Phase II Report: Baseline Characterization

Market Effects Study of Investor-Owned Utility Multifamily Residential New Construction Programs in California

Appendices

FINAL

5/22/2016

CALMAC Study ID: CPU0089.03

Submitted to:

California Public Utilities Commission

Submitted by:

NMR Group, Inc.

The Cadmus Group, Inc

DNV GL

50-2 Howard Street, Somerville, MA 02144
Phone: (617) 284-6230 Fax: (617) 284-6239
www.nmrgroupinc.com

Table of Contents

Tables

Figures

Appendix A Updated Estimate of LEED-registered MFNC Projects, 2002 Through 2012

This appendix updates our Phase I Market Characterization of the California Multifamily New Construction (MFNC) market. Here, we revise our estimate of the number of MFNC projects registered with the U.S. Green Building Council's (USGBC) LEED certification system from 2010 through 2012.[1] The estimates included in the Phase I report were based on an incomplete data set of LEED registered projects.[2]

Using the LEED Project Directory[3] and data provided by LEED staff, we estimate that 512 California MFNC projects were registered from 2002 through 2012.

A.1 Methodology for Developing the Data Set of LEED-registered MFNC Project Starts

MFNC projects can be registered through a number of LEED rating systems, including the following:[4]

- LEED For Homes Multi Family Low-Rise
- LEED For Homes Multi Family Mid-Rise
- LEED For Homes Single Family[5]
- LEED-Build, Design and Construction (BD&C) - Core and Shell (CS)
- LEED-BD&C - New Construction (NC)
- LEED-Neighborhood Development (ND)

Because LEED assigns unique registration numbers to individual buildings—and in some cases individual housing units—within the same MFNC project, we went through several steps to merge, clean, and aggregate the LEED registration data to develop estimates of the number of LEED-registered MFNC projects. We used the LEED registration date as a proxy to estimate the construction start date, but it is important to note that LEED does not track or publish project

[1] The USGBC is a nonprofit organization that promotes environmental sustainability through its LEED program. The program certifies building projects that meet the organization's sustainability criteria involving energy and water efficiency, environmental consciousness, sustainable materials, air quality, and other parameters.

[2] We estimated 352 California MFNC projects registered between 2002 and 2012 in the Phase I report. For more details, see the Phase I report; NMR. 2014. *Final Phase I Report: Baseline Characterization Market Effects Study of Investor-Owned Utility Multifamily Residential New Construction Programs in California.* http://www.calmac.org/publications/WO54_MFNC_-_Phase_1_Report_Final_070814_.pdf

[3] http://www.usgbc.org/projects

[4] For more details pertaining to the LEED rating systems for homes, see the following: http://www.usgbc.org/articles/residential-question-homes-midrise-or-new-construction

[5] The LEED For Homes Single Family rating system includes attached single-family homes, such as townhomes. The IOUs' MFNC program considers projects with three or more attached units to be multifamily. See the following LEED webpages for more details on the LEED for Homes rating system: http://www.usgbc.org/cert-guide/homes ; http://www.usgbc.org/articles/residential-question-homes-midrise-or-new-construction

construction start dates. Projects can be registered with LEED during many stages of the development process, ranging from the design phase to after construction has begun.[6]

We began by developing a comprehensive data set of California LEED registrations by combining the LEED Project Directory, which is publicly available from the LEED website,[7] and a data set of MFNC registrations provided by LEED staff. The LEED data sets included unique project registration numbers, allowing us to identify projects that were included in both data sets. The publicly available (downloaded) data set largely comprised LEED-BD&C registrations, while the list provided directly by LEED staff was largely LEED for Homes registrations. Next, we excluded any projects that would not have been considered MFNC by the IOUs' MFNC program eligibility requirements. To be considered a MFNC project and included in our analysis, a registration needed to be described within the LEED data as having a multifamily or multi-unit component; we excluded projects that appeared to be dormitories, military bases, hotels, or detached single-family homes (none of which are eligible for the IOUs' MFNC program).

Next, we aggregated the records for individual buildings that together comprised single multifamily projects. LEED creates unique registration records for individual buildings, such that a single high-rise MFNC project with three individual buildings would be considered three separate LEED records, whereas the IOUs' MFNC program and the Phase I Market Characterization report would consider those to be a single project. Similarly, for a MFNC project with three or more attached townhouse-style homes (i.e., adjoining units that are separated by vertical dividing walls), each housing unit might be considered a separate LEED project but treated as a single project by the IOUs' MFNC program and the Phase I Market Characterization report.[8] The data set provided by the LEED staff included a variable identifying projects with multiple buildings, which we used to aggregate individual building registrations into MFNC projects. For LEED projects only included in the downloaded LEED Project Directory data set, we aggregated by a combination of project type, project name, and address; in some cases, we conducted internet searches to verify that multiple building registrations corresponded to the same project.

Next, we investigated LEED for Homes registrations that did not clearly indicate if the project was a MFNC project to identify whether or not they included a multifamily component. LEED for Homes registrations include detached single-family homes (SFH), duplexes (which the IOUs' New Construction Programs would consider to be a SFH), and attached townhomes with three or more housing units, which the IOUs' New Construction Program would consider to be a MFNC project. We determined SFH and MFNC status through internet searches based on project names and addresses.

Finally, the data set included a number of "confidential" registrations that did not include project names, addresses, or any other indication that the registration was part of a multi-building project. We completed a multi-step process to estimate the number of MFNC projects from these

[6] Email correspondence with Green Building Certification Institute staff: July 24, 2013.
[7] http://www.usgbc.org/projects
[8] http://www.usgbc.org/cert-guide/homes

confidential registrations. To do this, we first grouped projects by their LEED rating type (i.e., LEED for Homes or LEED BD&C). Within LEED for Homes registrations, we further grouped by anticipated project type (SFH, SFH-Attached, Multifamily low- and mid-rise). Next, we estimated the number of projects for each group and then estimated the number of these projects that were MFNC projects, as opposed to SFH, hotels, dorms, etc.

Table A-1 illustrates the steps taken to estimate the number of MFNC projects from confidential registrations certified under the LEED for Homes rating system that had anticipated projects of SFH and SFH-Attached buildings. There were 67 confidential registrations in this grouping (Column A). First, using the non-confidential registrations of the same rating system (LEED for Homes) and anticipated project type (SFH and SFH Attached), we estimated the percentage of non-confidential SFH and SFH Attached Registrations that were associated with MFNC Projects (column B). Multiplying columns A and B results in the number of confidential registrations we expect to be associated with MFNC projects (Column C; i.e., 67 * 61% = 41 registrations). Next, in column D, we estimated the average number of registrations per MFNC project for the non-confidential registrations of the same certification system (LEED for Homes) and anticipated project type (SFH and SFH Attached). Dividing column C (estimated number of MFNC registrations) by column D (average number of registrations per MFNC project) results in the estimated number of MFNC projects (column E). We followed a similar process to estimate the number of MFNC projects for the confidential LEED for Homes Multifamily low- and mid-rise registrations and LEED BD&C registrations.

Table A-1: Estimating MFNC Projects from Confidential LEED Registrations (2002 – 2012)

LEED Certification System and Anticipated Project Type	Number of Confidential Registrations (A)	% of Non-confidential SFH and SFH Attached Registrations, MFNC Projects (B)	Estimated # of Confidential Registrations, MFNC (C)	Avg # of Registrations per MFNC project, Non-confidential Registrations (D)	Estimated Number of MFNC projects (E)
LEED for Homes, SFH and SFH Attached	67	61%	41	23.7	2

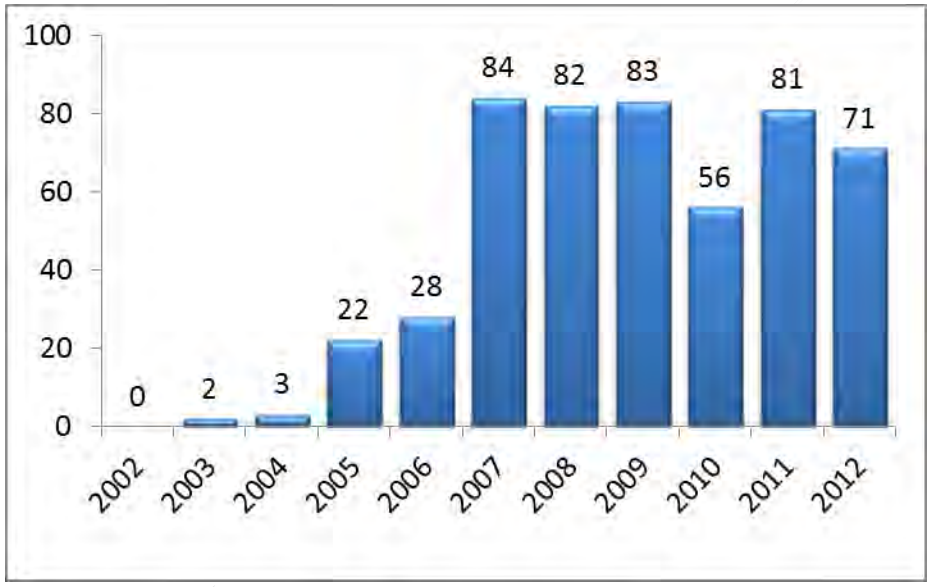
Sources: (1) U.S. Green Building Council (USGBC), Public LEED Project Directory, Updated June 27, 2013, Accessed September 20, 2015 at http://www.usgbc.org/projects/list/new-construction; (2) Multifamily LEED Registrations provided by LEED staff; and (3) Evaluation team estimates.

A.2 Analysis of LEED-registered MFNC Starts, 2002 Through 2012

Figure A-1 illustrates the estimated number of LEED MFNC projects registered each year. LEED project registrations experienced a steep increase in 2007 over previous years, from 28 in 2006 to 84 in 2007. In fact, from 2002 through 2006, we estimate that only 55 projects were registered (11% of all estimated registered projects over the 11-year period). As discussed in section 5.2 in the Phase I report, unit permits in the overall MFNC market hit their lowest point in 2009 and after that showed a slow but steady increase. LEED project registrations were somewhat different; project registrations declined *after* the housing crisis, dropping to an estimated 56 project

registrations in 2010 compared to 84 project registrations in 2007, 82 in 2008, and 83 in 2009. This may be due, in part, to the launching of a new version of the LEED rating system in 2009.[9] According to the Green Building Certification Institute (the organization issuing LEED certifications), it is common for developers to register a "flurry" of projects in anticipation of upcoming LEED rating specification version changes.[10] In 2011, the number of registrations rebounded (81 projects), but then dropped somewhat in 2012 (71 projects). This 12% decrease from 2011 to 2012, may be due to the increasing popularity of GreenPoint Rated's Build it Green program (see section 5.6.2 of the Phase I report).

Figure A-1: California Multifamily LEED New Construction Projects by Year (2002-2012)



Sources: (1) U.S. Green Building Council (USGBC), Public LEED Project Directory, Updated June 27, 2013, Accessed September 20, 2015 at http://www.usgbc.org/projects/list/new-construction; (2) Multifamily LEED Registrations provided by LEED staff; and (3) Evaluation team estimates.

Note: The project counts include the MFNC projects in the LEED database with disclosed addresses (429) and an additional 83 projects that the team estimated from confidential LEED registrations.

Of the 512 LEED MFNC projects started from 2002 through 2012, 429 had a disclosed location, while 83 had confidential locations (**Error! Reference source not found.**).[11] Forty-one percent

[9] USGBC. "LEED 2009". Accessed August 5, 2013 at http://www.usgbc.org/about/leed/current-version.
[10] Email correspondence with Green Building Certification Institute staff: July 24, 2013.
[11] Of the 83 LEED MFNC projects with confidential locations, seven were clearly MFNC projects because the data set the LEED staff provided included a variable identifying projects with multiple buildings. We mathematically estimated the remaining 76 projects from the confidential registrations using the methods described in Section A.1.

(208 of 512) of the LEED MFNC projects started from 2002 through 2010 were started within three years, from 2010 through 2012.

Table A-2: California LEED MFNC Projects with Disclosed and Confidential Locations (2002 – 2012)

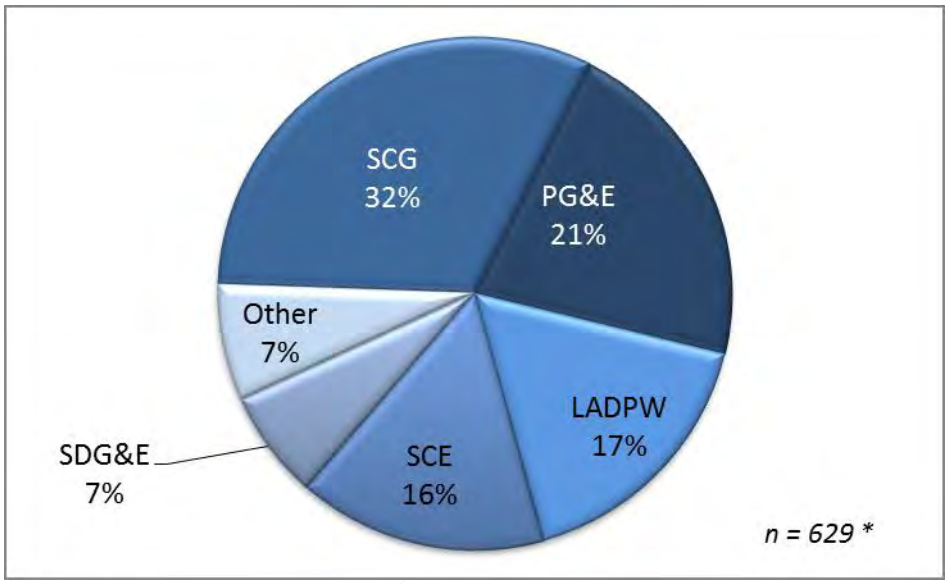
Time Period	Disclosed Location	Confidential Location	Total
2002 to 2009	233	71	304
2010 to 2012	196	12	208
Total	**429**	**83**	**512**

Sources: (1) U.S. Green Building Council (USGBC), Public LEED Project Directory, Updated June 27, 2013, Accessed September 20, 2015 at http://www.usgbc.org/projects/list/new-construction; (2) Multifamily LEED Registrations provided by LEED staff; and (3) Evaluation team estimates.

The following figures illustrate attributes associated with LEED projects' geographic locations for the 429 LEED MFNC projects with disclosed locations.

As with new construction starts from 2010 through 2012 (see Section 5.3.7 of the Phase I report), MFNC LEED projects registered from 2002 to 2012 were most commonly registered in SCG (35%) and PG&E (20%) service territories (see Figure A-2).

Figure A-2: Multifamily LEED New Construction Project Service Providers (2002-2012)



Source: (1) USGBC, Public LEED Project Directory and (2) Multifamily LEED Registrations provided by LEED staff.

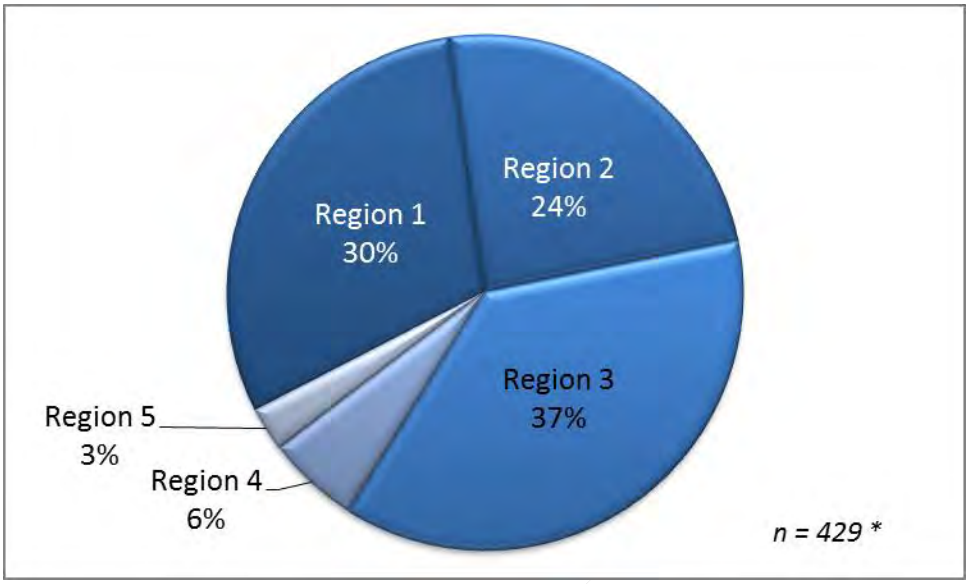
* The figure is based on the 429 LEED MFNC projects with disclosed locations. Two hundred of the 429 projects were served by SCG in addition to an electricity provider; as a result, the 429 projects represent 629 utility customers.

Climate Regions 3 (37%), 1 (30%), and 2 (24%) were the most common locations for LEED new construction project registrations from 2002 to 2012 (Figure A-3).[12] The climate regions for all MFNC starts from 2010 through 2012 were somewhat similar to LEED registrations. As presented in 5.3.8 of the Phase I report, new construction starts from 2010 through 2012 were most

[12] Maps of the California climate zones and regions can be found in section 5.3.8 of the Phase I report.

commonly in Climate Region 3 (32%) or 1 (30%), but less frequently in Climate Region 2 (19%) and more frequently in Climate Region 4 (16%) than in LEED registration data.

Figure A-3: Multifamily LEED New Construction Project Climate Regions (2002-2012)



Source: (1) USGBC, Public LEED Project Directory and (2) Multifamily LEED Registrations provided by LEED staff.

* The figure is based on the 429 LEED MFNC projects with disclosed locations.

From 2002 to 2012, nearly all LEED MFNC project registrations (99%) were located within the boundaries of an MSA. Table A-3 presents these by year.

Table A-3: Metro-Statistical Designation of LEED Multifamily Projects by Registration Date (2003-2012)

Time Period	Percent of Total Projects		Total Number of Projects *
	Metropolitan	Micropolitan	
2003	100%	0%	1
2004	100%	0%	1
2005	92%	8%	12
2006 **	90%	5%	21
2007	99%	1%	69
2008 **	98%	0%	60
2009	100%	0%	69
2010	100%	0%	53
2011	99%	1%	76
2012	100%	0%	67
Total 2003-2012	99%	1%	429

Source: (1) USGBC, Public LEED Project Directory and (2) Multifamily LEED Registrations provided by LEED staff.

* The table is based on the 429 LEED MFNC projects with disclosed locations. There were no MFNC projects registered in 2002. As a result, the table only shows projects registered from 2003 to 2012.

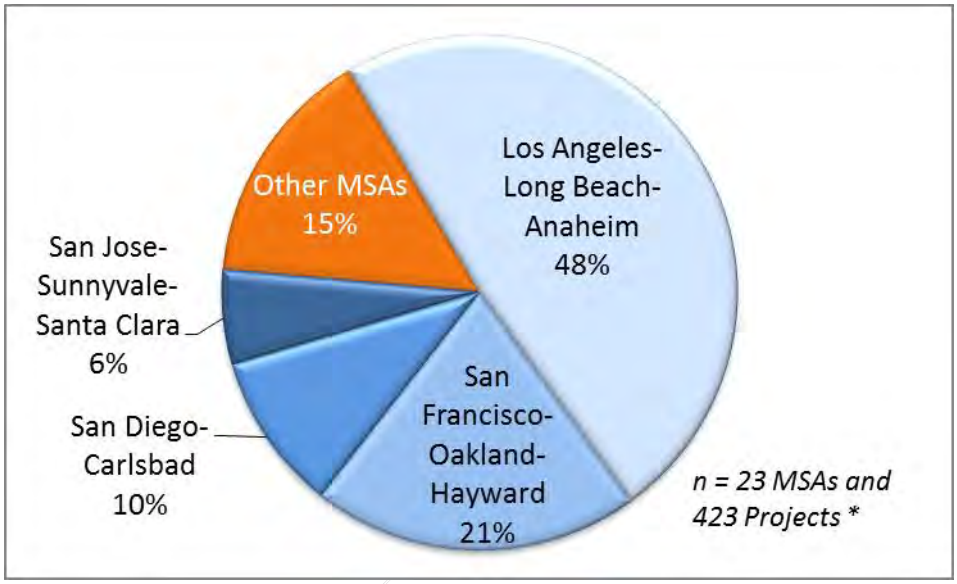
** In both 2006 and 2008, one project was in an area without a metro-statistical designation.

Unlike new construction starts (section 5.3.9 in the Phase I report), unit permits (section 5.2), and IOU program participation (section 5.5.1.5), where five MSAs account for the vast majority of projects and units (from 2010 through 2012), only four MSAs accounted for the majority of LEED project registrations from 2002 to 2012 (85%) (Figure A-4). However, these four MSAs overlap

with the top-five MSAs for new construction project starts, unit permits, and IOU program participation:

- Los Angeles-Long Beach-Anaheim
- San Francisco-Oakland-Hayward
- San Diego-Carlsbad
- San Jose-Sunnyvale-Santa Clara

Figure A-4: Top Four Metropolitan Statistical Area LEED Projects (2003-2012)



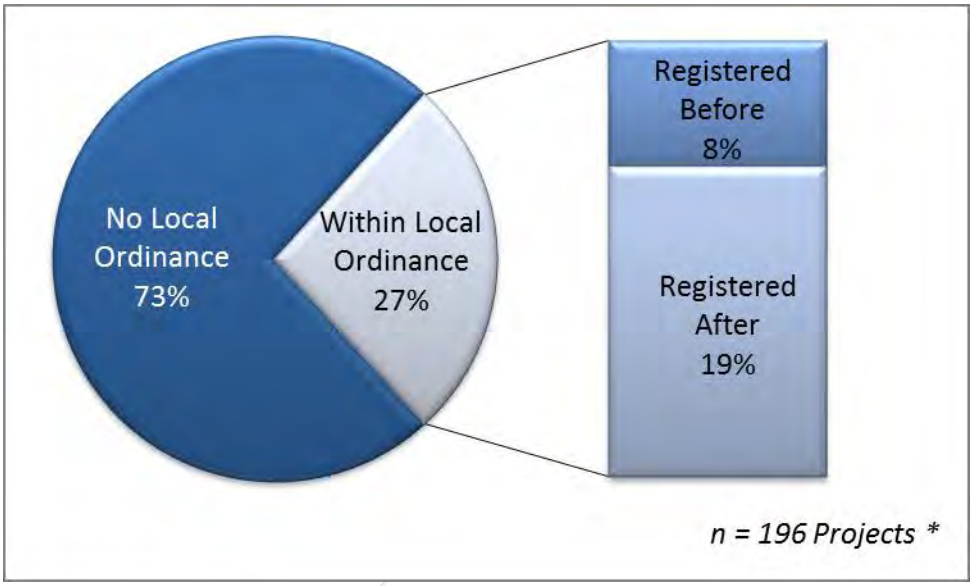
Source: (1) USGBC, Public LEED Project Directory and (2) Multifamily LEED Registrations provided by LEED staff.

* The figure is based on the 429 LEED MFNC projects with disclosed locations. There were no LEED MFNC projects registered in 2002. As a result, the figure only illustrates projects from 2003 to 2012.

Note: The four MSAs including the most registrations cumulatively from 2003 to 2012 include Los Angeles-Long Beach-Anaheim, San Francisco-Oakland-Hayward, San Diego-Carlsbad, and San Jose-Sunnyvale-Santa Clara.

From 2010 through 2012, slightly more than one-quarter of LEED projects registered in California were within areas with mandatory, above-code local energy ordinances ("reach codes") (27%); this is nearly identical to the overall MFNC starts project population during that period, with 26% of projects starting construction within localities that had reach codes. Similarly, about one-fifth of LEED projects (19%) were registered *after* the approval of local ordinances (compared to 18% among all MFNC starts).

Figure A-5: California Multifamily LEED New Construction Projects and Local Government Energy Ordinances (2010-2012)



Sources: (1) USGBC, Public LEED Project Directory; (2) Multifamily LEED Registrations provided by LEED staff; and (3) CEC, "Local Ordinances: Exceeding the 2008 Building Energy Efficiency Standards."

* The figure is based on the 196 LEED MFNC projects with disclosed locations started from 2010 through 2012.

Appendix B Detailed Findings of Individual Market Effects Indicators and Expected Outcomes

In this appendix, we present the detailed findings pertaining to eight key market outcomes that could potentially result from various IOU program activities (bold font in Table B-1) as well as three additional outcomes (summarized below in Table B-1).

Table B-1: Key Market Effects Outcomes Assessed by Research Team

Potential Market Effects Outcome	Evidence of Outcome Linked to IOU Programs
Increased above-code practices in non-program MFNC projects	Evidence of above-code practices, but more evidence of effects attributable to other green (i.e., LEED) and affordable housing programs and policies (CTCAC).
Reduced design and construction costs	Insufficient evidence.
Increased numbers of above-code units being constructed	Insufficient evidence from interviewees and survey respondents, but site visits provide evidence of above-code construction outside of the program.
Increased knowledge of efficient building practices	Evidence of increased knowledge from IOU MFNC program training and design assistance. Low levels of program awareness among developers and low training participation rates hinder the program's ability to affect the market.
Increased marketing of efficiency to the public	No evidence of increased marketing. However, evidence that at least some developers view efficiency and green labels as important marketing tools. Other programs, such as LEED, have much more market value than the IOUs' programs.
Enhanced readiness for code upgrades	Limited evidence that the program improved preparedness for future code cycles for a small number of developers.* Evidence from site visits of MFNC projects that are more efficient than code, suggesting at least some developers were ready for a more stringent code.
Increased consumer demand for efficient construction	Some evidence of consumer demand from the market-rate sector, particularly high-income buyers, but no evidence of increased demand.
Increased lender and investor demand for efficient construction	No evidence of increased demand. Lenders and investors factor expected utility costs into their financial calculations, but do not require EE.
Improved compliance with code/above-code programs	Some evidence that program elements helped improve compliance with program and code requirements.*
Expanded Certified Energy Plans Examiner (CEPE) market	Limited evidence that IOU MFNC program and other programs have increased demand for CEPEs and Certified Energy Analysts (CEAs) and that CEPEs and CEAs offer helpful guidance.*
Voluntary "green" programs develop standards consistent with the IOU program standards	Evidence of IOU planning efforts contributing to somewhat consistent standards, particularly reach code and CTCAC standards.

* Indicates evidence from the case studies but not the developer survey, suggesting limited evidence of this indicator in the market-rate MFNC sector (due to the sample disposition of the case studies).

