Participation has changed the type of equipment I incorporate in design projects.
3. Participation has increased the number of renewable elements I incorporate in design projects.
4. Participation has changed how I think about reducing energy loads in design projects.
5. Participation has increased the use of building energy modeling software in design projects.
00. Other, please specify:
96. No change

[SKIP IF QEM1=96]

EM2. Have these changes persisted over time?

1. Yes
2. No

EM3. What elements that you learned or used in the competition have you utilized since the competition?

1. Energy Use Intensity (EUI) metrics
2. Integration of wind power into design
3. Integration of solar power into design
4. Integration of biomass/biofuel into design
5. Whole building energy modeling software (e.g. OpenStudio, eQUEST, NREL PVWatts Grid Data calculator, etc.)
6. Strategies to reduce energy loads
7. Building envelope considerations
8. Space conditioning considerations
9. Water heater considerations
10. Lighting considerations
11. Appliance considerations
12. Plug load considerations
13. Occupant behavior considerations
14. Shading studies
15. Climate analysis

- 16. Passive system strategies (e.g. natural ventilation)
- 17. Controls and related strategies (e.g. Ensuring that systems talk to one another and work together)
- 18. Increased knowledge regarding specific equipment/measures (e.g. insulation, lighting controls, energy star appliances, smart strips, etc.)
- 00. Other, specify

EM4. Have you used your competition experience to further your career?

- 1. Yes, please specify [OPEN END]
- 2. No

Satisfaction

SAT1. Thinking about PG&E’s Architecture at Zero Competition, how satisfied were you with...

- a. The communication provided from PGE’s Architecture at Zero competition staff leading up to the submission deadline?
- b. The information provided about the competition site on Architecture at Zero’s website?
- c. The technical information provided on the Architecture at Zero’s website?
- d. The time given between when registration opens and final submissions are required?
- e. The prize offering for winners of the PG&E Architecture at Zero Competition?

○ 1	○ 2	○ 3	○ 4	○ 5	○ 6
Very Dissatisfied	Dissatisfied	Somewhat Dissatisfied	Somewhat Satisfied	Satisfied	Very Satisfied

[ASK IF SAT1a=1,2,3]

SAT1aa. Why are you dissatisfied with the communications? [OPEN END]

[ASK IF SAT1b=1,2,3]

SAT1ba. Why are you dissatisfied with the site information that was provided? [OPEN END]

[ASK IF SAT1c=1,2,3]

SAT1ca. Why are you dissatisfied with the time given for submissions? [OPEN END]

[ASK IF SAT1d=1,2,3]

SAT1da. Why are you dissatisfied with the amount of the prize? [OPEN END]

SAT2. How satisfied are you overall with PG&E’s Architecture at Zero Competition experience?

○ 1	○ 2	○ 3	○ 4	○ 5	○ 6
Very Dissatisfied	Dissatisfied	Somewhat Dissatisfied	Somewhat Satisfied	Satisfied	Very Satisfied

[ASK IF SAT2=1,2,3]

SAT2a. Why are you dissatisfied with the competition? [OPEN END]

SAT3. How likely are you to recommend PG&E's Architecture at Zero Competition to a friend or colleague?

<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5
Not at all likely	Slightly likely	Somewhat likely	Moderately likely	Very likely

[ASK IF SAT3=4,5]

SAT4. Since participating in the competition, have you recommended the competition to friends or colleagues?

1. Yes
2. No

Thank you for your time. Please select "Submit" to complete this survey.



**PG&E Architecture at Zero
Registrant Web Survey
Final – August 2017**

Survey Overview

The goal of this survey is to understand registrant knowledge of Zero Net Energy (ZNE) principles and approaches, experience designing with ZNE elements, and registration motivation.. This web-survey survey should take 3 - 5 minutes to complete.

Outreach Approach

The online survey will be deployed at the time of or as close to the time of registration as possible for the 2017/2018 Competition, which launched in June of 2017.

Survey Instrument

Introduction/Screener

Thank you for completing this survey.