B.1 Expected outcome: Increased above-code practices in non-program homes

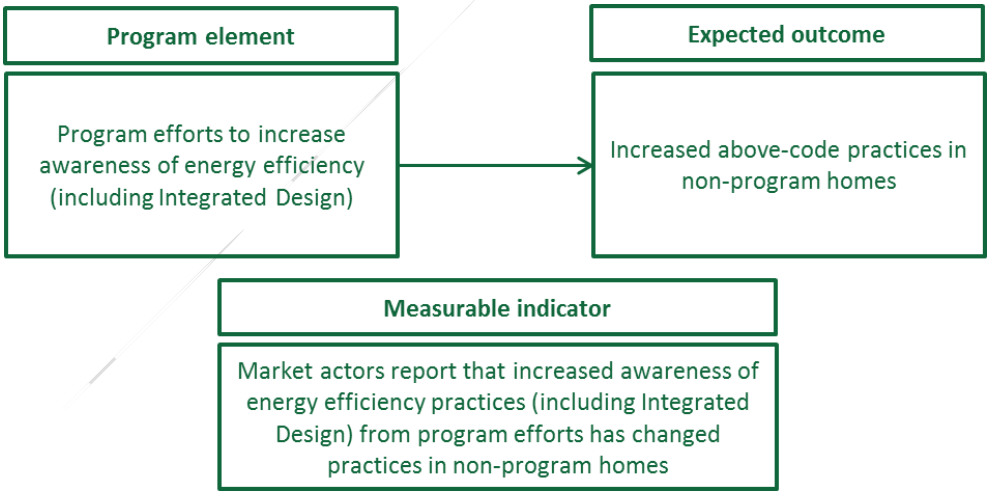
Several program elements could contribute to the outcome of increased above-code practices in non-program homes. In this section, we present findings associated with the following measurable indicators of a link between IOU program elements and that expected outcome:

- *Increased awareness of energy efficiency practices*
- *On-site inspections and energy modeling*
- *Increased stock and availability of high-efficiency equipment*

We present the findings associated with other indicators of the link between program elements and above-code practices, such as *increased knowledge* (due to IOU trainings and program design assistance), later in this chapter.

B.1.1 Increased awareness of energy efficiency practices

The figure below shows the link between the program element and the expected outcome, as well as the measurable indicator assessing how increased awareness influenced building practices as presented in the logic model (Figure 5-1).



Summary of Findings: Some evidence suggests that IOU MFNC program practices were adopted into non-participating projects, thus causing market effects, but the IOU program is not the only such—nor likely the most significant—market intervention driving this outcome, as various green and affordable housing programs and policies were reported to substantially increase market actor knowledge and impact their practices. Interviewees explained that practices learned through the IOU program—and from other similar programs—became like a habit and shifted mindsets, resulting in the implementation of new measures into non-program projects (especially if they

were cost-effective). Interviewees and respondents more often emphasized that reach codes, CTCAC, and LEED requirements had the greatest influence on developers' standard practices, both when they were and when they were not participating in non-IOU programs or subject to the requirements of reach codes or CTCAC funding.

B.1.1.1 Phase I Report Findings

In the Phase I report, the research team described how various IOU MFNC program elements could lead to above-code practices in the marketplace. However, the team also described how the IOU MFNC program exists within a complex array of programs and public policies that encourage energy efficiency in the MFNC market, including local reach codes, CTCAC, LEED for Homes, GreenPoint Rated, the ENERGY STAR Certified Building program, and even encouragement from public officials. Because of the complex interactions and, in some cases, coordination across the programs and policies, it is difficult to attribute the observed market effects of above-code practices specifically to the IOU program.

The Phase I report hypothesized that reach codes and CTCAC requirements had the greatest influence on driving developers to build to increased efficiency levels. Statewide, 37% of MFNC units started from 2010 through 2012 were subject to above-code energy standards because of either requirements associated with low-income funding sources or their location in a reach code locality, and 22% were encouraged to be above-code because of the low-income funding for which they were competing.[13]

B.1.1.2 Case Study Findings

While 37% of case study interviewees perceived an increase in knowledge among market actors from IOU MFNC program training and design assistance (Appendix B.5), only 18% of all interviewees (9 of 51) reported that building *practices* have changed in non-IOU MFNC programs as a result of the IOU program. In total, 41 interviewees expressed opinions about the existence of market effects from the IOU MFNC program. About one-fifth of that group (9 of 41) reported that the IOU program resulted in market effects, commenting that the program practices became "almost like a habit" or calling the program influence "a natural evolution." Their reasoning regarding the way in which IOU program elements impacted how market actors changed their practices for their non-IOU program projects varied:

- **Cost-effectiveness**. An engineer and a HERS/GreenPoint Rater explained that the practices that market actors adopted into their non-participating projects were usually those that were inexpensive and/or cost-effective.
- **Priming for energy efficiency.** A Title 24 Consultant and a HERS Rater reported that the program influenced developers in particular in that it "plants a seed," making the concept

[13] Section 2.5 of the main report explains the distinction and background between high-efficiency *required* and high-efficiency *encouraged*.

of energy efficiency "more active in their minds," and that the developers then integrate their focus on energy efficiency into the initial design process.

- **Specific practices.** Four respondents (three developers and one Title 24 Consultant) described how the program influenced market actors to apply practices that were required or encouraged by the program into non-program projects. In particular, they focused on measures or practices that worked well (based on IOU feedback or their own observations), including performing duct sealing and installing high-efficiency windows and water heating systems.

The remaining 32 interviewees rejected the idea that the IOU program changed market actors' standard practices in non-program projects. Respondents commonly reported that they had not changed their practices outside of their IOU program projects because they were already building to above-code standards to meet the requirements of other non-IOU programs or local energy codes, or because their practices were limited by budgetary constraints.[14]

- **Other programs and requirements.** The majority of the 32 interviewees (63%) reported that another, non-IOU program or local energy code had already impacted their practices. Many added that when projects are either aiming to receive financial support from other programs, such as CTCAC,[15] or required to meet high levels of energy efficiency (reach codes, Redevelopment Agency funding, etc.), the IOU program has no additional impact on the project's efficiency because they would have sought that level of efficiency as a result of the "carrots and sticks" from non-IOU entities. (See Appendix B.2 for a more detailed discussion of the pressure on developers to build efficiently from "soft money" sources, where public agencies and officials provide support and funding to developers on projects if they agree to meet certain criteria, such as building to above-code standards.) One architect explained that IOU incentives were too low to encourage additional efficiency:

  > *[IOU MFNC incentive amounts] are actually quite small relative to the overall construction budget that we have. So the level of energy efficiency is really driven by the tax credit requirements. That is the main driver.*

- **Cost-effectiveness.** Fourteen interviewees asserted that cost considerations drive market actors to aim for the basic, relevant requisites for their projects—whether it is to meet reach or Title 24 code requirements, fulfill CTCAC requirements, achieve a green certification for marketing purposes, or receive IOU program incentives. One architect summarized the expense involved in obtaining CTCAC points (which are essential to winning CTCAC funding):

[14] As noted previously, the reader should take into account that nearly all case study sites were low-income projects, which commonly have efficiency requirements associated with their funding.

[15] It is important to note that CTCAC intentionally chose to adopt efficiency standards that aligned with the efficiency requirements of existing programs, such as the IOU MFNC program, GreenPoint Rated, LEED, and EGC.

> *On buildings of these types, a point [on the CTCAC competitive scoring scale] in energy efficiency can translate into millions of dollars, and that can be a bitter pill for a developer to swallow.*

Case study respondents clearly indicated that carryover of advanced efficiency practices—due to their experience with various green programs—does occur, particularly for cost-effective practices that are easy to implement consistently across projects with minimal effort. Cost concerns do limit this carryover, but market actors reported that they can be influenced to adopt these practices: Carryover can be driven by participation in efficiency-related trainings (including those offered by the IOUs), by information gained from actually participating in various green programs, and by their interactions with other design team members who are already experienced in above-code building practices (potentially due to *their* experience with programs including the IOU MFNC program).

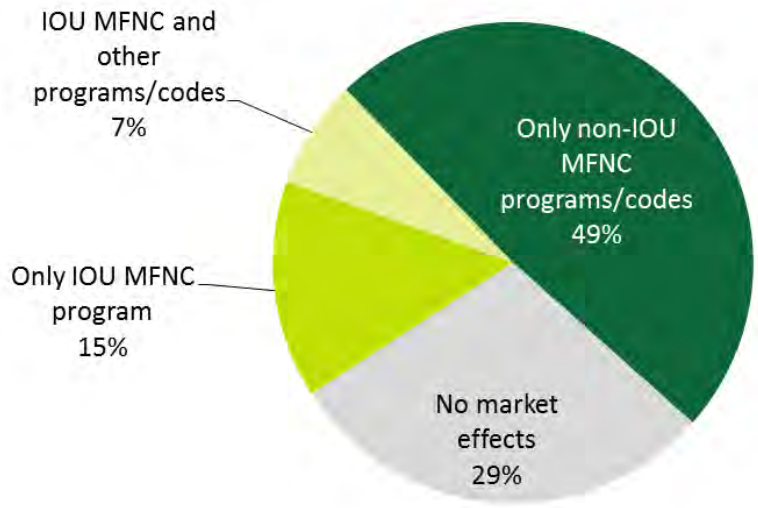
> *When you find something that works, you apply it to the next project as well. If I find a certain design standard or piece of equipment, then I would probably just use the same thing again. If we had to do a project with really high-end [measures], I wouldn't carry those [practices] over, but with a small margin of [cost] difference, I think those would just get applied across the board.*

Particularly for developers who regularly build to above-code standards due to participation in tax credit programs or working in reach code areas, starting from a set of relatively advanced but consistent practices leaves room for "value engineering" (i.e., cutting out planned features due to budgetary constraints) during design and construction in non-program projects. (Solar PV panels were one feature that respondents described as being easy to include in designs, but easy to cut from the project if there were budget overruns.)

Figure B-6 presents 41 case study interviewees' assessment of their adoption of energy efficiency practices attributable to various programs as well as reach codes (i.e., market effects). Nearly half of the interviewees (49%) attributed market effects to non-IOU MFNC programs—such as LEED, GreenPoint Rated, Enterprise Green Communities (EGC)—as well as reach codes. More than one-fifth mentioned that market effects were attributable to the IOU MFNC program: 15% determined

that only the IOU program caused the market effects, and 7% said that both the IOU program and other programs or reach codes caused them.

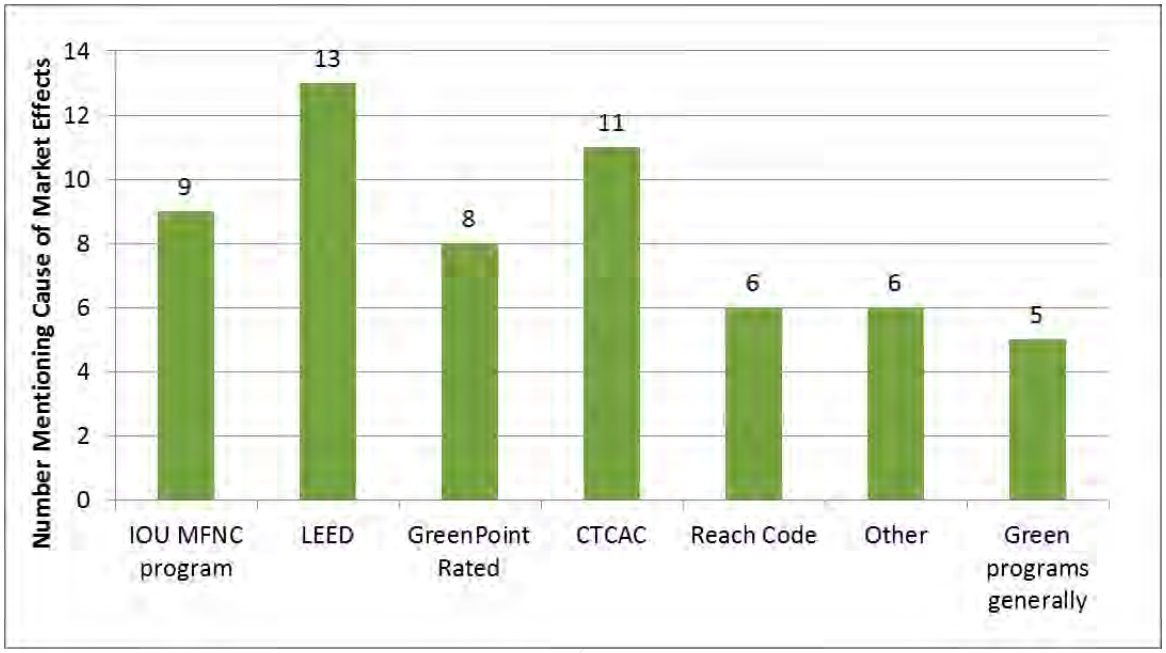
Figure B-6: Case Study Interviewee Perspectives on the Causes of Market Effects Related to Programs or Reach Codes (n=41)*



* Ten interviewees did not assess program market effects.
Note: "Other programs and codes" refers to efforts such as LEED, Greenpoint Rated, EGC, reach codes, etc.

Interviewees that associated market effects with programs and/or reach codes were most likely to specify that they were attributed to LEED (13 interviewees) or CTCAC (11; Figure B-7). Slightly fewer pointed to the IOU MFNC program (9) and GreenPoint Rated (8).

Figure B-7: Programs/codes to which Case Study Interviewees Attributed Market Effects (n=41)*

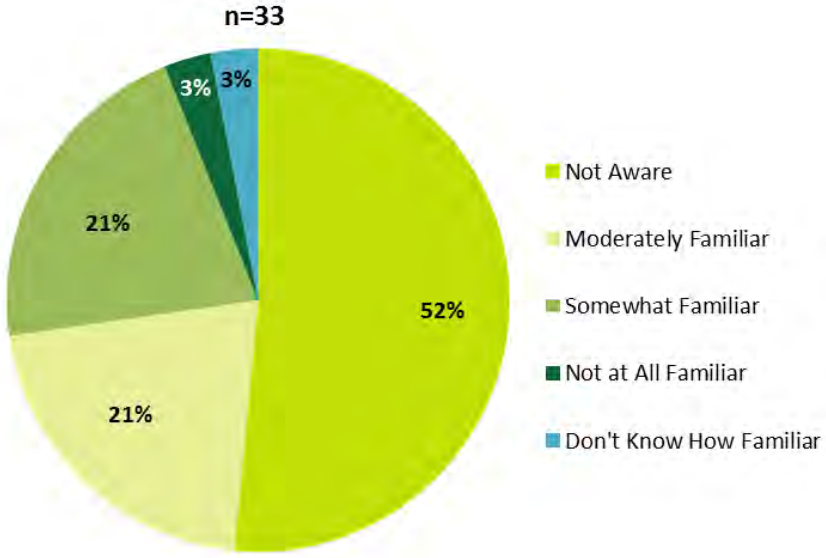


* Ten interviewees did not assess program market effects.

B.1.1.3 Developers Survey Findings

The developer CATI survey results showed limited evidence of IOU program market effects on the practices used in non-program projects, though there appears to be stronger evidence of market effects from reach codes and other programs, such as CTCAC. A key limiting factor on the effect of the IOU MFNC program on practices was the relatively low level of program awareness; over one-half (52%) of respondents were not aware of the IOU MFNC program (Figure B-8), and none of the respondents whose sampled project was a market-rate project were aware of the program.[16]

Figure B-8: Awareness and Familiarity with IOU MFNC Program



Interviewers asked the 33 developers if they had adopted any energy-efficient practices that were required by a given program or reach code that they later implemented in projects *not* subject to those requirements—or even if their *familiarity* with the IOU program had any carryover to non-program projects.

- **Adoption of energy efficiency practices from IOU MFNC program**. Ten percent of CATI survey respondents rated the IOU program as at least somewhat influential on the efficiency level of the *sampled* [17] (non-program) project (this value increases to 18% of respondents if the three program participants are included), and 15% of all respondents rated it as at least somewhat influential on the efficiency level of *all* of their other non-program projects.
- **Adoption of energy efficiency practices from reach codes.** Nine of 33 respondents indicated that that their experience working in reach code localities had been somewhat or

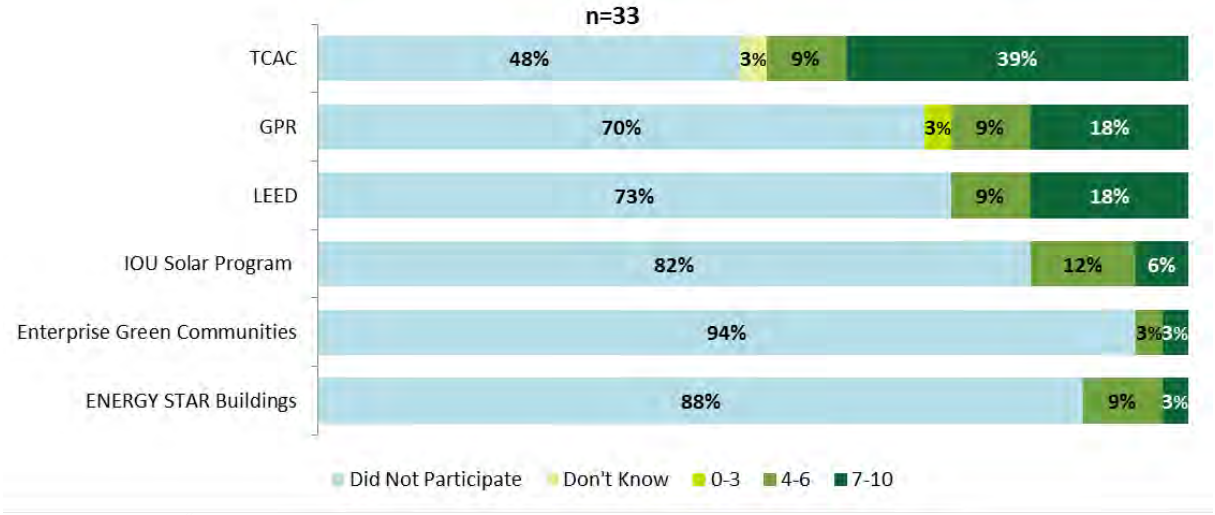
[16] Respondents were asked to discuss their decision making related to a single project to help them root their answers in specific experiences.
[17] As previously noted, respondents were asked to discuss their decision making related to a single project to help them root their answers in specific experiences.

very influential on their projects outside of reach code jurisdictions (only 11 builders had built in reach code localities).

- It is also important to note that two builders familiar with the IOU program reported that their familiarity with the program affected the energy efficiency of their non-program projects in reach code localities.

Influence of other programs. Large percentages of respondents who participated in non-IOU MFNC programs that required energy efficiency reported that their sampled projects were somewhat or very much influenced by the requirements of the specific programs in which they participated (Figure B-9). For example, 16 of the 17 sampled projects that participated in CTCAC were somewhat or very much influenced by its energy efficiency expectations/requirements (48% of all sampled projects). However, it is important to note that the CTCAC efficiency standards would not have been adopted without the existence of the IOUs' programs and their incentives.[18] In addition, five (29%) of the 17 respondents that participated in CTCAC said that their familiarity with the program affected the energy efficiency of their non-IOU program CTCAC projects.

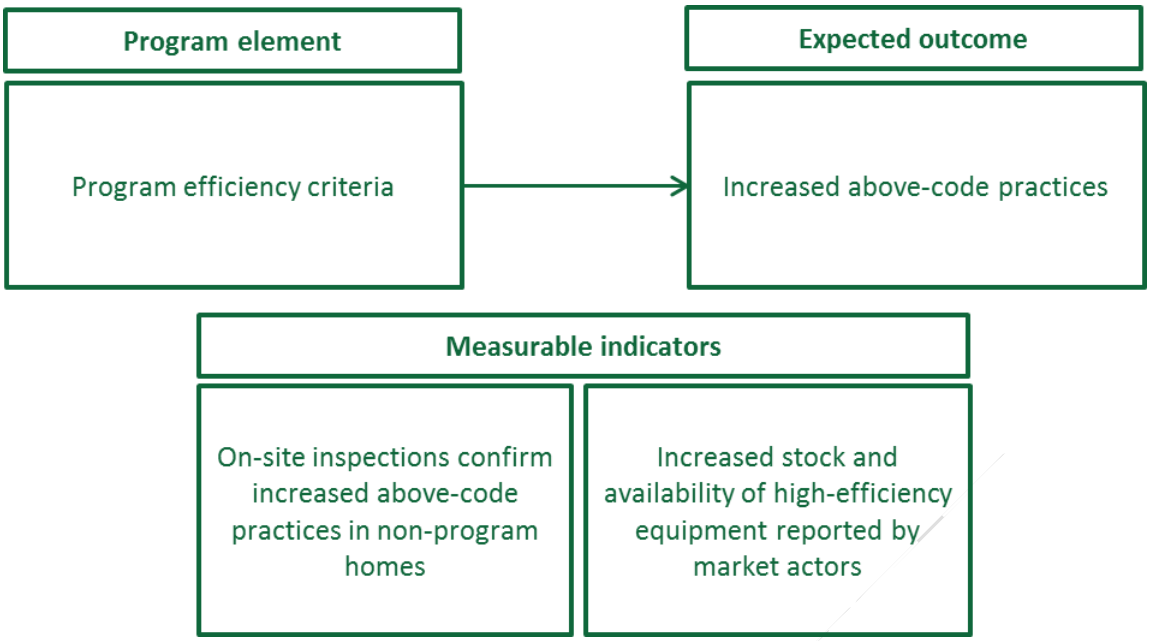
Figure B-9: Influence of Green Programs and Certifications on Efficiency Level of Sampled Project



B.2 Program efficiency criteria driving above-code practices and equipment availability

Program efficiency criteria are expected to lead to above-code practices. The indicators linking efficiency criteria and above-code practices include on-site inspections and increased stock and availability of high-efficiency equipment (see the figure below and Table B-1).

[18] As discussed in the Phase I report, market experts reported coordination between CTCAC and the IOUs to create consistent program standards, such that there could be a link to IOU efforts that is unknown to participants.



B.2.1 Increased Above-Code Practices – On-site Inspections and Energy Modeling

The first indicator shown above—on-site inspections confirm increased above-code practices in non-program homes—was addressed in Phase II research through on-site visits and contextualized through case study interviews.

Summary of Findings: While the sampled projects from this assessment are overrepresented by low-income projects and those with efficiency requirements, there is clear evidence that projects are being built outside of the IOU MFNC program to above-code standards due to market forces and various market interventions including reach code, CTCAC requirements, "soft money" sources, and so forth.

The research team calculated that all 28 projects with on-site visits were at or above code (24.6% BTS, on average), though 82% of these sites were subject to pressure or requirements to build more efficiently than code due to CTCAC or reach code. Case study respondents were also experienced with above-code building practices (all of the case study sites were designed to be at least 10% BTS), and 79% of surveyed developers reported that the biggest project they worked on from 2010 through 2012 was an above-code project.

B.2.1.1 On-Site Findings: Above-code Practices

As discussed in Section 3, all of the sample on-site projects exceeded the applicable Title 24 energy code requirements, ranging from slightly more efficient than code (1% annual energy savings compared to code) to much more efficient than code (66% annual energy savings). On average, low-rise sites (n=24) were found to be 23% more efficient than code, while high-rise sites (n=4) were 24% more efficient than code. In general, gas savings were substantially higher than electricity savings.

It is important to note that 82% of the sites (23 of 28) had either high-efficiency requirements or strong incentives to be high-efficiency, including all of the high-rise sites, either because they had received CTCAC awards or were built in reach code jurisdictions.[19] Of those 23 sites, 12 were mandated to be high efficiency, and 11 were encouraged to be high efficiency because they were projects that had won CTCAC funding before CTCAC required above-code practices in all of its participating projects.[20]

B.2.1.2 Case Study Findings: Above-code Practices

According to the consensus of the case study respondents, all of the case study sites were designed to above-code standards. Of the fifteen sites, respondents described six as being between 10% and 17% BTS, and nine of them being at least 20% BTS. The sample was over-representative of affordable housing projects, but this serves as a signal that projects were built to above-code standards outside of the IOU MFNC program, particularly given the strong activity level of the affordable housing market in California from 2010 through 2012. While these are self-reported data, we found that nine of 13 case study sites with on-sites had reasonably similar compliance margins to what the respondents estimated (within a 10% range); one site was calculated to be much less efficient than respondents thought (a 24% difference), and the remaining three were much more efficient than respondents thought (at least 14% more).

B.2.1.3 Developer Survey Findings: Above-code Practices

Seventy-nine percent of developers (n=33) reported that the largest multifamily new construction project they had worked on from 2010 through 2012 was built more efficiently than required by code—23% more, on average. It is important to note that two-thirds of the projects that developers were asked about were low-income projects, and a higher percentage of low-income projects were estimated to be more efficient than code compared to market-rate projects (90% compared to 58%). In contrast, we estimated that 50% of projects were low-income (won CTCAC awards) in the Phase 1 report. Because low-income projects are more likely to have efficiency requirements as part of their funding, the survey findings may be overstating the level of above-code construction in the MFNC market.

B.2.2 Increased Stock and Availability of High-efficiency Equipment

The second indicator in the above illustration related to this program element is the increased stock and availability of high-efficiency equipment.

***Summary of Findings*:** Future research is needed to shed light on the effects of the IOU programs on the stock and availability of high-efficiency equipment, such as through analysis of supplier

[19] In comparison, 59% of the population of nonparticipating MFNC projects located within IOU territories were required or encouraged to be high-efficiency (see **Error! Reference source not found.** for more details).

[20] As previously discussed, prior to 2011, CTCAC awarded competitive points for building to above-code standards, but did not mandate above-code practices in all projects. It is important to note that the competitive points were critical to securing CTCAC awards. Interviewees viewed meeting those higher efficiency criteria as de facto requirements that greatly increased their competitiveness for the CTCAC award money.

inventories. In general, case study respondents did not point to concerns about lack of equipment availability. However, they did express a common concern that the available high-efficiency equipment either was not—or was perceived not to be—as reliable as standard efficiency equipment.

B.2.2.1 Phase I Report Findings: High-efficiency Equipment

In the Phase I report, evaluators theorized that, due to developers' participation in above-code programs like the IOU program, manufacturers—and particularly distributors—may be encouraged to stock higher efficiency mechanical equipment, thus leading to changes in practices even in non-program construction due to the increased availability of high-efficiency equipment.

B.2.2.2 Case Study Findings: High-efficiency Equipment

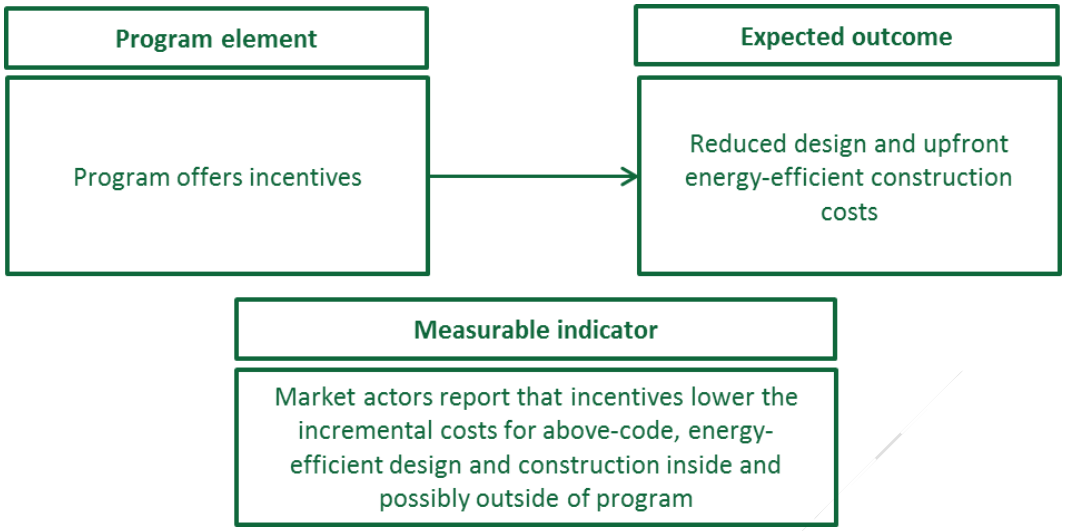
When discussing obstacles to energy-efficient construction, case study interviewees did not generally discuss problems with the availability of high-efficiency equipment. Rather, they more often reported concerns about the reliability and maintenance costs of this equipment. Ten of twelve respondents who explicitly discussed the topic[21] confirmed sufficient availability of high-efficiency equipment for their multifamily projects; only two mentioned that code cycle changes had started to outpace the availability of efficient equipment or capabilities of their energy modeling software. None of these 12 respondents mentioned that the IOU program drove this outcome, though two said that programs such as CTCAC and LEED (*not* the IOU program) drove the increasing availability of efficient equipment. As discussed in the Phase I report, market experts reported coordination between CTCAC and the IOUs to create consistent program standards such that there could be a link to IOU efforts that is unknown to participants.