S1. How many people did you register with on your team for the Competition? (If you only registered for yourself, please enter “1”.)

[NUMERIC OPEN END]

S2. Have you registered for the Architecture at Zero Competition in the past?

1. Yes
2. No

[ASK IF S2=1]

S3. Did you previously submit a proposed design into the Competition?

1. Yes
2. No

Engage

EN1. How did you first learn about the Architecture at Zero Competition?

8. Email from the American Institute of Architects (AIA)
9. Postcard from the American Institute of Architects (AIA)
10. American Institute of Architects (AIA)website
11. Architecture at Zero Competition website
12. My employer

- 13. My university
- 14. Word of mouth
- 01. Other, please specify

EN2. How satisfied are you with the Competition registration process?

○ 1	○ 2	○ 3	○ 4	○ 5	○ 6
Very Dissatisfied	Dissatisfied	Somewhat Dissatisfied	Somewhat Satisfied	Satisfied	Very Satisfied

[ASK IF EN2=1,2,3]

EN2a. Why are you dissatisfied with the registration process? [OPEN END]

Education and Behavior

EB1a. What does ultra-low energy building design mean to you? [OPEN END]

EB1b. What does Zero Net Energy (ZNE) building design mean to you? [OPEN END]

EB2. How familiar are you with ZNE principles and approaches?

○ 1	○ 2	○ 3	○ 4	○ 5
Not at all familiar	Slightly familiar	Somewhat familiar	Moderately familiar	Extremely familiar

EB2a. Why did you give that rating? [OPEN END]

EB3. Which of the following ways, if any, have you learned about ZNE principles and approaches? Check all that apply. [ROTATE]

- 6. Educational courses
- 7. My employer – on-the-job training
- 8. Industry conferences
- 9. Other professional training events or sessions
- 10. Online
- 00. Other, please specify
- 96. None of these

EB4. Have you designed or worked on projects that utilize ZNE principles in the past?

- 1. Yes
- 2. No

[ASK IF EB4=1]

EB5. Please describe your past experiences utilizing ZNE principles and approaches in design projects.
[OPEN END]

Motivations

M1. Why did you decide to register for the Competition? [OPEN END]

M2. Please select and rank the benefits on the right that you expect will come from participating in the Competition. Please rank up to 6 benefits. [ROTATE] (NOTE: This will display as an interactive ranking question where respondents can drag and drop the items in order to rank them from 1 to 6 depending on the number of benefits they select. 1 = most important, 6 = least important)_

7. Experience working with ZNE building principles and approaches
8. Advance my career
9. Strengthen my resume
10. A selling point for new work for my company
11. Translate classroom learning into real-world application
12. Opportunity to affect the environment

M2b. What additional benefits, if any, do you expect will come from participating in the Competition? [OPEN END, 96 – None]

M3. What additional feedback, if any, would you like to provide? [OPEN END, 96 – None]

Thank you for your time. Please select “Submit” to complete this survey.

Appendix B. Secondary Data Review Sources

Reports

ARUP. (2012). The Technical Feasibility of Zero Net Energy Buildings in California, (December). Retrieved from <http://www.cpuc.ca.gov/NR/rdonlyres/8DC39CB6-A29C-4789-B888-A9556F500BE5/0/CaliforniaZNETechnicalFeasibilityReport.pdf>

CPUC. (2008). California Long Term Energy Efficiency Strategic Plan. Retrieved from <http://www.cpuc.ca.gov/general.aspx?id=4125>

Hunt, M., Gas, P., Company, E., Hoeschele, M., German, A., Group, D. E., & Nittler, K. (2016). Achieving Zero Net in California – Balancing Energy Efficiency and On-site Renewable Generation, 1–14. Retrieved from https://aceee.org/files/proceedings/2016/data/papers/10_1199.pdf

King-scott, C., & Salameh, T. (2016). Measuring Up to Net Zero : The Status of New Construction Programs and How They Can Further Zero Net Energy in the Commercial Sector Policies & Market Drivers. Retrieved from https://aceee.org/files/proceedings/2016/data/papers/10_967.pdf