We did not address the stock and availability of high-efficiency equipment in the developer survey.

B.3 Expected outcome: Reduced design and construction costs

Financial incentives are a key IOU program mechanism designed to overcome barriers related to the cost and hassle of building to above-code standards and help address the split-incentive barrier, whereby the project owners/developers have less incentive to build efficiently because they do not pay the residents' utility bills. This program element, linked outcome, and measurable indicator of that linkage are illustrated below.

[21] Respondents were not directly asked to comment on equipment availability. In addition, respondents were generally experienced with above-code building practices, suggesting that they were able to procure the materials necessary to meet those standards, even if they did not comment on this directly.



***Summary of Findings*:** Case study interviewees provided insufficient evidence to suggest that there were changes in the incremental costs of energy-efficient practices or technologies outside of the IOU MFNC program.[22] IOU incentives can reduce the marginal cost of building to above-code standards, but some developers perceive barriers to program participation, such as the amount or timing of the incentives that are only received at project completion, well after developers have had to put together their project financing and capital.

B.3.1 Phase I Findings

In Phase I, the research team theorized that IOU program incentives can help lead to greater acceptance from builders and fuel demand for high-efficiency equipment in the marketplace, which in turn can encourage an increased supply of high-efficiency equipment, even outside of the IOU program.

B.3.2 Case Study Findings

Only two case study respondents reported that efficiency programs decreased costs by encouraging an increased supply of efficient technologies, and both attributed this to non-IOU programs (LEED and CTCAC) or other market forces.

While 16 of the 20 respondents who discussed the impact of program incentives said that the incentives helped with the cost of building their program projects to above-code standards, respondents also described the presence of barriers to program participation, such as hassle and transaction costs, that make pursuing the incentives unattractive to some developers. (We discuss program barriers in greater detail in Section 6.) Some respondents also pointed to developers of CTCAC and reach code projects obtaining program incentives that lowered the costs of those

[22] Only two respondents, a market-rate developer and a HERS Rater, specifically mentioned the price of newer technologies decreasing in recent years, and they both attributed this to demand triggered by efficiency programs, but not the IOU program; the developer saw it driven by LEED, and the rater by CTCAC.

projects without greatly impacting their efficiency. (This outcome represents an intentional and synergistic relationship discussed in IOU Program Implementation Plans.)[23] At least in part due to the large number of CTCAC participants in the sample, only three of these 20 respondents described the incentives as pushing developers to increase the marginal efficiency of their IOU program projects.

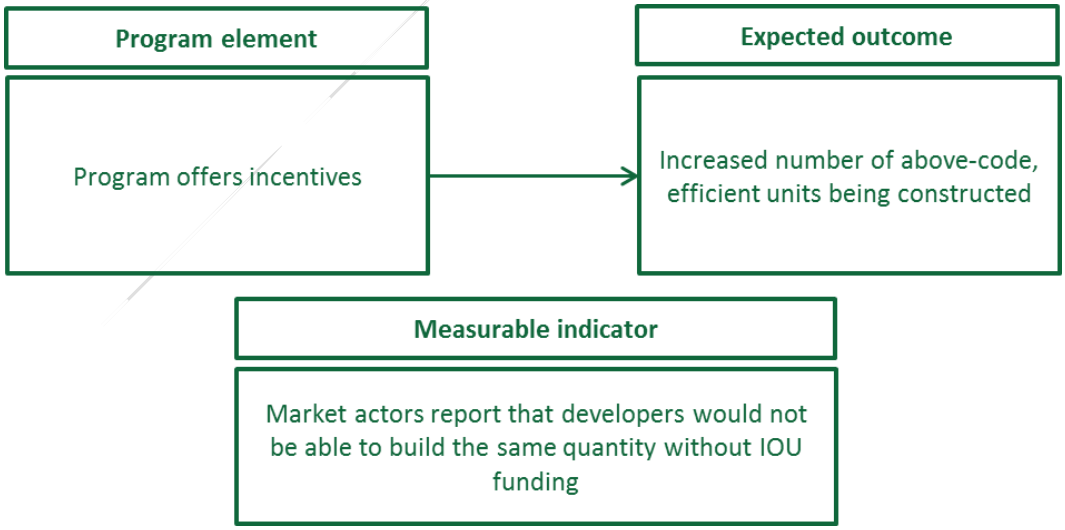
Four of these 20 respondents said that the IOU incentive amounts were too low to pursue; a fifth interviewee (a nonprofit developer) described the incentives as a "rounding error" that only helps offset the cost of hiring the consultants necessitated by program participation. Some respondents reported that they could not completely count on rebates as a part of their budget because the money came only at the project's completion (see Section 6.2.2).

B.3.3 Developer Survey Findings

Developers were not asked about changes to incremental pricing for efficiency measures.

B.4 Expected outcome: Increased numbers of above-code, efficient units being constructed

The IOUs' incentives and program outreach to developers are designed to encourage participation in the IOU new construction programs and potentially could encourage developers to build more above-code units than they would without that financial or informational support. This program element, linked outcome, and indicator of that linkage are illustrated below.



Summary of Findings: High levels of IOU MFNC program participation (38% of California units started from 2010 through 2012) suggest that the program could positively impact the number of

[23] Projects in reach code communities are permitted to participate in IOU programs. Source: Southern California Gas Program, Program Implementation Plans: Statewide Programs, Appendix B.2, Section A, April 23, 2013, http://www.socalgas.com/regulatory/documents/A-12-07-003/Appendix%20B.2%20Section%20A%20Statewide%20Programs.pdf, accessed March 23, 2015.

units built, but Phase II interviews and surveys did not uncover evidence that the program was doing so.

B.4.1 Phase I Report Findings

As the U.S. housing market started to recover in 2010 after the 2009 economic downturn, the number of units that were started ("broke ground") increased by 39% from 2010 to 2012, while the number of projects that started increased by 12% during the same period. We estimated that there were 60,834 units in the 763 multifamily projects that were started from 2010 through 2012. Nearly two-fifths (38%) of all units that started in the IOU territories from 2010 through 2012 participated in the IOU MFNC programs.[24] A total of 238 MFNC IOU program projects were started from 2010 through 2012, with nearly all (234) enrolled in the CAHP or CMFNH program, while only four were enrolled in the SBD program. This information can be used as a baseline for future studies.

B.4.2 Case Study Findings

Case study interviewees did not directly discuss the program's impact on their level of construction activity, other than one affordable housing developer mentioning that on his large projects, the incentive money had a negligible effect, and that incentives are "not something that's going to either get your project done or not get it done."

As previously discussed (Appendix B.3), interviewees did not report that IOU incentive levels were large enough to have an impact. Respondents involved with affordable housing projects typically viewed the CTCAC tax credit awards as a much bigger factor that increased the number of their construction starts than the IOU incentives.

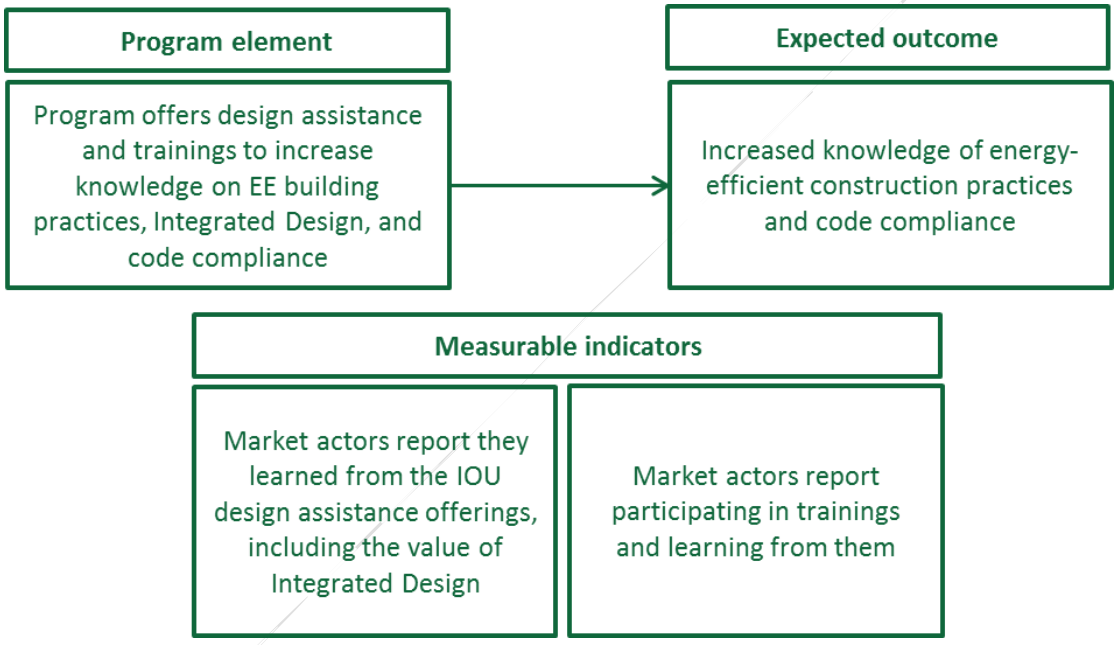
B.4.3 Developer Survey Findings

The developers surveyed did not directly comment on whether or not the IOU program affected the number of units they constructed from 2010 through 2012 (though they did discuss the impact on those projects' efficiency levels; see Appendix B.1).

[24] The IOU's MFNC programs accounted for about one-third (32%) of MFNC projects started in the IOU territories from 2010 through 2012. NMR Group, *Phase I Report: Baseline Characterization – Market Effects Study of Investor-Owned Utility Multifamily Residential New Construction Programs in California*, 2014.

B.5 Expected outcome: Increased knowledge

The IOUs offer design assistance and training to market actors in an effort to increase knowledge under the assumption that knowledgeable market actors are also better able to comply with code, meet voluntary criteria, and carry this knowledge into future projects (both program and non-program). The IOU MFNC program design assistance teaches market actors about advanced building practices and the value of Integrated Design practices by providing feedback on specific projects going through the IOU program. The trainings seek to increase market actors' ability to meet advanced building requirements cost-effectively through improving their designs and construction processes. Together, program design assistance and trainings strive to overcome barriers related to market actor knowledge, information, and willingness to build efficiently. The program element, theorized outcome, and measurable indicators of that link illustrated below summarize these dynamics as included in the program theory logic model.



Summary of Findings: Phase II case study interviews and developer surveys showed that the IOU MFNC program training and design assistance influenced those who participated but, as mentioned previously, the IOU program offerings serve as one of several market interventions in California (CTCAC, LEED, GreenPoint Rated, etc.) that offer trainings to help MFNC market actors to improve their design and construction. In addition, relatively low levels of program awareness and lower rates of participation in training hinder the program's ability to affect the market.

Case study respondents reported that these informational IOU MFNC program elements had increased attendee/recipient knowledge and also impacted their energy efficiency practices outside of IOU program projects: Nearly two-fifths of case study interviewees indicated that IOU MFNC program training and/or design assistance had increased their knowledge about energy efficiency, and sizable shares of developers who received training said that it had influenced the efficiency level of their non-program project practices. Some interviewees did not view the training and

design assistance as particularly influential, suggesting, among other things, that the IOUs increase the specificity of their guidance.

Twenty-seven percent of the 33 developer survey respondents received IOU training. Overall, 15% of respondents, representing 19% of all units started among respondents, said that the training was somewhat or very influential on their design practices, while 9% rated the training as very influential on their construction practices.

B.5.1 Phase I Report Findings

Phase I findings led the research team to hypothesize that multiple program efforts, including IOU trainings or design assistance, could result in better informed and more experienced design teams.

B.5.2 Case Study Findings

B.5.2.1 Design Assistance

Fourteen of the case study interviewees recalled receiving IOU program design assistance on specific projects; only five of them reported some degree of increased knowledge resulting from it, and the other nine did not find it valuable.

After saying that the design assistance helped his company "a lot," a developer concluded that the techniques that his company learned from design assistance became their standard practice: "All of what we learn on the projects, we apply it again." Additionally, after rating the design assistance as a five on a scale of 0 to 10, where zero equals "no influence" and ten equals "a great deal of influence" on their non-program projects' efficiency level, an engineer said that despite what they learn from program assistance, developers, as key decision makers, will only implement the level of energy efficiency that is required.

Of the nine interviewees who had received design assistance but did not find it valuable, a couple of the interviewees opined that communicating with the program staff was challenging and that the concepts that the program staff provided were too broad to be helpful or came too late in the design process.

B.5.2.2 Training

Twenty-one of the case study interviewees attended IOU MFNC program trainings.[25] Their assessment of the trainings' value varied, but the majority (17 of 21) reported that the program training increased their own or other recipients' knowledge of energy efficiency. They described how the program contributed to increased knowledge generally, or they specified the elements for which it increased knowledge: specific equipment and practices, cost-effectiveness, knowledge of base code, how to complete paperwork, etc. One HERS Rater remarked that the trainings increased

[25] Four code officials also commented on the value of the IOUs' codes and standards training (none were involved with the IOU MFNC program training). They found the codes and standards trainings to be immensely useful, helping them to recall old information, learn new information, and prepare for new codes. Two of the four added that the IOU trainings were even more helpful than trainings offered by other entities.

developers' focus on energy efficiency a great deal. This knowledge, from some interviewees' perspectives, was applied to non-program projects.

Fourteen interviewees provided a rating when asked about the level of influence that the IOU training had on non-program projects' efficiency level. On a scale of zero to ten, their median rating was 6 and average rating was 5.3.[26] One interviewee had seen some market effects, but only a small amount (rating greater than zero but less than five). He explained that its influence was limited because there were other green programs that contributed to his company's knowledge:

> *It had some influence, but it wasn't a very large influence. It was a lot of information that we were somewhat already very experienced with. And maybe there were a few tidbits that were offered up that hadn't been considered, but the majority of the program objectives and suggestions, they're the same as most every other green program, and they've all been discussed, mostly, on previous projects or in previous design developments.*

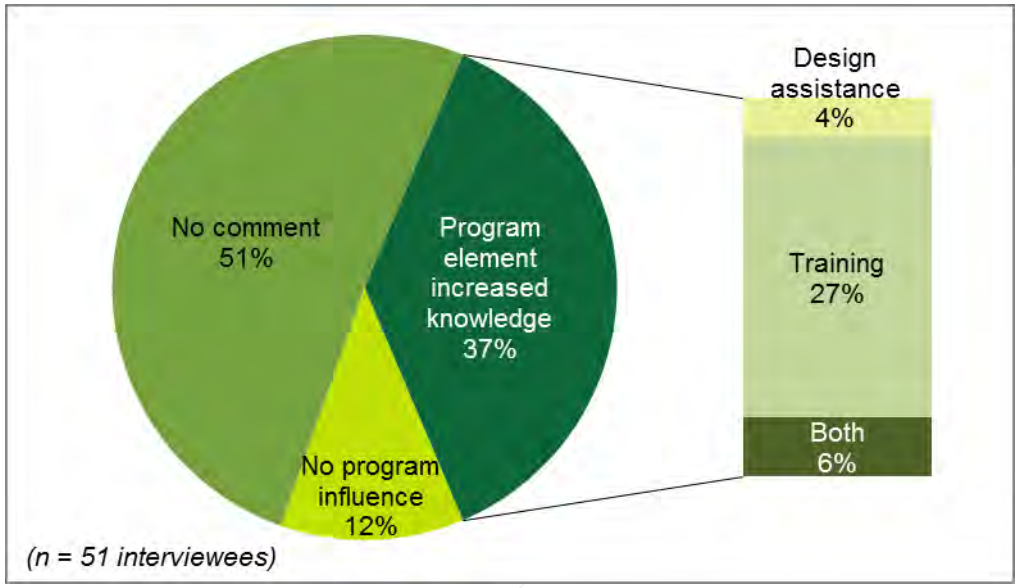
On that note, 16 interviewees (nine of whom reported that IOU program training had increased knowledge) said that other trainings had contributed to their increased knowledge; most often, they attributed it to trainings offered by GreenPoint Rated, the California Association of Building Energy Consultants (CABEC), and CalCERTS (a HERS Provider in California).

[26] We asked interviewees to use a scale of 0 to 10, where 0 is "no influence" and 10 is "a great deal of influence," to rate the influence that the utilities' trainings had on the efficiency level of non-program projects.

B.5.2.3 Combination of design assistance and training

Nineteen interviewees (37% of 51) indicated that IOU MFNC program training and/or design assistance had increased their knowledge. Figure B-10 below illustrates that there was some overlap, with 6% indicating that both program training and design assistance were influential.

Figure B-10: Case Study Interviewee Perspectives on IOU MFNC Program Training and Design Assistance Influence on Increased Knowledge

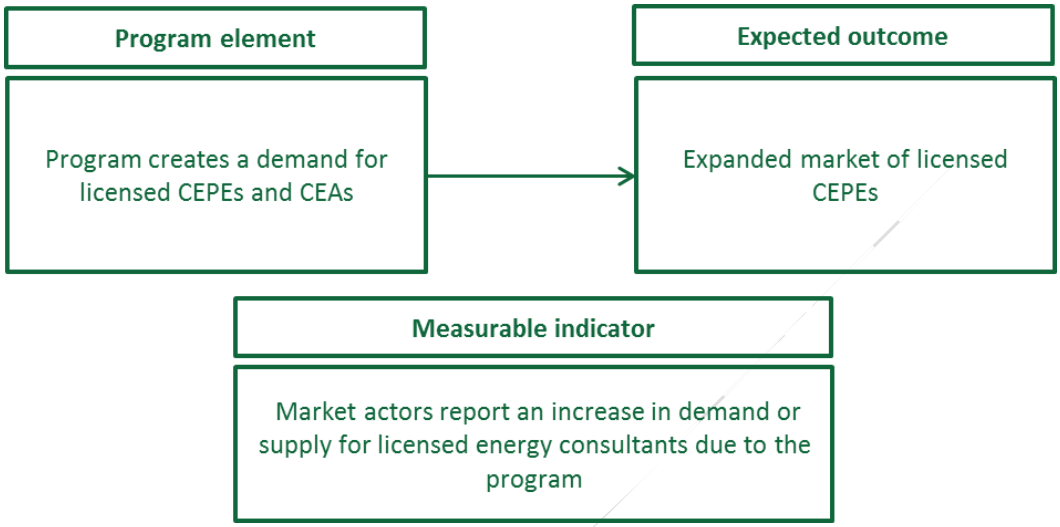


B.5.3 Developers Survey

According to the developer CATI survey, IOU training influenced the efficiency level of a limited number of developers' design and construction practices on their non-program projects (complete analysis in Appendix E). Twenty-seven percent of the 33 developer respondents, representing 25% of units, received IOU training. CATI interviewers asked respondents to rate the influence that the training had on the efficiency level of their *design* practices on non-program projects that started construction between 2010 and 2012. Their responses indicated that 15% of respondents—55% of those that received training, representing 19% of all units started among respondents—said that the training was somewhat or very influential on those practices. When rating the influence that the training had on their *construction* practices, 9% of all respondents rated it as very influential (none rated it as somewhat influential)—this represents one-third of those that received training and 12% of all started units.

B.6 Expected outcome: Expanded market of licensed CEPEs

Authors of Title 24 energy compliance documentation are not required to be Certified Energy Plans Examiners[27] (CEPEs), but the IOU program does require this of documentation authors in order to increase the quality of submissions to the program. The program theory logic model posits that this program requirement could drive demand for CEPEs in the marketplace, as shown below.



Summary of Findings: A limited number of case studies revealed that the IOU MFNC program, along with other programs and requirements, have increased demand for CEPEs and CEAs to some extent. Outside of the IOU program, the use of CEPEs is not required in the construction market in California, but it is encouraged by Title 24 compliance manuals and required by multiple above-code programs. A small number of market actors perceive that CEPEs and CEAs offer helpful guidance and the certifications themselves offer credibility to those attaining them. Our review of CABEC certification lists found that CABEC discontinued the CEPE certification and changed the CEA certification for the 2013 Title 24 standards, leaving only a small pool of individuals certified under the most recent standards. This required programs to temporarily rely on the larger pool of CEPEs certified under previous Title 24 standards.

B.6.1 Phase I Report Findings

The Phase I report did not quantify the CEPE market in California, but evaluators theorized that the IOU program's requirements could drive demand for them, resulting in an increase in certified CEPEs in the state.

B.6.2 Phase II Supplemental Findings

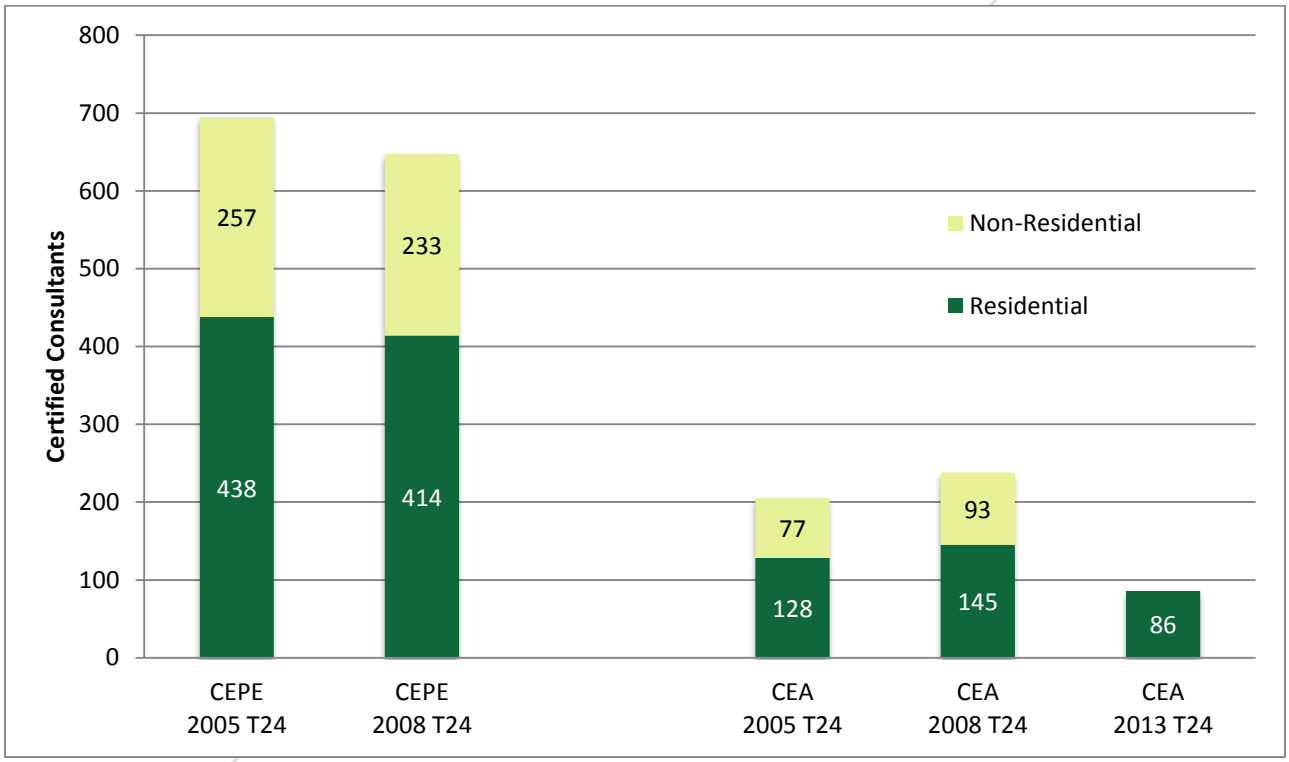
Fewer CEPEs were active in California at the end of the 2008 Title 24 energy code cycle than at the end of the 2005 Title 24 cycle (a 7% drop, from 695 to 647), due in part to CABEC

[27] Information on the CEPE certification is available at: http://www.cabec.org/cepeinformation.php.

discontinuing CEPE certifications.[28] The number of CEAs increased by 16% from the end of the 2005 cycle to the end of the 2008 code cycle (from 205 to 238 people).

The 2013 Title 24 energy code cycle discontinued the CEPE certification track and significantly revised the CEA certification requirements such that only 86 residential CEAs have been certified for the most recent Title 24 energy standards (down from 145 at the end of the 2008 Title 24 cycle).[29]

Figure B-11: Uptake in CEPE and CEA Certifications



* CABEC discontinued the CEPE certification for the 2013 Title 24 energy code.

Until a sufficient number of CEAs can be certified for the 2013 Title 24 standards, some programs, including the 2014-2015 IOU MFNC program, are allowing Title 24 compliance documentation to be submitted by 2008-version CEPEs and CEAs.[30,31]

[28] Data provided to NMR Group, Inc., by CABEC via e-mail in April 2015.
[29] Non-residential CEA exams have not yet been offered, and the residential exam was only offered at the end of 2014, as of this report.
[30] California Association of Building Energy Consultants (CABEC). "FAQ's about 2013 CEA Certification." http://www.cabec.org/index.php?option=com_content&view=article&id=242:faqs-about-2013-cea-certification&catid=38:about-cea&Itemid=57, last accessed March 27, 2015.
[31] California IOUs. 2014-2015 *Participant Handbook and Program Agreement for Single-Family and Multi-Family New Construction Projects.* 2014. https://www.socalgas.com/documents/construction/cahp-handbook.pdf, last accessed March 30, 2015.

B.6.3 Case Study Findings

Case study respondents confirmed that multiple programs—including the IOU MFNC program, LEED, and CTCAC—created demand for CEPEs and CEAs, as they all require Title 24 documentation authors to have these certifications.[32] Seven respondents described experiencing increased demand for CEPEs and CEAs, and four of them, including a developer, specifically noted that they rely on CEPEs[33] or CEAs to help them navigate the requirements of these various programs with efficiency requirements. While Title 24 does not require documentation authors to be CEPEs or CEAs, the Title 24 compliance manual does refer readers to the CABEC list of CEPEs to find "a list of qualified documentation authors,"[34] suggesting that Title 24 itself may have driven the CEPE market as well.

Two raters (both CEPEs) reported that this certification increased their value to developers. One stated, "I can speak louder to developers because of this added credential." An engineer described CEPE certifications as unnecessary for engineers, saying that his firm let its certifications lapse, but two raters for different projects reported that the non-CEPE MEP engineers on their case study projects had created flawed Title 24 compliance calculations that required significant revision.

B.6.4 Developer Survey Findings

The developer CATI survey did not explore the size of the CEPE market.

B.7 Expected outcome: Improved compliance with base code and above-code programs

The IOU programs include various program elements related to quality control, training, and measure verification that are intended to ensure compliance with program requirements, providing a level of quality control for energy efficiency measures beyond that provided for projects only subject to base code requirements. In this section, we describe the program elements and indicators that could lead to improved compliance and discuss the measurable indicators of those linkages between the program elements and that outcome. The program logic model theorizes that IOU program plan check, HERS inspections, usage of CEPEs, and training offerings lead to improved compliance metrics.

Summary of Findings: Generally, case study interviewees provided feedback that was consistent with the theorized links from the Phase I report between program elements promoting enhanced compliance with various relevant energy efficiency requirements, with some caveats. By fostering adherence to strict quality control standards, the IOU program likely resulted in market effects due

[32] Ted Bardacke. "Enterprise/SCANPH Green Bag," February 18, 2011. http://www.scanph.org/files/GreenBag-TCACRegs2011.pdf, last accessed March 30, 2015.
[33] One was a former CEPE.
[34] California Energy Commission. 2013 Residential Compliance Manual. See Section 2, "Compliance and Enforcement." http://www.energy.ca.gov/2013publications/CEC-400-2013-001/chapters/02_Compliance_and_Enforcement.pdf, last access March 20, 2015.

to fostering a market of developers and consultants better able to correctly implement above-code practices in their non-program projects, as discussed in Appendix B.2.1. Case study interviewees found that the IOU program plan check's thoroughness was useful in identifying problems with code compliance; they reported that HERS Raters (which are required by the program) were valuable in helping them navigate requirements of various above-code programs, and many thought that CEPE professionals (supported by the IOU program) did high quality work. Barriers from adopting these positive influences exist, such as code officials paying less attention to energy efficiency than do IOU program plan checkers, and some developers preferring not to use HERS Raters when not required to do so due to associated costs and hassles.

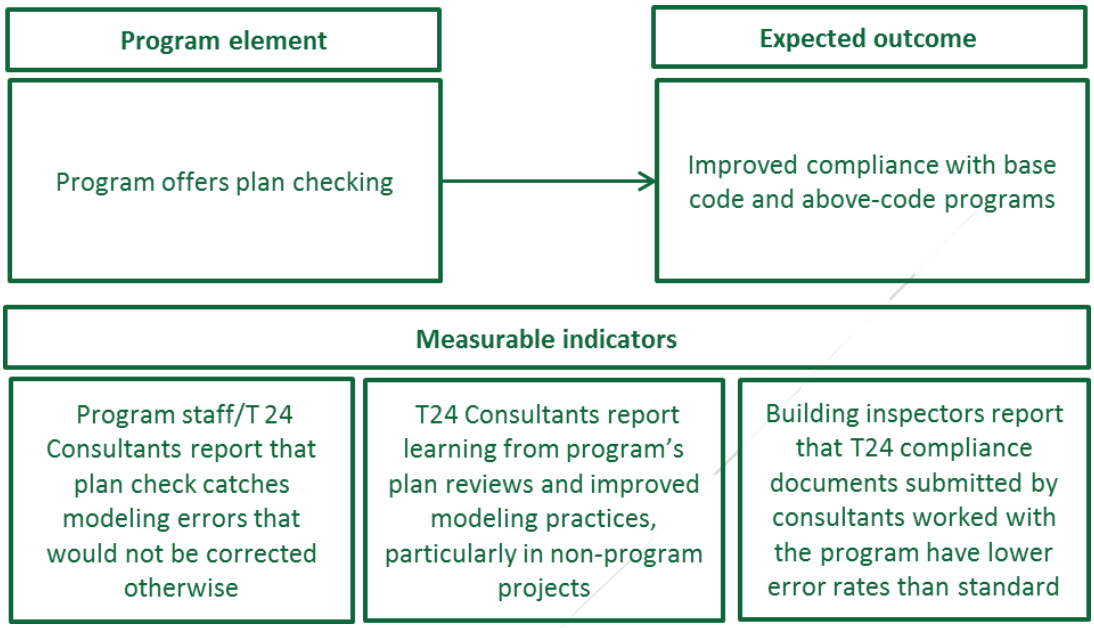
B.7.1 Phase I Report Findings

Market experts and IOU program staff interviewed during the Phase I study reported that various elements of the IOU programs could lead to improved compliance with code and various above-code program requirements. They cited the IOU plan check as a valuable quality control activity that went beyond what was done by most building officials, thus improving the quality of compliance submissions and educating document authors through program staff's feedback. Additionally, IOU program training efforts are designed to work in a variety of ways to help developers and their consultants better accomplish above-code design and construction practices. (The training indicator is assessed in detail in Appendix B.5.)

The IOU program requires HERS verification of more measures than required by Title 24, and because HERS Raters are trained to focus on energy issues, their on-site inspections are reportedly more thorough than that of most building departments. Similarly, respondents, including program staff, reported that the IOU program requires Title 24 compliance documentation to be authored by licensed CEPEs (or CEAs), largely to ensure high-quality Title 24 compliance documents. Title 24 does not require documentation authors to have CEPE or CEA certification, but it is encouraged.

B.7.2 Case Study Findings

The program logic model theorizes about the relationship between IOU program plan checks and improvements in modeling and documentation. The illustration below shows this and includes the measurable indicators of that link included in the program theory logic model.



Most of the case study respondents did not discuss the IOU program's plan check offering, but respondents familiar with the process indicated that it does serve as a useful tool for identifying problems with code compliance and errors with Title 24 compliance documents in IOU program projects.

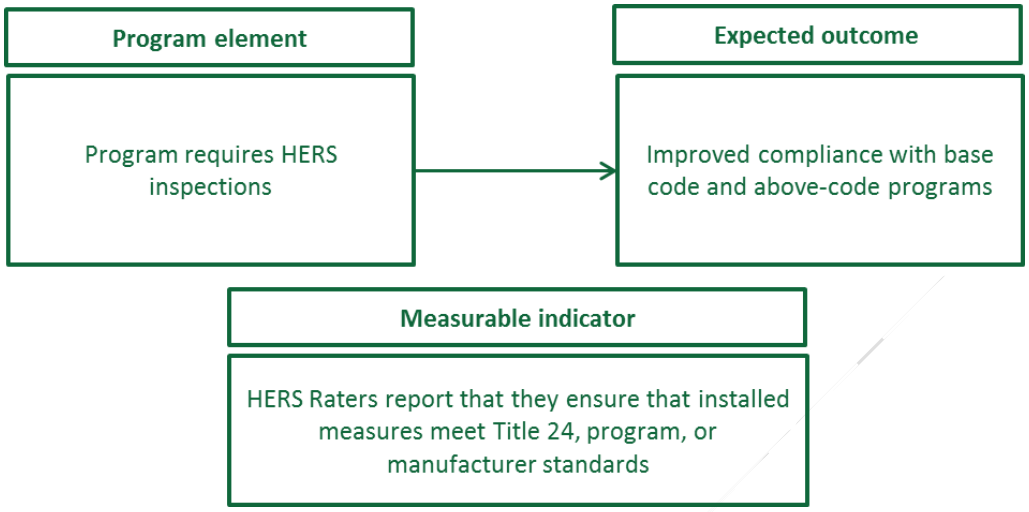
Four case study respondents reported that the IOU program's plan check is more thorough than that done by code officials, and that IOU program staff identify modeling errors that code officials would not notice. One HERS Rater described the IOU program's plan check as a critical code compliance tool for municipalities:

> *What you're thinking of as a secondary check from CAHP and CMFNH, that is a first real energy check. Cities and counties are just relying on what's printed [in the author's documentation].*

A code official interviewee reported that the IOU program serves as a valuable quality assurance check given that energy code inspection is not typically a priority for code officials.[35]

[35] For additional information regarding code officials' relationship with energy efficiency, see Section **Error! Reference source not found.**.

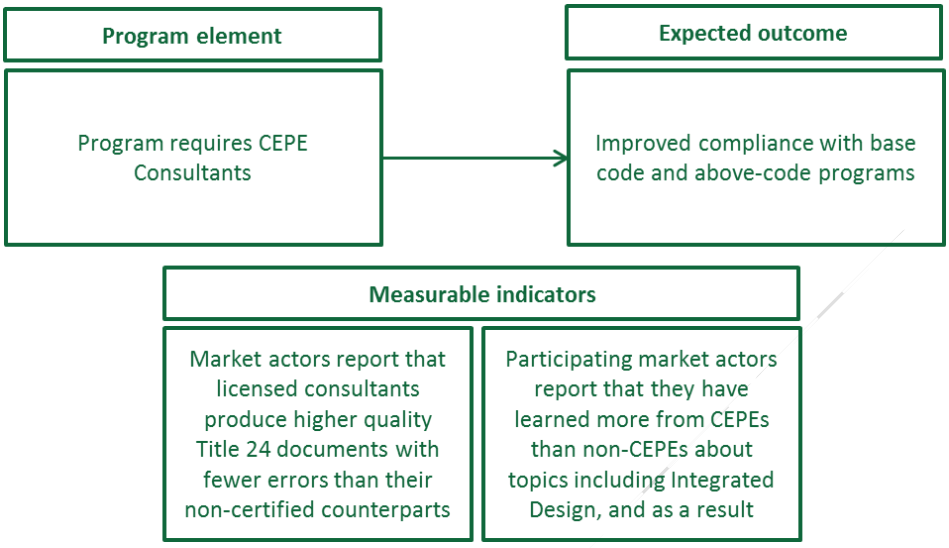
The illustration below shows the program theory logic model relationship between the mandatory IOU program HERS inspections leading to improved compliance and the indicator that can measure the success of the outcome.



All of the case study respondents who discussed developers' motivations for hiring HERS Raters (n=12) reported that Raters are valuable on multifamily projects and contribute to compliance with code and above-code program requirements by ensuring that measures are installed properly or by helping design teams navigate various programmatic requirements. However, the closeness of the working relationship between decision makers and HERS Raters varies: 64% of respondents (n=11) described working with key decision makers who appreciated HERS Raters' work, while 45% described working with developers who were ambivalent about HERS Raters' value or felt negatively about using them due to the associated hassle or cost.[36] Two tax credit investors also described how they relied on HERS Raters (and other consultants) to ensure that the projects met any CTCAC requirements so as not to jeopardize funding.

[36] Percentages do not add to 100% because some respondents described experiencing both situations.

The program's requirement of CEPE-certified Title 24 consultants is theorized to lead to improvements in Title 24 compliance. The indicators shown in the figure below (Indicators 11B and 11C) measure the success of this outcome.[37]



Interviewed market actors reported that CEPE (and the more advanced CEA) certification is correlated with the quality of a Title 24 energy consultant's compliance documentation, but work quality does vary from consultant to consultant. Ten out of twelve case study respondents who commented on CEPEs' work quality (including three out of four municipal code officials) reported that CEPE-certified Title 24 documentation authors do superior work, making fewer errors and demonstrating a better understanding of Title 24's energy requirements. Two code officials described how some consultants do better work than others in general, independent of their certification status; one noted that developers of large multifamily projects tend to hire better consultants than might be found on smaller or single-family projects. Only two out of those twelve respondents disagreed that CEPE authors inherently did superior work to non-CEPEs.[38]

Two Title 24 consultants also noted that the more advanced CEA certification had been more valuable to them than the CEPE certification, a finding that aligns with CABEC phasing out the CEPE in favor of the CEA certification for the 2013 Title 24 energy standards.

While respondents generally reported that CEPEs perform higher quality work than non-CEPEs, some qualified their statements. As previously mentioned (Appendix B.6), an engineer described CEPE certifications as unnecessary for engineers, saying that his firm had let its certifications lapse, but two energy consultants reported that the MEP engineers on their case study projects had created flawed Title 24 compliance calculations that required significant revision. Another respondent, a Title 24 consultant, expressed concern that some consultants might delegate too

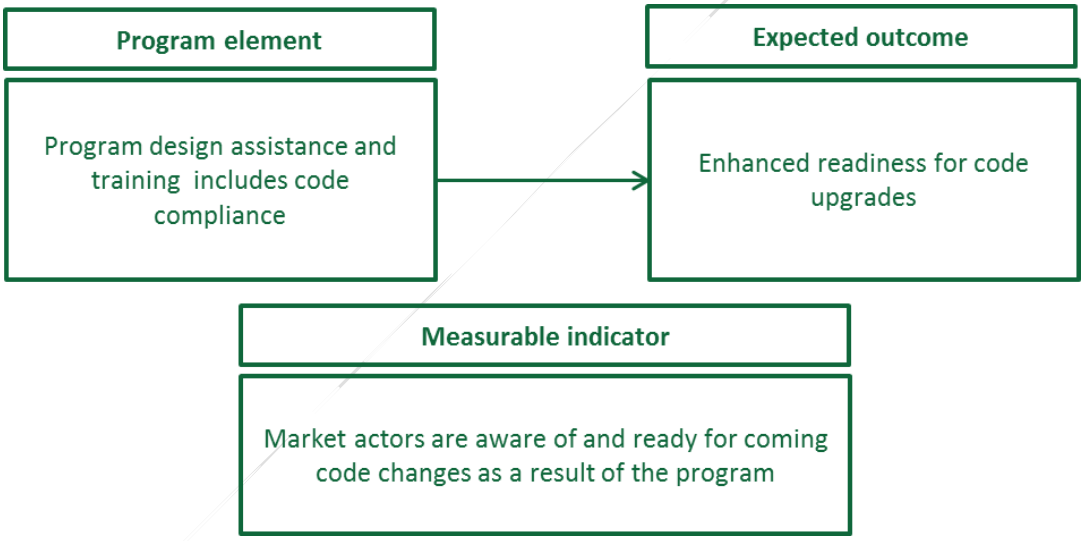
[37] Indicator 11A, "On-site inspections confirm above-code practices," is already assessed in the Link and Indicator 1 discussion (Appendix B.2.1).
[38] One, an engineer, thought that engineers were similarly qualified, while a code official thought it was the quality of the firm that determined the quality of the documentation, not the certification itself.

much of their document preparation to low-level employees. A HERS Rater suggested that Title 24 require CEPE or CEA certifications because qualified individuals do not "game" (i.e., attempt to take advantage of) the compliance system.

Case study respondents (other than CEPEs and CEAs) were not asked about their preferences regarding CEPE-certified consultants, though they did consistently report that having knowledgeable consultants on their design teams was important. One CEPE and an energy consultant specifically reported that they could teach design teams and developers about efficiency due to their CEPE qualifications.

B.8 Expected outcome: Enhanced readiness for code upgrades

Due to program activities that result in increased knowledge of energy efficiency techniques (e.g., design assistance, HERS verifications, and training), the IOU program is designed to assist market actors in meeting the requirements of future code cycles. The illustration below shows this relationship and its measurable indicator.



Summary of Findings: Meeting the requirements of changing energy code appears to be a challenge for many market actors, but based on findings from this study, there is strong evidence that significant numbers of non-program multifamily homes were built in the 2010 through 2012 period using above-code practices as a means of complying with the requirements or expectations of various energy efficiency programs, such as the IOU MFNC program, CTCAC, and reach code. This suggests that at least some market actors were able to prepare beforehand for an upcoming code cycle.[39] A small number of interviewees credited the IOU program with improving their preparedness for future code cycles.

[39] Most of the case study respondents built projects under the 2008 Title 24 energy efficiency standards, but as of 2014, the 2013 Title 24 standards have come into effect.

B.8.1 Phase I Report Findings

The evaluation team estimated in Phase I research that more than one-half of the MFNC projects (57%) and units (57%) started from 2010 through 2012 were required or encouraged to be high-efficiency due to CTCAC or reach code requirements. Of all the units started in IOU territories from 2010 through 2012, 38% participated in the IOU program; about one-half (53%) of those IOU program units were required or encouraged to be high-efficiency due to CTCAC participation or their location in reach code jurisdictions.

B.8.2 Case Study Findings

Case study interviewees commonly had experience building to above-code standards. All of the case study sites were designed to above-code standards, based on the consensus of respondents. On average, respondents said the case study projects were either around 15% BTS (6 out of 15 sites) or significantly above 15% BTS (9 out of 15 sites).

While they were experienced with above-code construction, nearly all of the case study respondents who addressed the topic of code cycle upgrades (17 of 19) mentioned some aspect of hassle, transaction, or information costs associated with meeting upgraded standards. One HERS Rater with market-rate clients said the following:

> *When you have these big code changes, our clients are pulling their hair out like there's no tomorrow.*

While only three interviewees explicitly credited the IOU program with improving their preparedness for future code cycles, the evaluation team infers that the IOU program—along with other above-code programs and requirements, such as CTCAC and reach code—does contribute to readiness for future code cycles by requiring them to follow standards that are typically comparable to the base requirements of the future code cycle.[40]

In addition, the IOUs have played a key role in reach code adoption, which helps ready the market for new code cycles. The IOUs' Codes and Standards Program includes a Reach Code Subprogram element that provided both policy guidance and technical support to local municipalities regarding the adoption and implementation of reach code. An important aspect of this assistance came in the form of performing climate-specific studies on the cost-effectiveness of implementing reach code, which municipalities could use in their applications to the CEC.[41]

[40] Unrelated to discussions of market effects, continuing to participate in above-code programs immediately after code cycle upgrades may still prove challenging to those used to building to the minimum efficiency thresholds of various above-code programs.

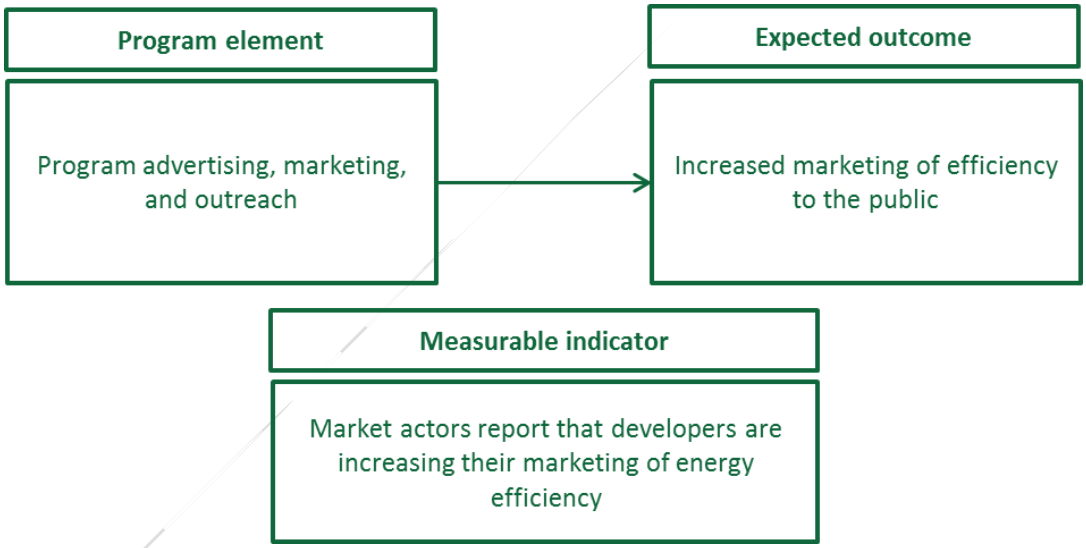
[41] For more information on the IOUs' efforts to foster the adoption of reach code in California, see the Cadmus Group evaluation of the 2010-2012 Reach Code Subprogram within the Codes and Standards Program. The Cadmus Group, Inc., *Reach Code Subprogram 2010-2012 Process and Pilot Impact Evaluations*, prepared for the California Public Utilities Commission, October 2013. https://www.pge.com/regulation/EnergyEfficiency2015-BeyondRollingPortfolios/Other-Docs/ED/2014/EnergyEfficiency2015-BeyondRollingPortfolios_Other-Doc_ED_20140507_304180Atch01_304181.pdf.

B.8.3 Developer Survey Findings

Surveyed developers commonly built to above-code standards. Of the 33 CATI survey respondents, many experienced working with green programs or in reach code jurisdictions with above-code efficiency requirements, which suggests some readiness for meeting future code upgrades. Overall, 82% of the respondents had worked with at least one above-code project. Most often, they participated in GreenPoint Rated (55%) and CTCAC (52%). Appendix E shows the results in full.

B.9 Expected outcome: Increased marketing of efficiency to the public

Through its own marketing and outreach efforts, the IOU MFNC program seeks to increase the amount of marketing that MFNC market actors conduct. The program encourages developers to market efficiency to homebuyers with the expectation that it will stimulate consumer awareness and demand for energy efficiency. (We discuss consumer awareness and demand specifically in Appendix B.10.) The figure below shows this dynamic as it exists in the program theory logic model.



***Summary of Findings*:** While we did not find evidence of the IOU program directly increasing developers' marketing efforts, we did find that developers saw energy efficiency as an important component of their promotional efforts, particularly as a way to differentiate their projects and make the projects more attractive to and more likely to be supported by investors, funders, municipalities, customers, and the general public**.** In addition, many interviewees (15) noted the importance of green labeling programs in their marketing of energy efficiency. Most often, developers and other market actors, market experts, and IOU program representatives perceived that the LEED "brand" carried the most prestige among consumers and other stakeholders. While the IOU program seeks to leverage the ENERGY STAR Homes program, market actors did not frequently point to ENERGY STAR Homes as carrying great weight for their target markets.

B.9.1 Phase I Report Findings

In the first phase of our research, we learned that the IOU program uses a variety of advertising and outreach mechanisms to encourage developers to participate in the program. While the IOUs target their marketing efforts at increasing developer participation in the program, they also encourage developers to market efficiency to homebuyers, thereby increasing consumer awareness and demand for energy efficiency. One facet of this involves leveraging the branding associated with green programs to increase the name recognition and demand for the programs, either among market actors within the construction industry or among consumers. Phase I interviewees speculated that ENERGY STAR Homes and LEED for Homes were likely the most recognizable programs to homeowners and renters, followed by GreenPoint Rated and EGC. CAHP name recognition appeared mostly limited to market actors in the new construction industry.

IOU program marketing and outreach activities were reportedly more likely to target market-rate developers with the assumption that they already have well-established relationships with affordable housing developers who more commonly participate in the program.

B.9.2 Case Study Findings

Twenty-four case study interviewees commented on marketing as it relates to energy efficiency in the MFNC market. Nearly all of them (22) described how energy efficiency is leveraged as a marketing tool, with only two asserting that developers in this market are not concerned with marketing energy efficiency. None of the interviewees attributed their usage of marketing to the IOU program.

Generally, interviewees explained that marketing energy efficiency offers market actors the opportunity to differentiate their projects, making the entities involved in the projects and the projects themselves more attractive in the eyes of investors, funders, customers, and the general public. For example, seven interviewees reported that public and private entities, such as municipalities or lenders, would be more likely to support the development of projects or market actors associated with green building practices. Six other interviewees focused on the distinctions across their markets' dynamics, often describing how developers marketed based on their perceptions of increased customer demand in their high-income or luxury markets.

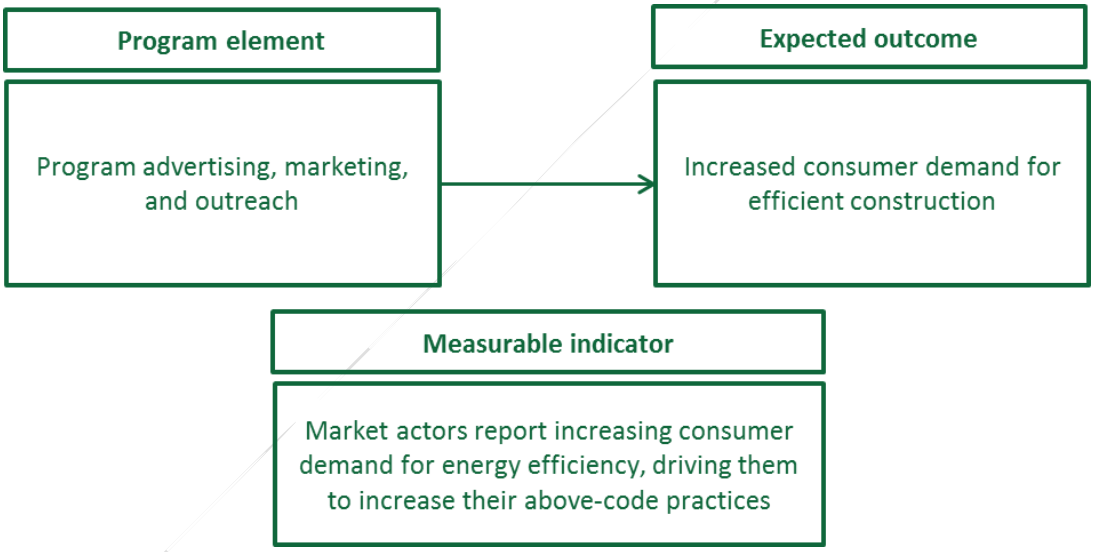
Many interviewees (15) focused on the importance of green labeling programs in market actors' energy efficiency marketing, with seven of them emphasizing how LEED in particular played a pivotal role in marketing. Others mentioned GreenPoint Rated (2), EGC (1), and ENERGY STAR (1) as important tools as well. One architect thought that green ratings enabled design and construction teams to "look responsible." The 17 interviewees who reported that certain green programs had particularly high levels of cachet all identified LEED as being highly recognized and valued by consumers. Two also identified GreenPoint Rated, but one of them clarified that GreenPoint Rated was popular among investors, not occupants.

B.9.3 Developers Survey

The developer CATI survey questions did not ask respondents directly about their marketing efforts, but it did, like many case study interviews, ask them if certain green programs have more cachet. Respondents most commonly identified LEED as having the most cachet among both homeowners (7 mentions) and renters (6 mentions). But, as shown in Appendix E.8, the majority of respondents did not know or rejected the idea that homeowners (70%) or renters (79%) placed importance on certain programs.

B.10 Expected outcome: Increased consumer demand for efficient construction

The IOUs' marketing, outreach, and training are intended to result in effective marketing of energy efficiency that would ideally lead to increased consumer demand for more above-code construction (marketing findings are described specifically in Appendix B.9). This relationship and its measurable indicator as presented in the program theory logic model are shown below.



Note: This measurable indicator was accompanied by another in the program theory logic model that was not included as a task within this research effort: *Home buyers and renters report increased importance of energy efficiency as a feature and report hearing about it from marketing by the program, builders, and developers.*

Summary of Findings: The Phase I and II research activities offered evidence that consumer demand for energy efficiency exists. In particular, our findings suggest that high-income buyers possessed the highest demand for energy efficiency, and low-income customers and renters were least likely to seek energy efficiency. Interviewees attributed a lack of concern for energy efficiency among low-income customers to the fact that these customers had limited housing options due to affordable housing demand far exceeding the supply;[42] market actors observed that

[42] CTCAC, CDLAC, HCD, and CALHFA. *Affordable Housing Cost Study: Analysis of the Factors that Influence the Cost of Building Multi-Family Affordable Housing in California*. October 2014.

the low-income consumer segment found energy efficiency to be an added bonus, but not a critical housing feature. Case study interviewees often associated customers who were concerned about energy efficiency with being market-rate and living in urban environments. We provide details on these and other findings below. Survey respondents also attribute higher levels of demand for energy efficiency to the market-rate sector, particularly high-income buyers, but also attribute moderate levels of demand to the low-income market.