Peterson, K., Taylor, C., & Grant, R. (2016). Establishing a Common Definition for Zero Energy Buildings, 1–11. Retrieved from https://aceee.org/files/proceedings/2016/data/papers/10_815.pdf

Seto, B., Leahy, J., Herrschaft, B., Butterworth, B., & Punjabi, S. (2016). Zero Net Energy Communities: Three Cities Leading the Way, (Usdn), 1–13. Retrieved from https://aceee.org/files/proceedings/2016/data/papers/10_1034.pdf

Websites

AIA (2018). High-Performance Building Design to Meet the 2030 Challenge Targets: A Professional Education Series for Architects and Design Professionals. Retrieved from: <http://aiaplus2030.org/>

Architecture 2030 (2018). The 2030 Challenge. Retrieved from http://architecture2030.org/2030_challenges/2030-challenge/

Architecture 2030 (2018). Why the Building Sector? http://architecture2030.org/buildings_problem_why/

Innovation 2030 (2018). Innovation 2030: A Student Competition to Transform the Course of Design in the age of Climate Change. Retrieved from: <http://innovation2030.net/>

The Living Future Institute (2018). The Living Building Challenge. Retrieved from <https://living-future.org/lbc/>

US Department of Energy Better Buildings (2018). Better Buildings Challenge. <https://betterbuildingsinitiative.energy.gov/challenge>

Appendix C. Case Study Notes

Student Team #1

Team Background

- Originally motivated to enroll in the Competition because the first company they worked for out of college focused on Net Zero designs and the competitor wanted to develop their own skillset in this area
- Currently works at a residential architecture firm with 20-30 employees.
- The competitor took courses in college which prepared them for the Competition including BPAC Building Performance Analysis (Autodesk)

Competition Experience

- Completed their competition entry alone and started their entry in June of their Competition year in order to complete their submission on time.
- Acknowledged their entry was a big undertaking to complete alone and required a large time commitment. In retrospect, this competitor believes the competition would be more manageable with a team.
- This competitor had been competed in several other design competitions and felt the Competition was the most fun. Perceived positive aspects of the Competition included:
 - The unique building type of student housing
 - The challenging site location
 - The amount of time given to complete the submission
- Believes the Competition provided more feedback than other Competitions they previously competed in and this competitor felt the feedback helped them better understand the strengths and weaknesses of their submission.
- In comparison to other design competitions this competitor felt the Competition had more objective judging criteria because it included technical data.

Outcomes and Recommendations

- Despite winning an award at the Competition, the Competition has had minimal influence on this competitor's career to date aside from the opportunity to add the Competition to their resume.
- This competitor is early in their career and does not have an opportunity to apply ZNE concepts and approaches in their current job but hopes they can apply the experience they gained through the Competition later in their career.

- Despite winning, this competitor would have preferred the Competition provide a reward that promoted career advancement instead of a monetary award. Examples of possible non-monetary awards included covering plane fare to a Competition-sponsored networking event or reception and increasing PR about the winning entries.
- If the Competition is integrated into architecture studio course, this competitor suggests the submission should be completed by a team or the Competition should feature a smaller building site (10,000 to 100,000 square feet)

Student Team #2

Background

- This competitor completed their submission as part of a three person team through an energy modeling elective course as part of their Master's of Architecture Program
- Their architecture program focuses on building modeling and design with a special focus on cities
- This competitor now works for a small architecture firm that focuses on design and outsources their energy modeling needs
- The interviewee is very interested in designing buildings in a way that connects people to nature

Competition Experience

- The competitor's team used an iterative process to complete their design, they would add new design features, run a simulation and then adjust their design repeatedly
- The competitor found this Competition to be more interesting than other competitions they participated in because of the focus on building functionality

Competition Challenges

- Gaining access to modeling software (Sefaira) this competitor would like the competition to supply software that can simulate energy production and lighting
- Abandoned design ideas they couldn't model or simulate
- Felt limited by the space on their design board

Competition Outcomes

- The competition helped this competitor's team gain confidence that they have ability to complete a ZNE design
- The competitor learned about insulation design and lighting strategies through the Competition
- The competitor does not have the opportunity to use ZNE design concepts in their current position and feels the Competition has had minimal impact on their career aside from providing them with a project for their portfolio.