B.10.1 Phase I Report Findings

Phase I market actor interviews indicated that consumer demand for efficiency was inconsistent and not highly prioritized by consumers. The following bullets detail the Phase I interviewees' common opinions and observations about MFNC consumer demand dynamics.

- **Affordable housing availability.** Demand for affordable housing far exceeds available supply; this is the primary reason why energy efficiency has limited importance in the affordable housing market.
- **Income level.** Because of its incremental cost, high-efficiency equipment might represent a tradeoff with other amenities, such as a desirable location, size, layout, or features such as granite kitchen counters. In line with the previous bullet, low- and middle-income renters are therefore more likely to view energy efficiency as an ancillary benefit.
- **Ownership.** Renters tend to have a lower demand for energy efficiency than condo buyers in both market-rate and low-income rental markets. Generally, renters may have less of a stake in the energy efficiency of their homes because they are not invested in long-term cost-effectiveness or they have limited access to information on the topic.

B.10.2 Case Study Findings

Twenty-five interviewees commented on consumer demand. In some instances, they spoke specifically about demand in relation to market segments; Table B-2 summarizes their opinions. Fifteen interviewees reported that demand existed among market-rate consumers—only one of the 15 also specified that demand was present in low-income populations. Eleven interviewees had not observed demand among low-income populations. While some of the 11 commented that low-income residents were "pleased" if the homes happened to be energy efficient, seven of them emphasized that low-income residents were focused on the *availability* of affordable housing, with one investor clarifying that there was a "tremendous need for affordable housing" in her geographic area.

Subsets of the 15 interviewees who had observed demand among market-rate consumers added that it was most common among those living in urban locations, earning high incomes, and/or purchasing homes instead of renting. More than one-half of them (8 of 15) associated consumer demand with consumers' attraction to labels and other green programs or initiatives with cachet,

http://www.hcd.ca.gov/hpd/docs/FinalAffordableHousingCostStudyReport-with-coverv2.pdf, last accessed May 14, 2015.

specifically LEED, GreenPoint, and ZNE. None of the interviewees attributed consumer demand to IOU MFNC program activities.

Table B-2: Case Study Interviewee Perspectives on Consumer Demand Existence and Population Segment Variation

Consumer Demand for Energy Efficiency		Number of Mentions (n=25 interviewees)*	
		Among Low-Income	Among Market-Rate
Does not exist		11	-
Exists		1	15
Common characteristics of markets with demand	Urban area dwellers	-	7
	High-income earners	-	3
	Home buyers (not renters)	-	1

* The other interviews made no comments or were unable to comment on the existence of demand.

B.10.3 Developers Survey

When asked to assess the level of demand for energy efficiency compared to other factors they expected from the prospective occupants of their projects, developers of market-rate projects were more likely to indicate moderate or high demand (87% of respondents) than developers of low-income projects (55%; see Table B-3).

Table B-3: Demand for Energy Efficiency – Prospective Occupants by Project Type

Demand for Energy Efficiency	Low-Income Projects (n=22)	Market-Rate Projects (n=15) **	Total (n=33)*
Very Little Demand (Ranking of 0 to 3)	45%†	13%	27%
Moderate Demand (Ranking of 4 to 6)	32%	47%	36%
High Demand (Ranking of 7 to 10)	23%	40%	36%

*Note that the n for total respondents is less than the combination of respondents who reported Low-Income and Market-Rate/No requirements because of multiple response options.
** Includes projects with no target market identified by the developer.
† Differences are statistically significant at the 90% confidence level.

Similarly, respondents were asked to estimate the level of demand for energy efficiency from prospective renters and buyers of market-rate multifamily homes (Table B-4). Respondents expect higher levels of demand from prospective buyers than from renters; 45% of respondents estimated high levels of demand for energy efficiency from buyers compared to 15% for renters.

Table B-4: Demand for Energy Efficiency – Market-Rate Renters and Buyers

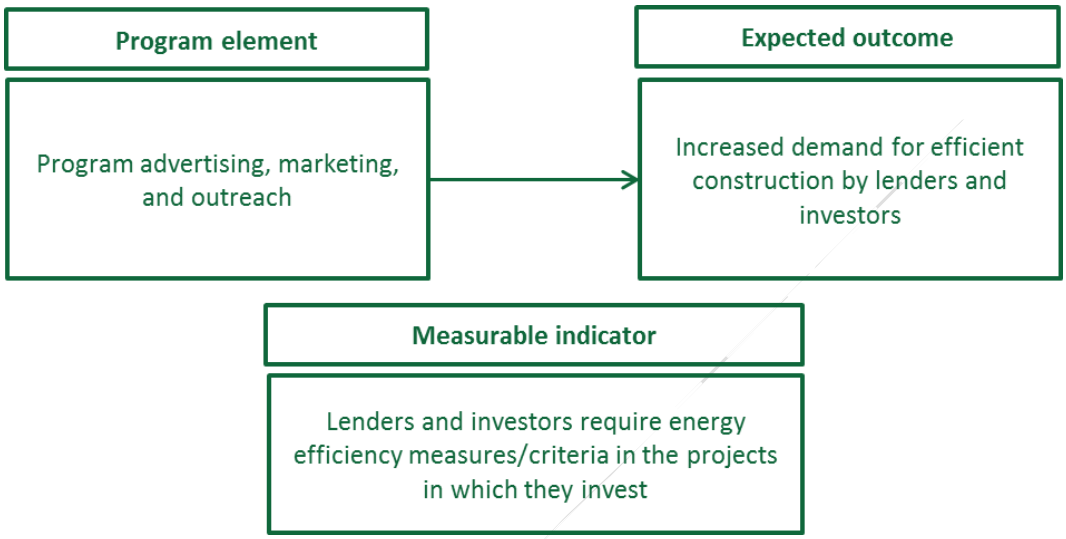
Demand for Energy Efficiency	Market-Rate Renters (n=33)	Market-Rate Buyers (n=33)
Very Little Demand (Ranking of 0 to 3)	27%†	9%
Moderate Demand (Ranking of 4 to 6)	33%†	12%
High Demand (Ranking of 7 to 10)	15%†	45%
Don't know	24%	33%

† Differences are statistically significant at the 90% confidence level.

Finally, we followed up by asking developers in an open-ended format to identify the MFNC market segments that were most likely to seek out energy efficiency. Respondents most often identified high-income customers (49%) and moderate-income customers (24%). We fully report the results in Appendix E.8.

B.11 Expected outcome: Increased lender and investor demand for efficient construction

To the extent that the IOU program offers successful advertising, marketing, and outreach efforts to developers and the public, its efforts could drive consumer demand for energy efficiency (as discussed in Appendix B.10). In turn, as lenders and investors perceive this demand, they could respond by requiring developers to meet energy efficiency criteria as a condition of funding. The illustration below captures this theory.



Note: This measurable indicator was accompanied by another in the program theory logic model that was not included as a task within this research effort: *Lenders to homebuyers increasingly offer and market energy efficient mortgage products.*

Summary of Findings: Investors and lenders could have a large influence on the multifamily market should they see that consumers are demanding energy efficiency and that energy-efficient buildings can allow for greater debt service through higher rents or sales prices. However, respondents (largely focused on affordable housing) consistently reported that private investors and lenders do not require above-code efficiency practices in multifamily projects, other than ensuring that the developers adhere to any commitments that they made to their various partners, such as obtaining CTCAC tax credits. While lenders and investors reported factoring expected utility costs into their financial calculations, it was not something that they would typically seek to improve, emphasizing that they prioritize attracting clients over energy efficiency.

B.11.1 Phase I Report Findings

The Phase I report theorized that the IOU program's attempts to increase consumer demand for energy efficiency would be recognized by lenders and investors who might see efficiency as a means of attracting homebuyers and/or allowing for greater debt service on developers' design and construction loans through higher rents or sales prices. Phase I interviews did not explore investor and lender demand directly.

B.11.2 Case Study Findings

Case study respondents reported that private investors and lenders do not require above-code efficiency in multifamily projects,[43] and such requirements would typically only come from "soft money" investors and partners. Respondents described these "soft money" partners as local agencies (such as the now-dissolved Redevelopment Agencies), municipalities, or other public officials that are willing to offer their assistance in helping with the development of a MFNC project (such as financial support, zoning variances, marketing assistance, and so forth) in exchange for the developer tailoring the project to meet certain goals of those backers, such as building to above-code standards or including affordable housing units, or similar goals. Six respondents confirmed that these soft money partners had at some point required efficiency performance on their projects, and four more described how these partners favor efficient projects even if they do not require above-code standards. A HERS Rater frequently encountered city officials demanding energy efficiency for projects even outside of reach code jurisdictions, particularly for large developments.

Interview results suggest that investors and lenders factor utility costs (based on expected energy performance) into their payback and underwriting analyses in order to estimate the owner's operating costs, though they do not appear to require above-code performance. Investors and lenders reported that they were eager to be involved in energy-efficient projects, but that they ultimately accepted projects in the form that developers presented them. A lender reported that developers "don't tell us about energy efficiency"—it only comes up if the developer's stated utility costs are lower than those of typical projects. Investors and the interviewed lender reported that they were happy to participate in green projects, but that they could not demand it from developers and it was not a major factor in their decisions to invest or support projects. Reinforcing that notion, a CTCAC investor asserted, "We're a business first."

CTCAC investors are particularly vigilant about ensuring that their developer partners meet CTCAC standards[44] because failure to do so would jeopardize their tax credits—which would be a "catastrophic failure," as described by one architect. Interviewees emphasized that because investors compete against other investors to take part in limited and profitable CTCAC deals, imposing requirements on developers could send those developers to other investors. A CTCAC investor explained as follows:

> *The competitive nature of [CTCAC] syndication business means we're competing with other people to invest. If we took that position [demanding efficiency] as a syndicating and investment partner, we can't do that.*

[43] Twenty-two case study respondents—all strongly affiliated with affordable housing—discussed investor and lender preferences, and all confirmed this perspective. They included ten developers, five architects, a lender, a city investor, and five CTCAC investors/syndicators.

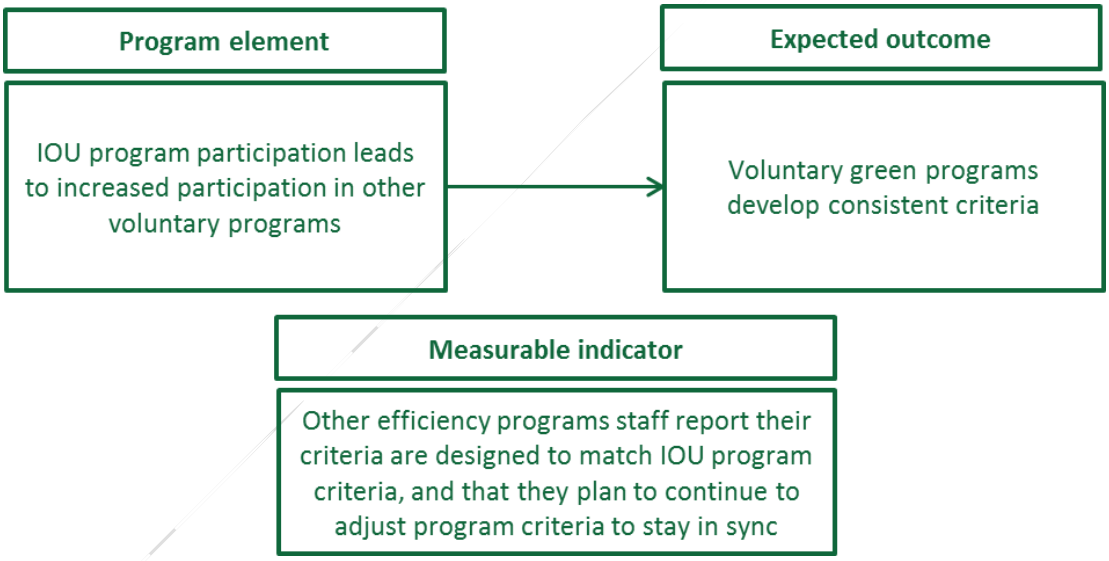
[44] Investors and lenders may hire third-party consultants to check plans and/or conduct on-site visits to ensure that the developer met all of its obligations. CTCAC investors and the interviewed lender both described this as a common practice.

B.11.3 Developer Survey Findings

More than one-quarter of the 33 developer CATI survey respondents (27%) reported that investors and lenders played a role in the efficiency of their projects; however, only 6% identified investors and lenders as primary decision makers. Eighteen percent of respondents, all low-income developers, said that investor requirements (other than CTCAC requirements) were a driver of the energy efficiency of their projects. Market-rate developers, however, were likely to mention that reach code and organizational commitments drove their projects to higher levels of energy efficiency.

B.12 Expected outcome: Voluntary green programs develop consistent standards

The IOU program includes standards that are designed to complement the requirements of other green programs. The program logic model suggests that by promoting consistent green program practices, market actors could develop best practices, thus making it easier to build above-code projects using these practices. The figure below presents these concepts as captured in the program theory logic model.



Summary of Findings: IOU planning efforts have contributed to the market effect of somewhat consistent energy-efficient construction practices that can be implemented in multiple green construction programs, particularly through its support of developing consistent reach codes throughout California. However, differing program standards remained a challenge during the 2010 through 2012 IOU program cycle, and program standards appear to have become more fragmented since the rollout of the 2013 Title 24 energy code.

B.12.1 Phase I Report Findings

During Phase I interviews, IOU staff reported encouraging developers to participate in other voluntary green programs. They also said that the program had worked to develop consistency

between its standards and those of other voluntary programs[45] as well as encouraged similar standards to be adopted as reach codes through the Reach Codes Subprogram. IOU staff reported that these different efficiency programs tend to establish similar efficiency requirements; this allows participants in other efficiency programs access to IOU incentive money, since the project is meeting the efficiency requirements of both programs. One consultant explained how the IOU program was essential to establishing CTCAC expectations:

> *CTCAC couldn't have put in those regulations requiring high-level efficiencies if not for the program. They wouldn't have done it. The CPUC also thinks that the IOUs shouldn't get savings credits for projects that go through CTCAC because CTCAC has those standards. But if the IOU program wasn't there to cover those costs, CTCAC would not have that requirement. It wouldn't be there.*

B.12.2 Case Study Findings

Respondents reported some overlap across various program standards, but said that this should be improved. Fifteen case study interviewees compared the energy efficiency requirements of various voluntary, above-code programs. Ten described instances of differing and inconsistent standards across the various programs, while five described how the programs they interact with—particularly CTCAC, LEED, and GreenPoint Rated—have some level of consistency between their program requirements, particularly because CTCAC allowed participants the option of using LEED or GreenPoint Rated to meet CTCAC sustainability criteria. A HERS/GreenPoint Rater described compiling a consolidated checklist of all the requirements for voluntary programs as a means of determining eligibility for various programs. An architect described a similar process where his design teams would look at the requirements of various green programs and then try to meet the requirements of the most restrictive one they could reasonably attain in order to give them the best chance of meeting at least one of those program's requirements.

However, progress toward consistent standards under the 2008 Title 24 efficiency standards faces an obstacle because the 2013 Title 24 standards were enacted in 2014. For example, CTCAC's minimum construction standards still allow compliance to be calculated relative to the *2008* Title 24 standards, just with a higher compliance margin than previously allowed (now 30% BTS). The IOU program has shifted to a scoring system based on the CA HERS Design Rating for low-rise projects and a 15% BTS requirement (calculated against the 2013 Title 24 standards) for high-rise projects.[46]

B.12.3 Developer Survey Findings

We did not explore the topic of consistency across programs with CATI survey respondents.

[45] As an example, HMG, the implementer of the CMFNH program, created this program requirement matrix to show the similarities and differences between various voluntary green programs: http://h-m-g.com/multifamily/Residential_Program_Matrix_04-2010.pdf

[46] http://cahp-pge.com/wp-content/uploads/2014/04/CAHP2014_ProgramOverview_042314.pdf

Appendix C Site-by-Site Discussion of Case Study Projects

This appendix expands on the site-specific findings from in-depth interviews with market actors involved in the fifteen case studies in order to paint a more nuanced and complete picture of how the design and construction teams came to build the projects that they did. The following sections describe site-specific information related to the following:

- Energy performance
- Efficiency of common areas vs. residential units
- Interesting energy efficiency (EE) features
- EE goals and priorities
- IOU program impact (if any)
- Allocation of budget to EE features
- Site-specific drivers and barriers to EE
- Key actors on the project
- Key project stages

C.1 Case Study Project: Site One

Site One is a relatively small market-rate, high-rise, mixed-use project built by a for-profit developer in PG&E territory under the 2008 Title 24 energy efficiency requirements (under 10 stories and with fewer than 20 units). The project participated in the GreenPoint Rated program as a means of satisfying San Francisco's local energy ordinance.

The research team interviewed three individuals involved with the project: the lead architect, the GreenPoint Rater, and the Title 24 Consultant.[47]

C.1.1 Site One – Energy Performance

San Francisco's energy ordinance mandated that this project be at least 15% more efficient than Title 24, but it achieved between 20% and 30% better than Title 24 levels, according to respondents (25%, on average). The research team's on-site visit estimates residential energy compliance at 21% BTS. The design team attained the GreenPoint Rated certification as a means of satisfying San Francisco's energy ordinance. The GreenPoint Rater and Title 24 Consultant both thought this project was more efficient than typical projects in the area at that time, largely due to its having a green-minded design team. However, the architect saw it as fairly typical for the area and for that firm's projects, noting that they were just trying to meet the local energy ordinances with a bit of cushion. The architect's comparable projects have an energy performance similar to the case study project. The GreenPoint Rater's projects typically only reach GreenPoint Rated's minimum 15%

[47] Researchers also conducted a joint interview with two local code officials associated with this project, but they did not comment on this project specifically.

BTS threshold, while the Title 24 Consultant's projects vary widely in energy efficiency performance.

C.1.2 Site One - Distinction between Common Areas and Units

Respondents reported that the only difference in efficiency between the common areas and the residential units on this project was that they installed less high-efficiency lighting in the residential units than in the common spaces, since the developer was responsible for operating costs. The architect noted that the developer now installs high-efficiency lighting throughout both the residential units and the common areas due to decreased prices for efficient LED lighting.

C.1.3 Site One - Energy Efficiency Features

Respondents thought that the Site One's energy efficiency performance was driven by mechanical equipment choices, including a radiant hydronic heating system and tankless water heaters, but that it used relatively commonplace practices otherwise, including typical ventilation systems and low-emissive glass windows. On the whole, the architect reported, "We were just doing what's common in the industry. No one was looking to break any new ground."

Neither the Title 24 Consultant nor the GreenPoint Rater encountered any serious quality control problems during their involvement with the project, such as finding aspects of the construction that failed to adhere to design specifications or code requirements.

Table C-1 presents a description of measures with the most significant impacts on energy consumption of the units, based on the research team's on-site visit.

Table C-1: Case Study Site One: Significant Measures from On-Site Analysis

Measure Type	Measure Description	Level of 2008 Code Compliance
Fenestration	• **U-factor:** 0.288 • **Solar Heat Gain Coefficient (SHGC):** 0.26	Above code
Envelope Insulation	• **Roof:** R-30 exterior • **Wall:** R-19 • **Floor type and insulation level:** Uninsulated raised floor	All right at code
HVAC Efficiency	• **Heating:** Gas-fired boiler with 0.923 Energy Factor • **Cooling:** No space cooling provided	Right at code
Domestic Hot Water	Gas tankless water heater with 0.93 EF	Above code

C.1.4 Site One - Energy Efficiency Goals and Priorities

The design team began planning the project during the height of the real estate boom and had "grand aspirations" for a green project that included a number of green features, including installation of a large solar PV array. However, the project was put on hiatus during the economic recession, and when the design team revived the project, they value-engineered out many of those

features, eliminating the solar array from the design and lowering the efficiency targets to the minimum required in San Francisco.

C.1.4.1 Site One - Priority of ZNE

ZNE was not a factor or goal in this project, according to the respondents.

C.1.5 Site One - IOU Program Impact

Interviewees said that the IOU MFNC program had no impact on the project. Since the developer was not interviewed, the reasons for not participating in the utility program can only be inferred from the other respondents. The architect was unaware of the program, but would have tried to participate had he known about it; the GreenPoint Rater said that hassle and costs were the reasons that developers typically declined to participate; the Title 24 Consultant speculated that the developer did not participate because the incentives were too low to offset the cost of participation.

C.1.6 Site One - Allocating Budget to Energy Efficiency Measures

The architect described allocating budget between energy efficiency measures and other, non-energy-related aspects of the project simply as a function of meeting the local energy ordinances. The team targeted the local energy ordinances and spent sufficient funds to meet those requirements. The GreenPoint Rater and Title 24 Consultant reported that they were not involved in decisions about how to allocate budget; this was a developer decision.

C.1.7 Site One - Drivers and Barriers of EE for the Case Study Project

Respondents described an environmentally conscious design team that had to scale back its initial plans for a particularly efficient project due to budget restrictions in the wake of the economic downturn. The key drivers and barriers to the energy efficiency level of Site One that interviewees described are presented below in Table C-2.

Table C-2: Case Study Site One - Key Drivers and Barriers

Drivers	Major	Minor
Reach code	✓	
Green-minded design team		✓
Marketability of GreenPoint Rated brand and energy efficiency		✓
Reduce operating costs		✓
Non-energy benefits of efficiency measures (noise reduction)		✓
Barriers	**Major**	**Minor**
Costs	✓	
Timing (GreenPoint Rater brought on late)		✓

C.1.7.1 Site One – Energy Efficiency Drivers

Site One interviewees perceived a number of factors that motivated the project's team to achieve the level of energy efficiency that it did. All interviewees asserted that the reach code requirements were the driving factors. Other drivers are as follows:

- The design team was environmentally conscious.
- Energy efficiency and the GreenPoint Rated brand are marketable.
- The project's team desired to be innovative.
- Noise-reducing measures were attractive and also have energy impacts.
- As an owner and operator, the developer was concerned with operating costs.

C.1.7.2 Site One – Energy Efficiency Barriers

Interviewees reported that the expense of the measures and the fact that the GreenPoint Rater was hired late in the design process were barriers to achieving even greater levels of energy efficiency.

C.1.8 Site One - Key Actors

All three respondents identified the developer as the key decision-maker on the project, particularly in terms of setting efficiency goals (to reach San Francisco energy code). The architect noted that he would have liked to do a "few more things, but it was the developer's money." The GreenPoint Rater and Title 24 Consultant did not push the developer to change any standard practices, but viewed their roles as providing guidance and advice to the developer and design team to help the developer meet its energy efficiency obligations under San Francisco code, including the GreenPoint Rated requirements.

C.1.9 Site One - Key Stages Regarding Energy Efficiency

All three respondents saw important decisions being made at the various phases when they were most involved with Site One. The architect discussed efficiency with the developer in early project conceptualization discussions; the Title 24 Consultant thought design development was a critical stage because that is when the team decided on the mechanical equipment to be installed in the project; the GreenPoint Rater thought that key decisions were still being made at the construction documents and permitting phase. The architect confirmed that Integrated Design was not used on this site, and energy efficiency decisions were addressed on an *ad hoc* basis during the design and construction process.

C.2 Case Study Project: Site Two

Site Two is large a high-rise building with more than 200 market-rate rental units. Constructed in San Francisco by a for-profit developer, the project participated in the LEED program as a means of satisfying the city's reach code requirements.

For this case study, we interviewed the developer and the architect.[48] While both had heard of the IOU program, neither was familiar with the details of it nor recalled ever participating in it. Both interviewees had a great deal of experience working in reach code localities.

C.2.1 Site Two – Energy Performance

This project attained LEED certification as an avenue to meet San Francisco's energy ordinance mandating that projects be at least 15% more efficient than Title 24. Neither of the interviewees was able to estimate the exact percentage of efficiency that it achieved, but the architect did think it was a little more efficient than 15%. The research team estimates that it was approximately 29% BTS, based on an on-site visit. The architect added that the city's required codes are "very tight," leaving designers little space to achieve efficiency levels greater than the base code. While the developer was not able to speak to how the efficiency level of this project compares to other high-rise market-rate projects built during that period, the architect conjectured that it probably was not different.

C.2.2 Site Two – Distinction between Common Areas and Units

The architect explained that his team takes different approaches in designing common areas than it takes in designing residential spaces because the spaces inherently have very different characteristics and, as such, they are not really comparable. He said that the project team sought the same level of energy efficiency for both space types in Site Two's design. In the developer's opinion, however, the project approach treated the areas differently; he recalled installing air conditioning (AC) in common areas only and explained that the penalties that Title 24 enforces for installing AC in tenant units deterred them from doing so and, in his opinion, reduced the energy efficiency of the building (see below for more details). The developer added that the team did install the same level of efficiency for the lighting throughout all building spaces.

C.2.3 Site Two – Energy Efficiency Features

Site Two's developer specifically wanted to install electric resistance heating to achieve high levels of energy efficiency. The architect explained that, to complement that approach, they installed high performance glass on the curtain wall and solar domestic hot water (DHW) systems. Other measures to increase the project's energy efficiency included installing roof insulation and ENERGY STAR appliances and, as mentioned above, not installing AC in tenant units.

[48] Researchers also conducted a joint interview with two local code officials, but they did not comment on this project specifically.

Table C-3 presents a description of measures with the most significant impacts on the energy consumption of the units based on the research team's on-site visit.

Table C-3: Case Study Site Two: Summary of Significant Measures

Measure Type	Measure Description	Level of 2008 Code Compliance
Fenestration	• **U-factor:** 0.288 • **Solar Heat Gain Coefficient (SHGC):** 0.26	Above code
Envelope Insulation	• **Roof:** R-38 exterior and R-18 interior • **Wall:** Spandrel panels with 0.3 aged solar reflectance and 0.75 thermal emittance (equal to R-17.4) • **Floor type and insulation level:** Raised with R-10	All above code
HVAC Efficiency	• **Heating:** 3.55 HSPF* electric baseboard heater • **Cooling:** No space cooling provided	Right at code
Domestic Hot Water	Gas tankless water heater with 0.95 EF (solar DHW for common spaces)	Above code

* Heating Season Performance Factor

C.2.4 Site Two – Energy Efficiency Goals and Priorities

For Site Two, the developer sought to attain LEED Gold certification as an avenue to achieve San Francisco's energy ordinance. Both interviewees stated that achieving the certification was their top priority, along with complying with other (non-energy) city codes. The developer reflected that it was easy to comply with San Francisco's energy codes because the team had acclimated to them previously and anticipated them from the start of the project.

This project was a combination of design-bid build and design-build approaches, with design build primarily employed in the mechanical, plumbing, and electric work.

C.2.4.1 Site Two – ZNE Priority Level

Both the developer and architect concurred that ZNE was not a priority for this project. The architect explained that ZNE is not applicable for urban projects like Site Two, suggesting that the renewable energy measures involved in achieving ZNE require more land area than is available in urban areas such as San Francisco.

C.2.5 Site Two – IOU Program Impact

While both were aware that it existed, neither the developer nor the architect was familiar enough with the IOUs' program to comment on it. The developer speculated that it probably required the technologies that his company already used and that its standards were the same as those of LEED. Neither knew why this project did not go through the program nor were they able to speak to the IOU MFNC program's impact on construction practices in the MFNC market.

C.2.6 Site Two – Allocating Budget to Energy Efficiency

The developer and architect explained that Site Two's budget did not require them to make tradeoffs between non-energy features and energy efficiency features during the project design and implementation. Both interviewees emphasized that their goal to achieve LEED guided the project design. The developer reported that his company's decisions to allocate budget involved determining what could actually be physically implemented in the project design and what energy efficiency measures were most cost-effective.

C.2.7 Site Two – Energy Efficiency Drivers and Barriers

Table C-4 presents the key drivers and barriers that interviewees said impacted the energy efficiency level of Site Two.

Table C-4: Case Study Site Two - Key Drivers and Barriers

Drivers	Major	Minor
Reach code (drove to LEED)	✓	
Green-minded design team		✓
Marketability of energy efficiency		✓
Reduce operating costs		✓
Expedited permitting		✓
Barriers	**Major**	**Minor**
Non-energy efficiency code requirements		✓

C.2.7.1 Site Two – Energy Efficiency Drivers

The developer attributed 80% of his company's energy-related decision making to achieving LEED requirements, and he attributed the other 20% to a desire to reduce long-term operating costs, given that his company owns the building. The architect underscored that the reach code primarily drove the construction and design team's decision to pursue LEED. He also found that LEED or other green program certifications were strong marketing tools, explaining that people in San Francisco "expect to live in sustainable and energy-efficient buildings." He added that pursuing high energy efficiency levels helps building permitting processes move more quickly and that this may have also been a factor in Site Two's goals.

C.2.7.2 Site Two – Energy Efficiency Barriers

Neither interviewee reported major barriers to energy efficiency on this project. The developer suggested that the Title 24 penalty for installing AC in tenant units limited the project's energy efficiency, likely assuming that tenants would install their own AC units that may not be as efficient as what the developer would have selected. Additionally, the architect opined that building safety codes impinged on their ability to install energy-efficient lighting features because building codes required that lighting to be kept on in common areas.

C.2.8 Site Two – Key Actors

The developer described the variety of actors involved in decision making throughout the course of the project: himself (as the project manager), his company's in-house construction team, the technical subcontractors, the architect, and the LEED consultant. While the developer ultimately made the final decisions in collaboration with his in-house construction team, the interviewee referred to the tremendous value received from their LEED consultant's input into design decision making; additionally, their technical subcontractors had a large impact on the mechanical and electrical systems that they selected.

The architect recalled that his firm and the developer were consistently in agreement in their approach to energy efficiency, describing how generally the developer drafted plans and how the architect helped them to "vet" those plans. The architect emphasized that, while the developer sets the budget, the building codes have the strongest influence—a single actor was not key, in other words. The developer financed this project himself; Site Two did not have an outside investor.

C.2.9 Site Two – Key Stages Regarding Energy Efficiency

Both interviewees reported that all members of their team considered energy efficiency throughout the project cycle, from systematic design through construction. They concurred that the majority of energy-related planning was done at the very beginning of the project. Neither thought that the project would have been more energy efficient if certain decisions were made earlier—the developer had only experienced that type of scenario when working with "experimental" technology, which was not the case with Site Two. The architect emphasized that, given that this project was seeking LEED Gold, energy efficiency was "part of the DNA" of (i.e., integral to) the project.

Like the developer, the architect saw a great deal of influence in the LEED consultant's input, recalling how even in later stages of construction, the LEED consultant helped them attain higher levels of energy efficiency than they had expected.

C.3 Case Study Project: Site Three

Site Three consisted of a high-rise building with between 60 and 79 affordable units intended for low-income tenants in the San Francisco area. This project sought GreenPoint Rated certification in an effort to meet San Francisco reach code requirements and achieve competitive points for CTCAC. In the words of its GreenPoint Rater, this design build project was "pretty much a complete gut rehabilitation" project, so no existing systems were maintained at all (thus making it eligible for the IOU MFNC program).

For the Site Three case study, we conducted three interviews. The first interview was with two representatives from the developer organization, the second was with the architect, and the third was with the GreenPoint Rater. The developers, who were from a nonprofit organization, were aware of the IOU MFNC program but not familiar with it. Similarly, the architect was somewhat aware of the program, but explained that he usually does not engage with that component of his

projects because the mechanical engineer is usually responsible for that. The GreenPoint Rater, who is also a HERS Rater and Title 24 Consultant, was very familiar with the IOU program and had worked on many projects that went through it. Working in the San Francisco area, all interviewees were familiar with reach code. This project did not participate in the IOU NSHP program.

C.3.1 Site Three – Energy Performance

The interviewees recalled that this project met the minimum requirements to meet San Francisco reach code: 15% above Title 24 requirements. The developers reported that its level of energy efficiency was no different than their other high-rise low-income projects built in the area during that period. The architect was unable to speak to how the project compared to other projects. The GreenPoint Rater reported that this building was less efficient than other similar project types, saying that it just barely met code and that the older structure used thinner walls than modern construction, requiring them to compensate for the thinner cavity insulation.

C.3.2 Site Three – Distinction between Common Areas and Units

The common areas and tenant units were built to the same efficiency level. Because tenants do not pay utility bills, split incentives likely were not a concern. The GreenPoint Rater noted that there were very few common areas in this project.

C.3.3 Site Three – Energy Efficiency Features

Because this project utilized an existing building structure and some elements had to be retrofitted, the approach to energy efficiency was somewhat different. Due to historical preservation laws, the project team had to preserve the building's façade. Retrofitting windows for energy-efficient windows presented the construction and design team with a major hurdle. The architect and GreenPoint Rater thought that the windows, along with new exhaust systems, energy-efficient boilers and fans, and a hydronic heating system allowed the project to meet energy efficiency code. The GreenPoint Rater speculated that it might have been more energy efficient if they had chosen a different boiler.

C.3.4 Site Three – Energy Efficiency Goals and Priorities

The top priorities for this project's energy efficiency were meeting the city and CTCAC requirements. To this end, it sought GreenPoint Rated certification.

C.3.4.1 Site Three – ZNE Priority Level

ZNE was never considered as a potential goal for this project.

C.3.5 Site Three – IOU Program Impact

The IOU program did not influence this project in any way, according to interviewees. None of the interviewees knew why Site Three did not attempt to apply for the program. The GreenPoint Rater speculated that, because it was not completely a new construction project, perhaps it would

not have been eligible. The developers guessed that it may have been an issue of timing, with IOU funds "running out" before they were able to apply.

C.3.6 Site Three – Allocating Budget to Energy Efficiency

Interviewees concurred that budget allocation, under the purview of the developers, is based entirely on the cost-effectiveness of measures. The developers have tight budgets, so they target only the minimum requirements needed to achieve city requirements and CTCAC priorities.

C.3.7 Site Three – Energy Efficiency Drivers and Barriers

Respondents had mixed perspectives on the drivers of and barriers to energy efficiency decisions made by the design team; some thought they prioritized efficiency early on, but others thought that decisions were made on an *ad hoc* basis and that things were quite "fluid." The key drivers of and barriers to the energy efficiency level of Site Three, as cited by interviewees, are presented below in Table C-5.

Table C-5: Case Study Site Three - Key Drivers and Barriers

Drivers	**Major**	**Minor**
Reach code	✓	
CTCAC	✓	
Barriers	**Major**	**Minor**
Historic preservation	✓	
Costs		✓
Timing (Rater brought on late)		✓

C.3.7.1 Site Three – Energy Efficiency Drivers

As mentioned previously, interviewees agreed that the "level of green design" targeted for Site Three was primarily driven by reach code and CTCAC. One of the developer interviewees noted that, in projects like this, his organization would sometimes aim for higher levels of energy efficiency if there were additional grants or rebates available; the other developer interviewee added that they also would aim for higher levels of efficiency if it would drive their long-term operating costs down. It appears that neither of these factors entered into play for Site Three. Interviewees reported that Site Three's lenders, both public and private, were not concerned about energy efficiency and, as such, were not a driving force. Additionally, because tenants were not paying their own heating bills, the developers explained that marketing or appealing to the potential tenants through energy efficiency was not a factor; the interviewees asserted that the low-income market is more focused on *affordable* and *quality* housing.

C.3.7.2 Site Three – Energy Efficiency Barriers

All interviewees spoke to the constraints of working with the existing building structure, particularly the need to preserve the historic façade, which made it difficult to find energy-efficient

windows. The GreenPoint Rater also noted that the walls could not change due to very thick existing masonry, making upgrading insulation a challenge, and that they were brought on too late to change much about the project's construction. Aside from the structural challenges, the developers and the architect emphasized that they had a very "tight" budget, so they could only pursue the minimum energy efficiency requirements.

C.3.8 Site Three – Key Actors

The developers, architect, and GreenPoint Rater viewed the developers as the decision makers when it came to "balancing the benefits with the cost of doing the work" or making any decisions related to the ultimate use of budget.

A key actor that the developers and GreenPoint Rater pointed to was the mechanical engineer, who conducted calculations and made recommendations for how to go about reaching energy efficiency requirements. The developers explained that the contractor estimated pricing and then the architect, developer, and construction manager discussed how to move forward. The architect said that he was 100% in line with the developers and met with them and the construction contractor weekly, adding that the developer did not express clear preferences for specific design and construction practices to meet their efficiency targets. The architect recalled that his firm's role was to give the developer various options and that they gave their input from "day one" when they were first presenting the project for funding. The architect asserted that, generally, the developer put the decisions into the architect's hands. The general contractor was also on board from the start, providing budgeting numbers; the developer and architect gave the contractor options, and the contractor would price them out. The GreenPoint Rater thought that, as the rater, not a Title 24 Consultant or HERS Rater, his ability to impact the project's energy efficiency was limited. Their lenders, public and private, were not involved with energy efficiency decisions.

C.3.9 Site Three – Key Stages Regarding Energy Efficiency

The developer interviewees reported that they would not have had the option to make decisions about energy efficiency during any later stages than they did. They were focused on energy efficiency most in the early stages of the project design, during which they assessed how to meet energy code and GreenPoint Rated requirements. At the very beginning, they made decisions around what windows, ventilation systems, roofing materials, and mechanical systems to select. The architect viewed the decision making somewhat differently, recalling that the measures changed all the time as they went through design, as was typical; he called the design process "a very fluid thing." The GreenPoint Rater's input was sought between construction documentation and construction commencement. The Rater speculated that if his input had been sought earlier in more of an energy consultant capacity, such as during the design stages when key decisions were made, the project might have been more energy efficient. According to him, mechanical engineers do not always value energy efficiency:

> *We want to do the energy evaluation because we recognize the value in doing the energy analysis as early as possible because it does influence so many design decisions; so we are*

already working in that direction to help with that. On this project, we were not the energy consultant, so I think it kind of limited our ability to have an impact.

C.4 Case Study Project: Site Four

Site Four is a high-rise building in Los Angeles County with between 60 and 79 units for low-income tenants. In an effort to receive funding from CTCAC and public funding, this for-profit developer pursued and obtained GreenPoint Rated certification. The building was constructed outside of a reach code area.

We interviewed Site Four's developer and HERS Rater/Title 24 Consultant (energy consultant). They reported that this project did not participate in either the IOU MFNC program or NSHP. The developer was vaguely familiar with the IOU MFNC program, but was unable to describe its requirements; she also was unfamiliar with reach codes. The energy consultant was very familiar with the program, having participated in about 20 projects that went through it; he also reported that he worked in reach code jurisdictions.

C.4.1 Site Four – Energy Performance

The developer estimated that the project was 25% more efficient than Title 24 requirements, saying that this was less energy efficient than her typical projects, which are normally 30% more energy efficient. She did not explain why this difference occurred. Conversely, the energy consultant estimated that the project was closer to 15% to 20% more efficient, asserting that this project was more energy efficient than similar projects constructed in the area during that period. Twenty-one percent BTS was the average compliance margin reported.

C.4.2 Site Four – Distinction between Common Areas and Units

The developer and consultant differed in their recollections of the differences in energy goals between common areas and units. The developer recalled that they focused on building the common areas to a higher level of energy efficiency because they, as the owners, pay the utility bills for the common areas; she asserted that they "used the minimum efficiency that was required" for the units' design. The energy consultant, however, did not remember anyone ever discussing that approach, saying that energy modeling takes into account all areas for a project, so construction and design teams normally build to similar levels of energy efficiency. Because the energy consultant gave reasoning that was more general and he was not involved during the early stages of development, it is likely that the developer's recollection is more accurate.

C.4.3 Site Four – Energy Efficiency Features

The developer did not recall any specific features that enabled this project to be as energy efficient as it was. The energy consultant explained that, in the spirit of prioritizing cost-effectiveness, this project was not very different than other projects he had worked on; however, he thought that their inclusion of a solar DHW system was somewhat unique and installed in only one-half of the projects in which he was involved.

C.4.4 Site Four – Energy Efficiency Goals and Priorities

As mentioned, this project set out to achieve GreenPoint Rated certification to receive funding from CTCAC and another agency. As such, according to the developer, energy efficiency was a high priority and factored into the entire planning process. In addition to reaching funding requirements, the developer expected that energy efficiency would be important to reduce long-term operating costs, especially considering their target market. If the units were targeted for senior occupants, then it would have been less important to them because, in her experience, seniors use less energy and typically do not need underground parking that would require 24-hour lighting. From the energy consultant's perspective, energy efficiency was not a high priority; the consultant speculated that if CTCAC or any other funding opportunities had not been available, then energy efficiency would have been less of a consideration—or not a consideration at all—and the project would have been built to a lower level of energy efficiency.

C.4.4.1 Site Four – ZNE Priority Level

Interviewees confirmed that ZNE was never considered as a potential goal for this project.

C.4.5 Site Four – IOU Program Impact

The IOU program did not influence this project. The energy consultant recalled that the program was never mentioned, and the developer had limited awareness of the program, speculating that they may not have considered participating because they had adequate funding and/or did not want to deal with the hassle of completing additional paperwork.

C.4.6 Site Four – Allocating Budget to Energy Efficiency

The developer explained how energy efficiency was factored into the project as being equally important as other elements:

> *We considered it just like it was a plumbing line item or a trade line item—[as if] it was just an additional cost to the project. It took equal consideration, I think, because of the funding. On both projects [constructed during that period], we did an allowance because we really didn't have a budget, so we created a budget, to be quite honest. We did it based on what the architects told us it would cost on a per-square-footage basis. And, purposely, we left it as a line item as an allowance because we didn't know what the [final] cost was going to be.*

The energy consultant reported that cost-effectiveness led Site Four's budgetary decision making process. On another note, he experienced "some push back" from design professionals who, in his opinion, may have been more concerned with "prestige and aesthetics" and desired more budget for non-energy measures.

C.4.7 Site Four – Energy Efficiency Drivers and Barriers

The design team reported that meeting CTCAC guidelines was critical for this project, and without the CTCAC efficiency requirements, efficiency would not have been a priority. The engineers on

the project were also less interested in efficiency than the designer, which created some hurdles in implementing an efficient design. Table C-6 summarizes the key drivers and barriers to the energy efficiency level of Site Four as described by the interviewees.

Table C-6: Case Study Site Four - Key Drivers and Barriers

Drivers	Major	Minor
CTCAC	✓	
Reduce operating costs		✓
Barriers	**Major**	**Minor**
Costs	✓	
Engineering consultant not interested in energy efficiency		✓
Timing (energy consultant brought on late)		✓

C.4.7.1 Site Four – Energy Efficiency Drivers

As mentioned previously, the interviewees said that the developer was driven to achieve GreenPoint Rated certification to appeal to CTCAC and meet its sustainability guidelines. Second, the project team was concerned with reducing their long-term operating costs. If there were not long-term benefits, the developer said, they may not have integrated energy efficiency measures into the project. The energy consultant added that they may have just been following what they had done in the past—leveraging GreenPoint Rated to obtain funding. He also speculated that, like other developers, they were possibly "interested in having up-to-date energy-efficient buildings" to some degree.

C.4.7.2 Site Four – Energy Efficiency Barriers

The interviewees emphasized that cost was strongly factored into the decisions that they made around energy efficiency measures. The consultant found that the mechanical engineering team's attitude also presented a hurdle. He reported that they, like other design professionals, had limited experience with GreenPoint Rated and ENERGY STAR requirements and, as such, did not welcome implementing new approaches. The energy consultant also thought that he being brought in earlier might have increased the project's efficiency.

C.4.8 Site Four – Key Actors

The developer recalled engaging the whole construction and design team in the pre-planning process, including the architects, engineers, and HERS Raters, "to make sure it would all work." Because Site Four was an affordable housing project, she explained that politicians and public funding agencies were involved in some of the discussions (but did not explain how). The developer responded that the private investors and lenders had no interest in whether the project was energy efficient; although, as explained above, CTCAC and government funding did encourage/require energy efficiency.

The energy consultant described his role in the project in more detail: He performed on-site inspections for code compliance and educated the design and construction teams. He explained that the developer had already planned the project approach before he was involved.

C.4.9 Site Four – Key Stages Regarding Energy Efficiency

The interviewees explained that because this project relied on public funding, energy efficiency had to be addressed from the very beginning through the end of the project, with the energy consultant adding that the checklists involved in the application process required consistent attention. The developer reported that the key stages occurred during the construction documentation and bidding-out phases, while the consultant considered the schematic design and bidding-out processes to be the key stages.

The developer considered that the timing for Site Four's decision making was appropriate, and it would not have been more energy efficient had they made decisions at different times. The energy consultant thought differently; he opined that if he had been involved sooner, the project would have been more energy efficient:

> *In regard to an energy modeling standpoint, I could [have suggested] potential energy measures that could be used over and above what they were thinking. Also, in combination from a HERS field-inspection standpoint—giving the team explanations of the problem situations that are brought into field, verifying and testing some of the equipment, and letting them know pitfalls of some of the installation practices of the HVAC systems, etc. It would be sort of two-fold.*

C.5 Case Study Project: Site Five

Site Five is an affordable, high-rise housing project built by a for-profit developer in the Los Angeles area (under 10 stories, with between 60 and 79 units and between 40,000 and 65,000 square feet). The project was subject to CTCAC's energy efficiency standards and was certified as a higher-tier LEED project. Respondents provided a wide range of efficiency estimates, from 24% to 50% BTS (29% on average); based on an on-site visit, the research team estimates that it was approximately 21% BTS.

The research team interviewed the city code official, along with four individuals involved with the project's design and construction: the lead architect; the president of the development company who oversaw the project; the mechanical, electrical, and plumbing (MEP) engineer; and the Title 24 Consultant (trained also as a HERS Rater).

C.5.1 Site Five – Energy Performance

This was a highly energy-efficient project that achieved LEED certification in an effort to increase its competitiveness for CTCAC funding. Respondents' estimated that its performance was between 24% and 50% better than 2008 Title 24 energy efficiency standards (29%, on average), while the research team estimates it was around 21% BTS, based on an on-site visit.[49] Based on the interviewees' estimates, the project appears to be more efficient than other CTCAC projects in the area from that period, except for some projects in the area that had achieved nearly ZNE. The MEP engineer and Title 24 Consultant reported that their typical projects perform around Title 24 minimum requirements whenever possible, while the architect's and developer's projects typically reach around 15% BTS with the aim of receiving CTCAC support.

C.5.2 Site Five – Distinction between Common Areas and Residential Units

Interviewees reported that Site Five's common spaces and residential units were built with the same envelope construction, but used different mechanical systems to suit the spaces. The common spaces utilized ductless mini-split heat pumps for cooling to avoid installing ductwork, and a solar PV array offset about 80% of the common area's electricity use. The architect noted that, on high-end market-rate projects, developers often prize aesthetics over efficiency, but that visible energy features such as solar PV panels were appealing on such projects. This project also used solar PV panels to offset the owner's operating costs on the common spaces.

C.5.3 Site Five – Energy Efficiency Features

Respondents described using standard equipment and practices to meet LEED standards—including a tightly sealed envelope, high-efficiency windows, and efficient mechanical systems

[49] The engineer recalled it being 4% BTS, but we speculate that the engineer's estimate is likely erroneous given that the project achieved LEED certification, received CTCAC funding, and the engineer's recollection was from an early modeling result, not the final performance. In addition, the interviewed local code official did not have strong ties to the project and incorrectly thought the project was right at code minimums.

(along with other green features that earn LEED points)—and a solar PV system to offset much of the common-area load.

Table C-7 presents a description of measures with the most significant impacts on the energy consumption of the units based on the research team's on-site visit.

Table C-7: Case Study Site Five: Summary of Significant Measures

Measure Type	Measure Description	Level of 2008 Code Compliance
Fenestration	• **U-factor:** 0.29 • **Solar Heat Gain Coefficient (SHGC):** 0.38	Above code
Envelope Insulation	• **Roof:** R-38 exterior • **Wall:** Wood-framed R-21 • **Floor type and insulation level:** Uninsulated slab on grade	Roof and wall insulations are above code, floor insulation is right at code
HVAC Efficiency	14.5 SEER/12 EER	Above code
Domestic Water Heater	Gas-fired storage water heater with Energy Factor of 0.67	Slightly above code

C.5.4 Site Five - Energy Efficiency Goals and Priorities

Early in the project's conception, the developer established a flexible efficiency target of 15% BTS and LEED certification to be competitive for CTCAC funding (though the team weighed the budgetary advantages of building to lesser efficiency standards).[50] The developer reported that attaining LEED certification was their typical efficiency goal, knowing that they can revise that goal, including choosing to forego the actual LEED certification, if they hit unexpected construction costs. On this project, construction bids came back much lower than expected due to the economic recession – contractors were eager to win work during a slow period for construction and bid low (a circumstance that has not happened since this project for the developer). The developer applied some of the savings to energy efficiency, boosting the LEED target to a higher LEED tier. The changes required minimal design changes according to respondents and allowed them to lower their long-term operating costs.

C.5.4.1 Site Five - Priority of ZNE for the Project

ZNE was not a goal for the project, even among respondents who had worked on other ZNE buildings. As the architect noted, "We hadn't even thought [about it] or discussed it."

[50] The MEP engineer appears to have been excluded from these conversations between the developer and architect as the MEP engineer reported that energy efficiency and LEED were not a priority for the developer.

C.5.5 Site Five - IOU Program Impact on the Project

All four respondents were familiar with the IOU MFNC program, but reported that it did not have an impact on the project. The developer, responsible for making decisions about which incentive programs to participate in, said that they did not participate in the IOU program due to a lack of awareness of what the incentive opportunities were. The developer described the southern IOUs as being less engaged in developer outreach than other California utilities, particularly municipal utilities that heavily support ZNE projects.

C.5.6 Site Five - Allocating Budget to Energy Efficiency Measures

The developer made the decisions about budget allocation for energy efficiency. The developer reported having flexible efficiency goals at the outset of the project (LEED, in this case), thinking that if construction costs were higher than expected, they could cut back on non-energy aspects of the project, such as flooring, counters, window coverings, and so forth, before cutting efficiency measures, particularly since efficiency upgrades can reduce the developer's long-term operating costs. The Title 24 Consultant described this as a less common viewpoint in the market-rate world, where developers put more emphasis on marketable finishes and amenities than on efficiency.

C.5.7 Site Five - Energy Efficiency Drivers and Barriers

Table C-8 summarizes interviewees' descriptions of the key drivers and barriers to the energy efficiency level of Site Five.

Table C-8: Case Study Site Five - Key Drivers and Barriers

Drivers	Major	Minor
CTCAC	✓	
Standard design practices	✓	
Economic downturn lowered costs	✓	
Reduce operating costs		✓
Marketability of energy efficiency		✓
Barriers	**Major**	**Minor**
Costs	✓	
Hassle of LEED certification		✓
Equipment reliability concerns		✓
Limits to modeling software capabilities		✓

C.5.7.1 Site Five – Energy Efficiency Drivers

Respondents identified several additional details about the drivers to energy efficiency on this project, including the following:

- Marketability of energy efficiency, LEED, and solar PV
- Mission-driven developer and architect
- Federal financing incentives

- Knowledgeable design team
- Contractors/consultants wanted to attract green-oriented developer
- Public officials encouraged LEED certification

C.5.8 Site Five - Key Actors

The interviewees portrayed the developer as the key decision maker with regard to setting efficiency targets and allocating the available budget. The consultants, particularly the MEP engineer and the Title 24 Consultant, worked on determining how to meet the developer's efficiency targets cost-effectively and priced out various options, while the architect served as the overall coordinator, acting as the intermediary between the consultants and developer to discuss pricing and feasibility of envelope and mechanical measures. The architect noted that the general contractor was particularly important on this project; because of their focus on constructability and construction sequencing, the general contractor had to be involved in the upgrade to LEED Platinum to ensure that efficiency upgrades did not slow the project's schedule.

The MEP engineer and Title 24 Consultant described having minimal impact on the project other than selecting measures that would meet the demands and efficiency targets of the developer and comply with Title 24, LEED, and CTCAC obligations.

C.5.9 Site Five - Key Stages Regarding Energy Efficiency

The interviewees confirmed that Site Five did not use an Integrated Design approach for energy efficiency. The developer and architect set the project's 15% BTS energy performance goal early in the project's conception, before applying for CTCAC funding. The team established efficiency targets early—before the engineer and Title 24 Consultant were hired—to meet CTCAC requirements and deadlines, thus limiting the available time for early coordination between the whole design team.

The MEP engineering team became involved during the schematic design phase—too late, in the engineer's opinion, since many decisions about the project's mechanical systems had already been made; the project was already a year underway at that point, and the Title 24 Consultant was hired during design development to cost out alternative measures to achieving compliance. Many decisions about envelope and mechanical measures were made, as needed, during the design development and construction documents phases. In most projects, the decision to pursue LEED certification happens early in the project development, but for Site Five it occurred during the construction phase because contractor bids were lower than the construction and design team had expected.

C.6 Case Study Project: Site Six

Site Six is a high-rise building (fewer than 10 stories) with between 60 and 79 affordable units. It was constructed in Orange County in a non-reach-code area. It attained LEED certification and did not participate in the IOU MFNC program or NSHP.

The research team interviewed four individuals involved with Site Six: the lead architect, the head of development for the non-profit development firm, the mechanical and plumbing (MP) engineer, and the main CTCAC investor.

C.6.1 Site Six - Energy Performance

Respondents reported that Site Six was approximately 21% above 2008 Title 24 energy efficiency requirements; based on on-site visit findings, the research team estimates that the residential portion was about 26% more efficient than a standard building. It used its LEED status to compete for CTCAC funding. The architect and CTCAC investor reported that, as a LEED project, Site Six was more efficient than comparable projects built in the area at that time; the developer and engineer reported that it was similar in efficiency to their typical projects at that time.

C.6.2 Site Six - Distinction between Common Areas and Units

Respondents reportedly built the common and residential areas to the same level of efficiency; the developer never considered constructing them differently. He had used less efficient glazing on a previous project that had resulted in lost incentive opportunities, and he wanted to avoid that problem with Site Six. The architect reported that the distinction was not much of a consideration on projects like this because of its minimal common space.