- The competitor said the Competition inspired them to think about creating patentable ideas
- The competitor found the greatest benefit of the Competition to be the feeling that they were doing something to help the world.

Professional Team #1

Team Background

- Currently works for consulting firm that focuses primarily on building performance analysis in existing residential existing buildings
- Helps residential building owners strategize about the best way to invest in energy efficiency projects in their buildings.
- This competitor has a technical background and frequently works on code compliance issues
- Was originally motivated to enroll in the Competition to gain more experience with real-world projects that focus on building functionality after graduate school.

Competition Experience

- The competitor worked in a two-person team. The team split the work relatively evenly so one person worked on the building façade and the other focused on the interior.
- The team collaborated on working out the technical aspects of the design including the massing and unit counts.
- Felt the competition staff was very responsive but did not have access to technical staff to answer questions.

Challenges

- Experienced confusion around Competition restrictions, such as setback criteria
 - Observed several nonsensical building features in other competition submissions including buildings built on top of other buildings and geothermal heat pumps in areas with no geothermal resources
- Believes some of the required documentation was unnecessary.
 - The Competition required shading studies which were already factored into their building design software

Outcomes and Recommendations

- Believes the technical portion of the judging criteria should be more transparent. This competitor completes energy analysis for code compliance and believes energy analysis comprehension and documentation is an industry-wide challenge.

- This competitor believes the Competition can help address this challenge by placing more importance on clean technical documentation
- This competitor has applied some of the topics they learned through their design submission including daylighting and shading in work projects since the Competition. This competitor also incorporated some emerging technologies in their design submission and these technologies have not advanced to the level where the competitor could offer them to clients.
- Recommended the Competition incorporate feasibility of construction in design criteria.

Professional Team #2

Background

- Large (400+ employee) professional design firm with multiple locations across the US and world
- Competition Winner
- Their firm has four design focus areas: healthcare, retail, workplace, and community offices are balanced between these focus areas
- The competition team was comprised of experts with diverse backgrounds from across the country including specialists that conduct research and stay apprised of the latest topics in renewable energy
- The firm views the Competition as a business development opportunity as it allows them to build expertise in new building types and approaches.

Competition Experience

- The team received a local grant which they used to fund their participation in the Competition
- The team solicited design ideas from people in offices across the company and then narrowed down the ideas
- The team worked on their submission in one room so they could collaborate and easily solicit feedback from other team members during the design process

Competition Challenges

- Despite winning, this team felt the feedback they received from the judges did not equate with the high level of effort they put into their design and they would like to know more about why their design stood out from the others
- This team listed a lack of site specifications as a challenge and noted they did not receive a survey with the topographic quality of the site and were unable to attend the site walk-through because they were located outside of California

Competition outcomes

- The Competition gave this team the opportunity to explore topics they aren't ordinarily able to explore. The Competition also gives competitors a chance to tap into their personal areas of interest
- The Competition reminded this team that ZNE is an achievable outcome
- The firm is currently designing a zero energy school and their design strategy is informed by lessons learned from the Competition including minimizing building energy loads to reduce the amount of renewable energy needed at the site.
- Participated in another Competition where submission were graded using an algorithm, and recommended this type of judging transparency might be helpful.
- The firm has been able to incorporate some features of their design into other building designs since the Competition. Other submission features were more of an experiment with pushing the envelope but not something they could feasibly implement in the future.

For more information, please contact:

Ellen Steiner, Ph.D.
Vice President

720-262-5857 tel
esteiner@opiniondynamics.com

1 Kaiser Plaza, Suite 445
Oakland, CA 94612