C.6.3 Site Six - Energy Efficiency Features

Respondents described accomplishing LEED certification using fairly typical construction methods: common energy-efficient windows, insulation, ENERGY STAR appliances, heating and domestic hot water equipment, and so forth.

The research team's on-site visit determined that the features listed in Table C-9 significantly impacted the project's efficiency.

Table C-9: Description of Significant Measures

Measure Type	Measure Description	Level of 2008 Code Compliance
Fenestration	• **U-factor:** 0.29 • **Solar Heat Gain Coefficient (SHGC):** 0.27	Above code
Envelope Insulation	• **Roof:** R-30 with cool roof membrane (ASR – 0.63, TE – 0.90) • **Wall:** R-19 Wood-framed • **Floor type and insulation level:** Uninsulated slab on grade	Cool Roof is above code,* the rest are right at code
HVAC Efficiency	**Heat Pump:** 13 SEER/11 EER/7.7 HSPF	Right at code
Domestic Water Heater	Gas-fired Tank-less with 0.82 Energy Factor	Above code

* Minimally code compliant cool roof membrane is not CRRC-Rated, ASR-0.55, TE 0.75

C.6.4 Site Six - Energy Efficiency Goals and Priorities

Energy efficiency was a relatively high priority for the design team because the developer planned to meet one of the higher levels of LEED certification at the outset of the project. This is a standard practice of this developer whenever budget allows. Energy efficiency was thus incorporated into the project at the outset, and LEED was considered a goal along with other practical considerations, such as fitting a sufficient number of units on the site, according to the architect. As with Site Five, the design team was able to increase its initial energy efficiency targets, meeting a higher level of LEED certification than planned because construction bids were coming back lower than anticipated due to the economic downturn. This is the developer's standard practice: Start with fairly aggressive energy efficiency targets that will satisfy competitive CTCAC funding requirements and adjust the project based on the funding available at the time of construction. The team participated in a LEED charrette to identify the most cost-effective ways to use the extra contingency funds that became available.

C.6.4.1 Site Six - Priority of ZNE for the Project

The developer and MP engineer reported that ZNE was not a goal for this project.

C.6.5 Site Six - IOU Program Impact

The developer had applied for the IOU MFNC program, but was unsure as to why they ultimately failed to participate. All of the respondents were fully aware of the program, though the CTCAC investor knew fewer details, and the architect viewed dealing with the program as the developer's job. None credited the program with impacting the project. The developer reported that they now regularly participate in the IOU program because they had already been building to the ideal

CTCAC efficiency levels; the architect thought the program had minimal impact even on participating projects, since many were already building to CTCAC levels.

C.6.6 Site Six - Allocating Budget to Energy Efficiency Measures

Interviewees concurred that making the decision to put budget toward energy efficiency or non-energy aspects of the project was the developer's role. The developer reported having a standard specification level for amenities and energy efficiency that he uses across his portfolio. He could increase the energy efficiency if he found—as he did on Site Six—that he had extra contingency funds due to lower-than-expected construction costs. The extra energy efficiency could then be used to be more competitive with CTCAC funding. Respondents reported that they very rarely need to adjust the project amenities and specifications in order to meet their energy efficiency targets.

C.6.7 Site Six - Energy Efficiency Drivers and Barriers

The nonprofit developer normally targeted LEED certification on his projects and would adjust the final efficiency performance based on available budget after nearing the construction phase. Table C-10 lists the key drivers and barriers to the energy efficiency level of Site Six, as cited by interviewees.

Table C-10: Case Study Site Six - Key Drivers and Barriers

Drivers	Major	Minor
CTCAC	✓	
Standard design practices	✓	
Economic downturn lowered costs	✓	
Reduce operating costs		✓
Marketability of energy efficiency		✓
Mission-driven developer		✓
City partners encouraged energy efficiency		✓
Barriers	**Major**	**Minor**
Costs	✓	
Hassle and timing impacts of adding energy efficiency	✓	

C.6.7.1 Site Six – Energy Efficiency Drivers

The interviewees cited the following additional details about the drivers of energy efficiency for Site Six:

- CTCAC (LEED as compliance path)

  The dominant force has to be CTCAC. When CTCAC made the sustainable practices part of the 9% scoring, there was no question that the industry was going to follow suit. That's a huge piece of capital. – Developer

- Knowledgeable design team
- LEED charrette
- City partners and sources of soft money (MHP funds, Redevelopment Agency funds, etc.)
- Marketability to investors

C.6.7.2 Site Six – Energy Efficiency Barriers

The design team members were somewhat impeded in incorporating energy efficiency into Site Six. They mentioned that the investor prioritized cost over energy efficiency, thus limiting available budget to allocate to energy efficiency. They also reported that adding energy efficiency can slow down the project schedule.

C.6.8 Site Six - Key Actors

The developer, the project's key decision-maker in terms of energy efficiency, conceived of Site Six as a LEED Silver project from the outset and required the design team to attempt to meet that goal. The architect and engineer worked to meet the goal cost-effectively but were not involved in setting the goal. The developer reported that, in addition to his firm's in-house project manager, its construction manager was also important in identifying how measures affected construction sequencing or cost, and the sustainability consultants were increasingly important to facilitate meeting various programs' requirements.

The investor did not ask the developer to increase his efficiency targets: "We try pretty hard not to" have any input on a project's efficiency. The CTCAC investor, operating as a syndicator (packaging low-income tax credit investment projects for other investors), can market energy efficiency to other investors, but its main role was to ensure that the developer complied with the various energy efficiency elements he had presented to the investors, and they had discussed efficiency and LEED a great deal.

C.6.9 Site Six - Key Stages Regarding Energy Efficiency

At project conception, even before seeking CTCAC funding, the developer had planned to attain LEED Silver certification. The developer reported that typically, after design development, he puts the construction documents out for bid with contractors and then gets the first "reality check" about the budget, at which point the team can determine whether they have extra money to spend on energy efficiency or not. At Site Six, they did have extra funds, and at the construction phase they decided to increase the green features to LEED Gold levels.

C.7 Case Study Project: Site Seven

Located in the San Francisco area, Site Seven is a low-rise project (fewer than four stories) with between 20 and 39 affordable housing units. The project was funded by the now-dissolved San Francisco Redevelopment Agency, and the units were intended for sale to low-income families. To comply with the city's reach code at the time, the project participated in GreenPoint Rated. It did not participate in the IOU MFNC program. It did, however, receive IOU incentives from NSHP.

For this project, we interviewed the developer, architect, and Title 24 consultant. All three had a great deal of experience with reach codes. Only the architect and Title 24 consultant had familiarity with the IOU program, and both were able to describe its requirements and processes.

C.7.1 Site Seven – Energy Performance

Our on-site visit found that Site Seven was 19% greater in energy efficiency than 2008 Title 24 requirements. The architect and Title 24 consultant records, to which the developer deferred, included an estimate of about 15% BTS.

All three interviewees concurred that this project was comparable in energy efficiency to most low-income low-rise projects constructed from 2010 to 2012. The Title 24 Consultant added that most other low-income projects likely also met the minimum energy efficiency requirements (15% greater than Title 24) given that they would have needed to keep their construction costs low (and building to higher efficiency levels would have required larger budgets than they likely had).

C.7.2 Site Seven – Distinction between Common Areas and Units

The developer and architect interviewees reported that the common areas and residential units were not treated differently with regard to energy efficiency. The architect, who was closely involved with project planning, explained that the energy efficiency of the common area and tenant units were considered in aggregate in an effort to achieve the overall energy goal (15% greater than Title 24). The design team would then "fine-tune" specific measures, as needed, to achieve those goals, but they did not give preference to either type of space regarding energy efficiency levels.

C.7.3 Site Seven – Energy Efficiency Features

The architect identified the solar measures—solar DHW and PV—as the two most important measures that allowed Site Seven to meet the city's reach code. When joining the planning discussion to help the project meet code, the Title 24 Consultant recommended that the project add the solar DHW and that they install additional insulation and energy-efficient windows.

C.7.4 Site Seven – Energy Efficiency Goals and Priorities

The developer chose to pursue GreenPoint Rated as a means of satisfying city code. The developer and architect both viewed the city's now-dissolved redevelopment agency, Site Seven's funder, as the primary entity driving the project's goals. It appears that the agency's requirements went hand-

in-hand with the reach code and the agency was, in effect, a reach code enforcement entity through its funding mechanism. The architect was the key actor in developing how to meet those goals and indicated that it was not a challenge to meet the GreenPoint Rated requirements for Site Seven because they were the standard requirement at the time.

C.7.4.1 Site Seven – ZNE Priority Level

The interviewees indicated that ZNE was not a goal for Site Seven. The architect recalled, however, that it was discussed in the earliest phases of the project. The team decided not to pursue it because of space constraints:

> *This is an urban site with not a lot of site area; [as a result,] it was difficult for us to think about implementing enough renewable energy strategies to really make the building net zero. [Many are] space-based: wind turbines, solar PV, geothermal. It's not really part of the building culture in San Francisco, so instead we focused on trying to make the building energy efficient rather than focusing on creating on-site energy.*

C.7.5 Site Seven – IOU Program Impact

Site Seven received IOU incentives from NSHP, but it did not receive incentives from the MFNC program. While none of the interviewees could pinpoint why it did not participate, the Title 24 Consultant speculated that it was probably too difficult and too expensive to participate, adding that utility program involvement in a project "matters very little." It is also likely that this project did not participate in large part because the developer was unfamiliar with the program.

C.7.6 Site Seven – Allocating Budget to Energy Efficiency

The developer described the process of determining how to allocate the project budget toward energy efficiency, explaining that after setting an initial goal, they went through measure by measure to see which were the most cost-effective to pursue and would earn the points that they needed to attain GreenPoint Rated certification. The architect clarified that none of them thought of these decisions as tradeoffs, explaining that they considered non-energy project areas (e.g., landscaping and finishes) to be entirely separately from energy measures. He added that the limited budget forced them to adhere to "tried-and-true" technology. The Title 24 Consultant emphasized that the main focus was on meeting the code, and this resulted in limited opportunities to consider reallocating budget.

C.7.7 Site Seven – Energy Efficiency Drivers and Barriers

Table C-11 presents the key drivers and barriers to the energy efficiency level of Site Seven that the interviewees reported.

Table C-11: Case Study Site Seven - Key Drivers and Barriers

Drivers	Major	Minor
Reach code	✓	
Reduce operating costs for future homeowners		✓
Encouragement from Redevelopment Agency		✓
Barriers	**Major**	**Minor**
Costs (split-incentive)	✓	
Timing (energy efficiency not incorporated early enough)		✓

C.7.7.1 Site Seven – Energy Efficiency Drivers

Throughout their interviews, the developer, architect, and Title 24 Consultant reiterated that the energy efficiency level of this project was driven by the city's code and the funding agency's requirement that they meet the code. The architect observed that the developer also had a strong goal to reduce the homebuyers' long-term operating costs, which were considered throughout the project cycle, but the developer asserted that pursuing GreenPoint Rated certification was not out of a desire to better market the units to buyers; he assumed that nearly all would not "see the significance of it." The architect noted that the decision to install solar measures was driven by the availability of incentives and subsidies.

C.7.7.2 Site Seven – Energy Efficiency Barriers

All three interviewees agreed that costs were the project's limitation to achieving a greater level of energy efficiency.

C.7.8 Site Seven – Key Actors

The architect and developer described how the developer's role was to determine that the project would pursue funding from the redevelopment agency and use GreenPoint Rated to receive it. The architect and his firm led the process of figuring out "how to do it" by leveraging their expertise around meeting codes. The developer then ensured that they actually followed requirements and then made the final decisions on budget allocation. The developer recalled that a representative from the redevelopment agency was quite involved in all aspects of the project cycle as well. The Title 24 Consultant reviewed documentation for energy code compliance and worked with the design team to improve its approach to reaching the project goals by specifying certain measures to reduce energy consumption. All interviewees concurred that Site Seven's design and construction team members' goals for and approaches to energy efficiency were aligned.

C.7.9 Site Seven – Key Stages Regarding Energy Efficiency

The development and design team considered energy efficiency throughout Site Seven's construction cycle, with interviewees identifying the conceptual design phase, when they also decided to pursue GreenPoint Rated, as the most important decision-making stage in achieving Site Seven's energy efficiency goals.

Due to the cost constraints, none of the interviewees thought that the project would have been more efficient if decisions had been made earlier in the project cycle. The Title 24 Consultant explained that since they had not sought greater energy efficiency than they reached, it would not have mattered when they made decisions—their priority was to minimize costs. However, the interviewee reflected that if they actually wanted to reach a greater level of energy efficiency, they should have involved him earlier in the process, during the schematic design phase rather than the design development and modeling phase. In fact, the architect explained that the schematic design phase was critical to seeing how the project components like energy targets, engineering, budget, and government requirements interact.

C.8 Case Study Project: Site Eight

Site Eight consisted of low-rise buildings housing between 40 and 59 units for low-income residents. It was a higher-tier LEED project located in southern California and not within a reach code jurisdiction. It was developed by a nonprofit organization and supported by CTCAC and other public and private funds, including the local redevelopment agency. This project did not receive incentives from the IOU MFNC program or NSHP.

For this project, we were unable to make contact with the developer; we interviewed the architect and the Title 24 Consultant. The Title 24 Consultant was also involved with Site Four. Both interviewees had experience with projects that went through the IOU program, but the architect reported that he is generally not aware if his projects go through the program because the developers complete that paperwork. Both interviewees had worked on projects that had been built in reach code areas.

C.8.1 Site Eight – Energy Performance

The architect and Title 24 Consultant knew that, because it was a LEED project, it was more energy efficient than Title 24, but they were not sure of the percentage. A publicly funded website reported that the project was about 20% higher than Title 24 Code. Our on-site visit found that Site Eight was 21% greater than 2005 Title 24 requirements.

C.8.2 Site Eight – Distinction between Common Areas and Units

Site Eight's common areas and residential units were not treated differently with regard to energy efficiency. The architect emphasized that the design team would never differentiate between the two spaces.

C.8.3 Site Eight – Energy Efficiency Features

Site Eight's architect explained how the project's design employed passive design elements to limit AC demand needs for this project, which sits in a very sunny and hot climate (CZ-15). The interviewee reported that using shading, overhangs, and thoughtful glazing orientation was cost-effective; he estimated that these design elements could allow a building to be 50% more energy efficient than it would have been otherwise.

C.8.4 Site Eight – Energy Efficiency Goals and Priorities

Based on the architect's understanding, the developer chose to pursue higher levels of LEED in accordance with the public funding entity requirements and to attain points for CTCAC funding (CTCAC encouraged but did not require above-code energy efficiency at this time). He clarified that the developer's only priority with regard to energy efficiency was that it meet the minimum requirements that it needed to receive its funding, saying, "It is based on economics."

C.8.4.1 Site Eight – ZNE Priority Level

The architect and Title 24 Consultant reported that ZNE was not a goal for Site Eight.

C.8.5 Site Eight – IOU Program Impact

The architect was did not know why the project had not participated in the IOU program. The Title 24 Consultant speculated that, like other developers he had worked with, this developer either did not know about the program or did not want to deal with the hassle of applying for it.

C.8.6 Site Eight – Allocating Budget to Energy Efficiency

The approach to allocating Site Eight's budget began with the architect making a checklist of where they thought they could get the needed LEED points and then assessing what was feasible and cost-effective—in other words, they were trying to "get the most bang for the buck." Because LEED points are not entirely based on energy efficiency, the design emphasis was not always on energy efficiency when they were trying to attain the certification. The architect said that, generally in their practices, they focused first on passive design, then on insulation and caulking, and then they turned to other elements like indoor air quality.

C.8.7 Site Eight – Energy Efficiency Drivers and Barriers

Table C-12 lists the key drivers and barriers to the energy efficiency level of Site Eight that the interviewees mentioned.

Table C-12: Case Study Site Eight - Key Drivers and Barriers

Drivers	Major	Minor
CTCAC	✓	
Encouragement from Redevelopment Agency	✓	
Barriers	**Major**	**Minor**
Costs	✓	
Timing (some energy efficiency measures added later)		✓

C.8.7.1 Site Eight – Energy Efficiency Drivers

According to the architect, Site Eight's developer was driven to increase energy efficiency exclusively in an effort to receive funding. Speaking about developers like this one, he said, "All they want to do is maximize their CTCAC points" so that they are more competitive to receive more funding.

C.8.7.2 Site Eight – Energy Efficiency Barriers

The architect pointed to a couple challenges that he thought impeded Site Eight's ability to achieve greater energy efficiency than it did. First, he said that the maximum limitations on rent amounts for developers did not take into account "the real cost" of energy; he explained that developers like this one are less motivated to achieve energy efficiency because it does not benefit them economically. Second, he spoke about timing and how they did not incorporate some energy efficiency measures early enough in the design process, thereby making it too difficult to bid on them and add to the design later (see below for further explanation).

C.8.8 Site Eight – Key Actors

The architect explained that Site Eight's approach, like that of all of his other projects, did not include one single actor making all of the decisions. The architect presented the developer with options of what they could do to meet requirements, how they could conduct them, and what the cost associated with them was; after the developer received that information, then the final decision was "left in their [the developer's] hands." The architect said that, while he had a very high level of input—especially related to the minutiae of the building or its orientation—and acted as a guide explaining what was cost-effective, the developer made the final decisions about budget allocation. The Title 24 Consultant was engaged in Site Eight's project cycle to the extent that he performed the modeling and Title 24 paperwork, but he recalled that this was long after the project design was established; he did not recall making any recommendations for changes.

C.8.9 Site Eight – Key Stages Regarding Energy Efficiency

This project was design-bid-build. The architect said that the design and construction team made decisions related to the project's energy efficiency very early in the project cycle. He added, however, that decisions were made throughout the project cycle, and specifically during design and Title 24 modeling: "It is all pieces of a puzzle that you keep moving to comply with Title 24 [requirements]." As mentioned above, the architect found that making adjustments to project materials after the outset of the project cycle limited Site Eight's level of energy efficiency. While he did not specifically cite what happened with Site Eight's energy efficiency measures, he offered an example of a time when the design and construction team could not include sustainable wood materials in Site Eight because of that dynamic:

> *It has largely to do with material selections—for example, things that go out to bid like framing systems using [Forest Stewardship Council] certified products. If we committed to that early, then it would have been in the project because it is very hard to substitute or change once you get bids for it. It is sometimes hard to go back and recalculate structure based on those things, so decisions have to be made at the get-go about that.*

C.9 Case Study Project: Site Nine

Site Nine is an affordable, low-rise housing project with between 40 and 59 units built by a for-profit developer in the Central Coast region in a non-reach code jurisdiction. The project met the CTCAC sustainability guidelines (not mandatory at that time), but did not participate in any green certification programs. Respondents described the project as performing around 10% better than 2005 Title 24 code, though an on-site visit conducted for this evaluation estimated its performance as 18% better than standard.

The research team interviewed four project participants: the lead architect (a second architect participated for some of the interview), a project manager from the development company familiar with the project, the main tax credit investor/syndicator, and a local code official.

C.9.1 Site Nine - Energy Performance

This project was more efficient than Title 24 because it was an affordable housing project seeking CTCAC funding, and at that time CTCAC provided competitive scoring points for building to above-code standards. Respondents described the project as just efficient enough to comply with CTCAC sustainability expectations; the developer estimated it was around 10% better than Title 24 required. Since this project, the developer has begun only building LEED projects; it was their last non-LEED project. The investor only worked with affordable housing projects receiving tax credit awards, and thus typically dealt with projects of similar efficiency—those that were sufficient to meet CTCAC standards, but not much more efficient than that. The local code official who reviewed the energy compliance documents confirmed that it was built using standard construction practices.

C.9.2 Site Nine - Distinction between Common Areas and Units

Other than using different light fixtures in the common areas—a common practice due to different lighting requirements in commercial spaces—the common areas and residential units were reportedly built to the same efficiency level. The developer originally planned to install a solar PV array to offset their utility costs, but that was left out of the project due to cost constraints.

C.9.3 Site Nine - Energy Efficiency Features

Respondents reported that it was easy to keep the energy consumption of this project low because of the mild climate in the project's geographic area. For example, the design team did not install AC in the residential units. The team included reliable and inexpensive—if relatively inefficient—ductless electric resistance heating systems in the residential units, anticipating that they would not see much use during the mild winters. The team attributed much of the project's energy efficiency performance to the use of efficient central domestic hot water systems, along with a white roof and other common efficiency measures such as ENERGY STAR appliances.

The local code official did not recall unique practices for Site Nine, reporting that it was built using standard construction practices and that the reputable mechanical engineering firm that worked on the project typically did a "great job" in terms of preparing their code compliance documents.

C.9.4 Site Nine - Energy Efficiency Goals and Priorities

In targeting CTCAC funding, the developer's consultants were "looking for the best value" on measures that could meet those requirements (choosing between higher efficiency mechanical equipment and windows, for example). The architect described this as a standard practice unless the developer specifically requests higher efficiency performance.

However, this project was built during a transition period for the developer. The company had decided to attain green certifications for all future MFNC projects and was trying to decide which one to adopt as standard practice. "We wanted to stand above our competitors." After weighing the costs and benefits of GreenPoint Rated, LEED, and EGC, the developer adopted LEED as standard practice going forward. It reportedly costs more to achieve this certification than other competing green standards, but the developer thought its marketability as a national brand and ability to satisfy CTCAC and reach code requirements outweighed this cost. The investor confirmed that this developer has begun to include solar PV and solar-assisted DHW on an increasing number of its projects since Site Nine.

C.9.4.1 Site Nine - Priority of ZNE

ZNE was not a factor or goal for this project.

C.9.5 Site Nine - IOU Program Impact

The IOU program was not attributed with any influence on the project. The architect was unaware of the program's existence. The developer said that they did not participate because energy

efficiency was a lower priority for the firm at the time, and the project manager on that project likely had little awareness of the IOU program—something that has since changed.

C.9.6 Site Nine - Allocating Budget to Energy Efficiency Measures

Allocating budget to energy efficiency measures was an exercise in cost-benefit analysis, where the developer tries "first and foremost . . . to meet the standard base" efficiency requirements most cost-effectively, then tries to keep operating expenses low, and then addresses the other factors that increase the appeal of the units, such as amenities and aesthetics. The developer described budget allocation as a collaborative process between departments at their firm. The development division sets the overall budget, the construction team prices out measures, and the asset development team provides feedback based on operating costs and experience with the suggested measures.

C.9.7 Site Nine - Energy Efficiency Drivers and Barriers

Table C-13 summarizes the key drivers and barriers to the energy efficiency level of Site Nine that the developer and the other interviewees mentioned.

Table C-13: Case Study Site Nine - Key Drivers and Barriers

Drivers	Major	Minor
CTCAC	✓	
Standard design team practices		✓
Marketability of energy efficiency		✓
Differentiation from other projects		✓
Knowledgeable design team		✓
Barriers	**Major**	**Minor**
Costs	✓	
Timing (energy efficiency requires early planning)		✓

C.9.7.1 Site Nine – Energy Efficiency Drivers

The interviewees cited the following additional details about the drivers of energy efficiency for Site Nine:

- Lower operating costs
- Differentiation, particularly to city sponsors and investors

C.9.7.2 Site Nine – Energy Efficiency Barriers

The design team recalled that timing was a concern. Energy efficiency requires early budgeting; in the words of the investor, "It's not free. It has to be built into the budget." Also, the perceived budget restrictions imposed a ceiling on the architect's ability to make suggestions to the developer.

C.9.8 Site Nine - Key Actors

Respondents underscored that the developer made the decisions affecting Site Nine's energy efficiency guided by the consultant's advice and anticipated return on investment; the architect and CTCAC investor both downplayed their own impact. The architect described having "zero" impact on the project's energy efficiency because efficiency targets were set by the developer, particularly since this developer had a great deal of knowledge about the cost and benefit of various efficiency measures. The architect's key impacts, such as orientation and shading, are also limited by the needs of the site to fit the necessary number of units on the site.

> *I think you can tell by our answers that [efficiency is] really not driven by us. It really comes from the developer. For our industry and our types of clientele, it's not suited for an architect to set goals for a client. That would be backwards, considering the financial impact of that. We don't get to spend other people's dollars that way.*

The CTCAC investor described having to compete with other tax credit investors to get access to tax credit projects, giving them minimal leverage to make suggestions about energy efficiency unless, as was the case with this project, they have a strong relationship with the developer. Even so, the investor's (unsuccessful) suggestion was limited to including solar PV or solar DHW on the project.

C.9.9 Site Nine - Key Stages Regarding Energy Efficiency

The developer leaned heavily on consultants early in the project cycle to take into account CTCAC efficiency requirements and conduct tradeoff analyses to meet them in the most cost-effective manner. The project did not use an Integrated Design approach. The architect thought that most of the key efficiency decisions were made after the early schematic design and during the design development and construction document phases.

C.10 Case Study Project: Site Ten

Site Ten is a low-rise affordable housing project including between 40 and 59 units. Constructed in a reach code location in the southern Central Coast of California by a nonprofit developer, this project received CTCAC funding and participated in the NSHP but did not participate in the IOU MFNC program.

The research team interviewed six individuals involved with the project: the lead architect, the head of new construction for the nonprofit developer, the MEP engineer who also served as the Title 24 Consultant, the main CTCAC investor, and a local code official.

C.10.1 Site Ten - Energy Performance

Respondents agreed that Site Ten was much more efficient than 2008 Title 24 standards—41% BTS, on average,[51] which corresponds to the on-site team's estimate that it was 51% BTS. The MEP engineer, code official, and HERS Rater observed that it was more efficient than similar construction projects in the area, though the architect and developer, who both worked on affordable housing projects, reported that it was typical. The code official reported noticing only minor—and typical—types of errors in the Title 24 paperwork, such as mistakes in the square footage and the size of windows.

C.10.2 Site Ten - Distinction between Common Areas and Units

At Site Ten, the commercial/common spaces and residential units were reportedly built to similar levels of efficiency, though the mechanical systems were different. This is a common practice, given that residential and commercial code have different requirements. For the architect, aesthetics played a bigger role in the common spaces than in the residential units. Similarly, the engineer described the need to accommodate a wider range of occupants in the common spaces, requiring them to consider heating, cooling, and ventilation needs outside of energy efficiency.

C.10.3 Site Ten - Energy Efficiency Features

Respondents reported that the mild climate of the area minimized the need to invest heavily in energy-efficient measures. The research team's on-site visit confirmed that the extremely small heating load due to the mild climate and the tankless DHW systems drove the bulk of the savings beyond Title 24 (every two units were served by a single tankless DHW system). Due to the mild climate, they created a site plan that utilized passive cooling, and they did not install mechanical AC in the units. They also chose inexpensive and simple electric resistance heating units that were easy to repair.[52] Solar PV and DHW systems were attached to the owner's master meter for the common spaces. The code official reported that thick concrete slabs were used in the project's flooring to prevent issues with the infill site's previously contaminated soil, and this gave the

[51] Estimate excludes one respondent misremembering the project's efficiency.

[52] They considered more energy-efficient hydronic heating systems, but they viewed these as extremely expensive for the minimal amount of use they would get in the mild climate, and as having potentially higher maintenance costs as compared to the self-contained electric heating units.

project a higher thermal mass than typical projects, thereby helping it to maintain cooler temperatures on hot days and warmer temperatures on cold nights.

C.10.4 Site Ten - Energy Efficiency Goals and Priorities

All of the respondents saw energy efficiency as a moderate or high priority for the developer and design team, as they routinely meet CTCAC performance thresholds. The design team had to reach code energy requirements (which also satisfied the CTCAC sustainability criteria that were not mandatory at that time), but otherwise had no specific numeric targets for energy efficiency relative to code. The team wanted to maximize the efficiency of the project with a focus on simplicity and low maintenance costs.

C.10.4.1 Site Ten - Priority of ZNE for the Project

Achieving ZNE was not a goal for Site Ten, as confirmed by the architect and developer. However, the engineer noted that the project was made "solar-ready," such that more solar panels could be added in the future, and the HERS Rater projected that with the building's significant savings beyond Title 24, achieving ZNE might not have been an insurmountable hurdle.

C.10.5 Site Ten - IOU Program Impact

The developer and the architect were unaware of the IOU program. The engineer, HERS Rater, and the CTCAC investor[53] were aware of it, but could not speak to the program's impact on the project; they viewed participation as a developer responsibility. The HERS Rater correctly surmised that the developer was not aware of the program, while the engineer guessed that they may not have participated due to the perceived hassle of meeting the requirements of yet another program on top of CTCAC, reach code, and the NSHP.

C.10.6 Site Ten - Allocating Budget to Energy Efficiency Measures

During construction, as on other case study projects, the economic recession yielded lower-than-expected construction costs, thus freeing up additional budget. With a priority on simplicity, the team used that extra budget to upgrade the project's energy efficiency (including installing solar systems through the NSHP program) until they felt that they had made as many upgrades as were reasonable to do. The developer described applying the extra budget to efficiency first, then to functional upgrades, and then to aesthetic upgrades.

[53] The CTCAC investor was only minimally aware of the program, in contrast to the engineer and HERS Rater, who knew it well.

C.10.7 Site Ten - Energy Efficiency Drivers and Barriers

Table C-14 summarizes the key drivers and barriers to the energy efficiency level of Site Ten, as cited by interviewees.

Table C-14: Case Study Site Ten - Key Drivers and Barriers

Drivers	Major	Minor
Reach Code	✓	
CTCAC	✓	
Economic downturn lowered costs		✓
Reduce operating costs		✓
Standard design practices		✓
Mission-driven developer		✓
NSHP incentives		✓
Mild climate (e.g., no AC)		✓
Knowledgeable design team		✓
Barriers	**Major**	**Minor**
Costs	✓	
Reliability concerns	✓	
Timing (HERS Rater hired and inspections done too late)		✓
Public/zoning officials prioritize aesthetics		✓
Low investor interest in energy efficiency		✓
Mild climate makes energy efficiency less critical		✓
NSHP participation hassles		✓

C.10.8 Site Ten - Key Actors

Interviewees relayed how Site Ten's developer set its budgets and minimum performance levels based on CTCAC and reach code. The architect described how he, like the developer, favored simple, passive approaches to energy efficiency rather than using the latest "whiz bang" technology. The architect played a key role in the passive design elements and as a project coordinator, and while the architect hired some of the consultants, he reported working closely with the developer. Title 24 Consultants, MEP engineers, and contractors were tasked with making specific mechanical equipment recommendations to satisfy the developer's need for simple, reliable equipment. The HERS Rater's role was limited to verifying energy efficiency performance for the NSHP program, and therefore the HERS Rater reported having no impact on the efficiency of the project. Similarly, the CTCAC investor reported having no impact on the project's efficiency, saying she just looks for a "solid investment":

> *We're relying on [developers'] expertise and their team's expertise to get that done. We know what we're good at, and we know what our developers and the architects and the engineers are good at.*

C.10.9 Site Ten - Key Stages Regarding Energy Efficiency

Site Ten was not an Integrated Design project. The developer set the goal to pursue CTCAC at the start of the project. The architect then incorporated energy efficiency into the site layout, allowing for passive cooling, natural ventilation, solar shading, and so forth, while the MEP engineer and Title 24 Consultants worked in the design development phase to identify specific mechanical choices.[54] The HERS Rater was involved in the project quite late; he was only brought on to verify efficiency compliance for the NSHP program, rather than actually make suggestions to the design team or installers. While the HERS Rater did not find problematic quality control issues on site, he joined the project late in order to qualify the project for the NSHP incentives, so he was not able to fully inspect wall cavities that had already been closed (some of the units were already occupied during the final inspection).

C.11 Case Study Project: Site Eleven

Site Eleven is a low-rise project in the Los Angeles region that includes between 20 and 39 affordable units for low-income tenants. In an effort to receive funding from CTCAC, the nonprofit developer pursued and obtained GreenPoint Rated certification. The building was constructed outside of a reach code area using a design-bid-build delivery method.

We interviewed Site Eleven's developer and architect. They reported that this project did not participate in either the IOU MFNC program or NSHP. The developer was unaware of the MFNC program; the architect was generally aware that it existed but was unfamiliar with it. Both were familiar with the concept of reach codes but were inexperienced with them.

C.11.1 Site Eleven – Energy Performance

This project achieved GreenPoint Rated certification. The developer speculated that Site Eleven may have also obtained ENERGY STAR Homes certification, but he was uncertain (we could not find any evidence in our secondary research that it was ENERGY STAR Homes certified). Similar to all of his organization's projects from that period, the developer estimated that Site Eleven was 25% more efficient than Title 24 requirements. The architect was unsure how this compared to other similar projects built locally during that period.

C.11.2 Site Eleven – Distinction between Common Areas and Units

The developer reported that common areas and units were built to the same level of energy efficiency. The architect reported that, regardless of the targeted level of energy efficiency, on projects like Site Eleven the designers always viewed common areas and units differently. Some energy efficiency measures were implicitly different in their energy efficiency levels. The developer pointed to lighting specifically, where they could not have much control within the units,

[54] Presumably, the construction phase also included some mechanical equipment choices, as this likely was when the team found out that they were under budget.

whereas in the common areas they installed occupancy sensors that would reach higher levels of energy efficiency.

C.11.3 Site Eleven – Energy Efficiency Features

The architect said that the high-performance glazing, insulation, and solar measures enabled this project to reach the level of energy efficiency that it did, but he identified the high-efficiency elevator system as a substantial source of energy savings despite the higher upfront costs.

C.11.4 Site Eleven – Energy Efficiency Goals and Priorities

As mentioned previously, interviewees identified that the project's energy efficiency goals were based on the developer's plan to obtain CTCAC funding. The architect indicated that getting CTCAC points was a high priority, making energy efficiency essential. CTCAC did not require above-code practices at the time, but awarded competitive scoring points for building to above-code standards. The architect explained that the design and construction team outlined their energy efficiency approach in their application, binding them to meet or exceed those requirements from the project start. The developer assumed that their goals aligned with local reach codes; however, it appears that there are not and have never been reach codes in the city or county where Site Eleven was constructed.

C.11.4.1 Site Eleven – ZNE Priority Level

The developer was unfamiliar with ZNE, and the architect was only vaguely familiar with the concept. As such, it is likely that ZNE was never considered as a potential goal.

C.11.5 Site Eleven – IOU Program Impact

The developer was unaware of the IOU MFNC program, and the architect was only moderately aware that it existed. Neither reported that the program had impacted Site Eleven in any way. The architect said that, because the client did not require it, they did not pursue it.

C.11.6 Site Eleven – Allocating Budget to Energy Efficiency

Speaking to the project's approach to allocating budget to energy-saving measures, the architect reported that cost-effectiveness was a large factor in determining the correct elevator system for Site Eleven. The architect also recalled that their CTCAC application stipulated that they needed to spend a certain amount specifically on solar energy measures. Initially, they spent far less than the budget allotted to solar energy measures, and ultimately they needed to redirect their approach and install different systems that were more costly.

C.11.7 Site Eleven – Energy Efficiency Drivers and Barriers

Table C-15 summarizes the key drivers and barriers to the energy efficiency level of Site Eleven that interviewees described.

Table C-15: Case Study Site Eleven - Key Drivers and Barriers

Drivers	Major	Minor
CTCAC	✓	
Barriers	**Major**	**Minor**
Project layout/size limited possible energy efficiency measures		✓

C.11.7.1 Site Eleven – Energy Efficiency Drivers

As mentioned above, the developer and architect concurred that CTCAC requirements drove the energy efficiency of this project. Additionally, the developer was under the assumption that local reach codes required that they build to 25% greater than Title 24, but the research team could not find evidence of reach codes in that locality. The developer assumed that the building's tenants were not concerned with energy efficiency: "It is an affordable housing project, so they were happy to have a place to live."

C.11.7.2 Site Eleven – Energy Efficiency Barriers

The developer reported minimal barriers to efficiency on the project, given that the design team is accustomed to building to high levels of energy efficiency that meet CTCAC requirements. The architect alluded to the fact that the size of the building and the lot put some limits on the technologies they could use on the site, as not all technologies will fit on every lot and some projects require engineers to develop more complex HVAC system zoning, which might dictate the equipment used and the resulting efficiency.

C.11.8 Site Eleven – Key Actors

The architect, who was hired by and reported to the developer, was involved with the project from beginning to end and said that his goals were entirely in line with those of the developer. He described the relationships between the different actors on the design and construction team.

- The architect worked closely with the mechanical engineer, informing him of the energy efficiency requirements.
- After the architect informed the engineer, the engineer provided the architect with modeling results showing the energy efficiency level that would be possible with installation of the equipment that he (the engineer) recommended.
- After this, the developer usually accepted the plans. The architect concluded:

  In this particular case, the developers looked to us as the design professionals to come up with whatever [they needed] to meet their requirements.

> The developer concurred and said that his main role was to review the CTCAC requirements and ensure that they complied with them.

The project was funded by public entities and borrowed from a for-profit bank and a nonprofit organization. The developer said that all of the funding agencies and investors were involved with allocating budget to energy efficiency, but he did not comment on the extent of their involvement.

C.11.9 Site Eleven – Key Stages Regarding Energy Efficiency

The developer said that energy efficiency considerations were integrated throughout the entire construction cycle, but that they did not make any critical decisions after they submitted their CTCAC application. He identified the original discussion in the design phase and the CTCAC application process as the key stages where they made decisions about energy efficiency. The architect identified design development as the most important stage; once the schematic design was determined, they honed in on specific building components. He added that it spills into the construction document phase.

The architect asserted that projects like Site Eleven are quite straightforward, so, in his opinion, this project would not have been more energy efficient if they had made decisions earlier:

> *In these types of projects, it is more about site utilization and trying to maximize the site in terms of the number of residential . . . units we can fit on the site in combination with the parking configurations. And once you have that in place, [the question becomes] "How can we make that work?*"

C.12 Case Study Project: Site Twelve

Site Twelve is an affordable, low-rise housing project with between 40 and 59 units built by a for-profit developer in a non-reach-code area near San Diego. Built under the 2005 Title 24 requirements, the project was GreenPoint Rated and supported by CTCAC. It did not participate in the IOU MFNC program, but did participate in the NSHP program for solar panels added to the common spaces.

The research team interviewed four individuals involved with the project: the lead architect, the vice president at the development company who oversaw construction, the GreenPoint Rater who also provided some HERS Rater inspection services, and the vice president of the bank that served as the key lender for the project.

C.12.1 Site Twelve - Energy Performance

This affordable housing project was built to above-code standards to meet the criteria of multiple programs. It was in pursuit of competitive CTCAC funding, and it received incentives for the installation of solar PV and DHW equipment through the NSHP program, which has similar efficiency criteria to that of CTCAC and the IOU MFNC program. The project was 14% more efficient than standard construction, according to the respondents, and the research team's on-site

visit results estimate it at 12% BTS. Respondents on the design and lending team described this project as similar in efficiency to their typical CTCAC projects from that time, but perhaps more efficient than some due to the inclusion of solar systems in the common areas.

C.12.2 Site Twelve - Distinction between Common Areas and Units

The design team used similar construction practices for the common areas and the residential units, except that the common area incorporated ductless heat pump AC systems as well as solar PV and solar DHW systems. The developer noted, "I don't know how we could justify building them differently," other than including solar systems to offset the developer's operating costs; they did not have the budget to install solar systems for the entire building complex.

C.12.3 Site Twelve - Energy Efficiency Features

Respondents assessed that, other than the solar systems on Site Twelve, its energy-related equipment was standard. The architect reported focusing on building orientation and the inclusion of overhangs to decrease the cooling load and maximize natural light.

The GreenPoint Rater (also a HERS Rater affiliated with the Title 24 Consultant) encountered insulation installation errors that needed to be fixed by contractors. The developer usually uses a mechanical engineer to perform preliminary Title 24 calculations with the knowledge that other consultants working on the project will revise them later. The GreenPoint Rater noted that those initial calculations were quite inaccurate and well below CTCAC's 15% BTS requirement; the rater's company fixed the calculations, bringing the building's performance up to CTCAC requirements, and the design team updated the materials schedule accordingly.

C.12.4 Site Twelve - Energy Efficiency Goals and Priorities

The design team designed the project to cost-effectively reach CTCAC's 15% better than standard energy efficiency requirements. They chose the GreenPoint Rated certification as the compliance path, thereby satisfying CTCAC and NSHP, in an effort to achieve as many GreenPoint Rated points as possible within their budget to build in a compliance cushion.

C.12.4.1 Site Twelve - Priority of ZNE

ZNE was not a goal on the project, according to the respondents.

C.12.5 Site Twelve - IOU Program Impact

The interviewed design team members reported that the IOU program did not impact the project, but they were unable to pinpoint why they had not participated, given that the project did participate in the similar NSHP program. The architect and lender were entirely unaware of the IOU MFNC program, though the architect was aware of the IOU Savings by Design program for commercial buildings. The developer mistakenly thought the project was an IOU MFNC program participant, but still thought the program had no impact since the project was already being built

to obtain CTCAC funding, and the team would not have needed any design assistance from IOU staff to meet the incentive requirements.

C.12.6 Site Twelve - Allocating Budget to Energy Efficiency Measures

The developer described allocating budget between efficiency and non-energy aspects of the project by first prioritizing the CTCAC and GreenPoint Rated efficiency obligations (with a bit of cushion), with a preference for efficiency measures that would reduce their long-term operating expenses. Once satisfying these requirements, the developer "considered that task done, and focused on other things" like occupant amenities, according to the GreenPoint Rater. As previously mentioned, the developer was able to spend more money on energy savings measures, such as solar measures, than would have been typical because the developer did not pay full market price for the site, as it was a redevelopment project supported by the city.

C.12.7 Site Twelve - Energy Efficiency Drivers and Barriers

Table C-16 summarizes the key drivers and barriers to the energy efficiency level of Site Twelve that interviewees described.

Table C-16: Case Study Site Twelve - Key Drivers and Barriers

Drivers	Major	Minor
CTCAC	✓	
Mission-driven developer	✓	
Public funding sources	✓	
Reduce operating costs	✓	
Knowledgeable design team	✓	
Marketability of GreenPoint Rated	✓	
Barriers	**Major**	**Minor**
Costs	✓	
Hassle of GreenPoint Rated		✓
Too many decision makers at developer firm		✓
Timing (GreenPoint Rater hired too late)		✓
Disinterest from engineer		✓

C.12.7.1 Site Twelve – Energy Efficiency Drivers

The interviewees discussed several additional details about the drivers of energy efficiency, including the NSHP program and the impact of soft money public funding decreasing the non-energy-efficiency-related expenses. The developer described his knowledgeable design team and standard practices as follows: "The [consultants] know the drill, and we do a similar process each time."

C.12.7.2 Site Twelve – Energy Efficiency Barriers

The design team provided additional details about the following barriers to incorporating energy efficiency in Site Twelve:

- The available budget dictated levels and type of equipment
- The mechanical engineer was not fully invested because they did not win the bid for installing the equipment
- GreenPoint Rated participation presented hassles
- The GreenPoint Rater was hired too late to have much impact
- The developer company had too many decision makers/departments, each with their own priorities

C.12.8 Site Twelve - Key Actors

Respondents said that the developer made key decisions related to energy efficiency, such as budget allocation, overall efficiency targets, and means of complying with CTCAC (GreenPoint Rated). The architect was involved very early in the project as an advisor, while also serving as the coordinator of the project's many consultants (Title 24 Consultant, GreenPoint Rater, MEP engineers, etc.). Based on the developer's targets, the architect described his role as follows: "I fill in the blanks to make it comply." The consultants emphasized that they veer away from pushing developers to raise their efficiency targets in an effort to keep good relations with the developers. However, the architect reportedly did have to push some of the consultants to be more mindful of energy efficiency. The GreenPoint Rater identified some insulation installation problems that needed to be fixed and helped the design team meet the GreenPoint Rated requirements, but he admitted to having minimal impact on the project's efficiency due to being brought in fairly late to a project that already had clear efficiency targets.

The lender reported having no influence on the project's energy efficiency; she did not discuss efficiency with the developer. The lender's typical role related to energy efficiency is factoring in anticipated construction and utility costs into her underwriting, wherein the lender would use a third-party inspector to confirm that the higher construction expenses will be balanced against claimed lower operating costs from efficiency.

C.12.9 Site Twelve - Key Stages Regarding Energy Efficiency

Site Twelve's design team's depiction of the pivotal stages in energy efficiency decision making were similar to those of the other case study sites. They set efficiency targets at the outset of the project based on CTCAC, incorporated those requirements into the initial architectural designs (overhangs, orientation, etc.), put "flesh on the bones" during design development (a key stage for incorporating energy efficiency decisions into the project), and made refinements during the construction documents phase, where they re-performed many variations of the Title 24 calculations and weighed choices about the specific mechanical systems that should be used. The GreenPoint Rater was brought in during the construction documents phase, when the project was

close to applying for permits—later than what would be ideal for the rater to have much impact. It was not fully an Integrated Design project, though the architect and GreenPoint Rater reported that the developer was receptive to feedback from the various consultants and met with them frequently to incorporate their advice. The architect and GreenPoint Rater both described coming closer to a true Integrated Design process on their other LEED projects that used design charrettes to involve various members of the design team.

C.13 Case Study Project: Site Thirteen

Site Thirteen was a low-rise project with between 60 and 79 affordable housing units set in central California, outside of a reach code jurisdiction. Developed by for-profit developer, this CTCAC project achieved GreenPoint Rated certification and received incentives from the IOU NSHP. CTCAC required above-code efficiency at the time this project was developed.

The research team interviewed four project participants: the lead architect, the MEP engineer who also served as the Title 24 Consultant, the HERS and GreenPoint Rater, and the representative from the municipality's Housing Authority[55] that served as a key investor on the project.

C.13.1 Site Thirteen - Energy Performance

Interviewees estimated that Site Thirteen was approximately 15% BTS (17%, on average); an on-site analysis estimates it was 21% BTS. All four respondents reported that their typical market-rate projects at that time were generally built to base Title 24 standards and that their CTCAC projects were commonly about 15% BTS. The MEP engineer recalled working on some high-performing LEED projects at that time (around 40% BTS) as well.

C.13.2 Site Thirteen - Distinction between Common Areas and Units

All four respondents concurred that the common spaces and residential units were constructed similarly but that they used different mechanical systems, partly due to the requirements of commercial code on the commercial spaces and partly to lower the developer/owner's operating costs. The architect reported that they were built similarly, even though CTCAC's efficiency standards did not apply to the common areas, because it was more complicated to build them differently. The MEP engineer confirmed that it was standard practice to construct these areas similarly.[56] However, the MEP engineer also reported using different mechanical systems on the common spaces due to Title 24's commercial requirements. The HERS/GreenPoint Rater and Housing Authority investor recalled using more efficient systems and solar PV on the common spaces as a means of lowering the developer/owner's operating costs.

[55] Respondent had worked with PG&E on various other housing projects, but had never heard of the CMFNH program or that the IOUs offered incentive programs for multifamily new construction.

[56] The engineer also noted that the compliance margin on the common spaces will typically be lower than for residential spaces because compliance is calculated differently under Title 24's commercial and residential codes.

C.13.3 Site Thirteen - Energy Efficiency Features

Respondents described using measures such as efficient hydronic heating and DHW systems, efficient windows, and foam-backed insulating siding to achieve their 15% BTS efficiency goals. They also used HERS verification of measures, such as duct sealing and Quality Insulation Installation (QII), to gain Title 24 compliance credits. As mentioned, a solar PV system was also installed.

The HERS/GreenPoint Rater reported doing multiple site visits to perform HERS inspections and requiring that the HVAC installers return to repair leaky ductwork that initially failed the duct leakage requirements. He also said that the insulation contractors did not fully understand the QII requirements. The HERS Rater reported that the initial Title 24 compliance calculations on Site Thirteen had been improperly executed by the MEP engineer and explained that it is preferable to have CEPEs perform this type of modeling.

C.13.4 Site Thirteen - Energy Efficiency Goals and Priorities

All four respondents characterized energy efficiency as a high priority for Site Thirteen's developer, who set CTCAC's 15% BTS minimum efficiency requirement as a goal at the outset of the project. The architect and HERS Rater both confirmed that the developer asked them to meet, but not exceed, that threshold.[57] The HERS Rater reported that his team would not build to a higher level than 15% because this was their standard protocol when they worked for this developer. The project designers implemented their own standard design and construction practices on the project.

The Housing Authority representative emphasized that, while the developer was quite concerned with using efficiency as a means of lowering future operating costs, the developer also weighed efficiency gains against current design and construction costs. The same representative added that when the Housing Authority is the developer on its own projects—as opposed to an investor, as it was for Site Thirteen—it targets efficiency goals greater than 15% BTS.

The team participated in GreenPoint Rated to satisfy CTCAC's sustainability expectations because it was a California-specific program that was less expensive than LEED, according to the architect.

C.13.4.1 Site Thirteen - Priority of ZNE

Achieving ZNE was not a goal on Site Thirteen.

C.13.5 Site Thirteen - IOU Program Impact

Respondents could not identify any impact of the IOU MFNC program on Site Thirteen. They said that deciding to participate in the IOU programs was ultimately up to the developer, and while the developer was not interviewed for Site Thirteen, the HERS Rater was able to confirm that the developer had applied to participate in the program, but was rejected because he had applied when

[57] Site Thirteen was not targeting CTCAC's competitive tax credits, so there was no direct incentive from CTCAC to build more efficiently than 15% BTS.

the project was too far along in construction to modify the design to meet the program's inspection requirements. The HERS Rater did express frustration at this, given that he had already performed HERS verifications and QII inspections for Title 24 compliance. The engineer noted that, in affordable housing, there are so many programs available to developers that keeping track of all of them can be a challenge.

The Housing Authority respondent was surprised to learn of the IOU MFNC program during the interview, despite having worked with the IOU on other housing projects.

C.13.6 Site Thirteen - Allocating Budget to Energy Efficiency Measures

None of the respondents could speak to how decisions were made about allocating budget to energy efficiency aspects of the project other than to clearly emphasize that this was the developer's responsibility and not something that the developer communicated about with the rest of the team.

C.13.7 Site Thirteen - Energy Efficiency Drivers and Barriers

Table C-17 presents the key drivers and barriers influencing the energy efficiency level of Site Thirteen.

Table C-17: Case Study Site Thirteen - Key Drivers and Barriers

Drivers	Major	Minor
CTCAC	✓	
Standard design practices	✓	
Reduce operating costs	✓	
Mission-driven developer		✓
NSHP and USDA energy efficiency incentives		✓
Knowledgeable design team		✓
HERS verification		✓
Marketability of energy efficiency to investors		✓
Barriers	**Major**	**Minor**
Costs	✓	
Developer only somewhat mission-driven		✓
Hassles (HERS verification)		✓
Timing (HERS Rater hired too late)		✓

C.13.8 Site Thirteen - Key Actors

On Site Thirteen, the four respondents agreed that the developer—an experienced, high-output developer of affordable housing that they had all worked with before—was the ultimate decision maker about energy efficiency and program participation. The developer set the project's efficiency target at the outset, and the design team was tasked with cost-effectively meeting that target.

The Housing Authority respondent described his agency as "the passenger" during the project design, not as the driver of energy efficiency decisions. The Housing Authority representative reported that he would have liked to see even greater energy efficiency in the project, particularly the common spaces, because, as the investor, he had first right of refusal if the developer decided to sell the project. This means that the Housing Authority could eventually own the project and would then be responsible for the utility bills associated with the common spaces.

The HERS/GreenPoint Rater focused on compliance, verifying proper measure installation, and reportedly educating design team members about proper construction practices to maximize efficiency.

C.13.9 Site Thirteen - Key Stages Regarding Energy Efficiency

The developer reportedly set the target of meeting CTCAC's minimum efficiency standards (15% BTS) during project conceptualization. The engineer, architect, and Housing Authority investor all confirmed that they were told Site Thirteen's target when they were first brought on to the project. The Housing Authority was involved in the project during conceptualization, as getting city support early on was reportedly appealing to CTCAC. The engineer described how he made specific measure choices during design development and that it would have been too late to make them during construction. The HERS/GreenPoint Rater was brought on during construction and was used to verify that specified measures were installed properly, but he would have preferred to be involved earlier than this to provide guidance to the installer team *before*, rather than after, installation.

C.14 Case Study Project: Site Fourteen

Site Fourteen is the only confirmed IOU MFNC program participant among the fifteen case study projects. Site Fourteen is an affordable housing project with between 20 and 39 units in low-rise buildings. Built in San Diego County in a non-reach-code community by a nonprofit developer under the 2008 Title 24 energy efficiency requirements, this project participated in the GreenPoint Rated program as a means of obtaining competitive CTCAC funding (CTCAC required above-code efficiency at the time).

The research team interviewed four project participants: the lead architect, the developer's project manager for the site, the HERS and GreenPoint Rater (one person served both roles), and the local housing authority representative who commissioned the project and oversaw the municipality's investment in the site.

C.14.1 Site Fourteen - Energy Performance

The on-site visit estimated that the project was 66% more efficient than 2008 Title 24 requirements. Respondents' opinions and recollections on the percentage varied, with an average estimate of 31%: Two respondents recalled it being about 40% BTS, one reviewing a Title 24 calculation reported it was 24% BTS, and the last was unsure, but thought at least 20% BTS. The developer

reported that he consistently built projects to similar levels of energy efficiency at that time, though the architect and rater (who was both the HERS Rater and the GreenPoint Rater) reported that there was very little green MFNC activity in the area at that time, and this project stood out for that reason.

C.14.2 Site Fourteen - Distinction between Common Areas and Units

Respondents reported building the common space similarly to the residential units, but said that they used different mechanical systems on the common spaces—i.e., spaces where the developer will have to pay the utility bills. The common space benefited from a particularly high-efficiency heat pump heating system and solar DHW, lowering the utility bills considerably. The developer also noted that the common space appeared to be less efficient on paper than the residential portion because the commercial portion of Title 24 calculates energy compliance margins very differently than it does for residential areas.

C.14.3 Site Fourteen - Energy Efficiency Features

Site Fourteen included an array of measures contributing to its level of energy efficiency: an advanced heat pump heating system and solar-assisted DHW for the common areas, energy efficient windows, more insulation than required by Title 24, etc. The HERS Rater (who also served as the GreenPoint Rater) found incorrect refrigerant charges on the AC systems that needed to be remedied and multiple instances of leaky ductwork that needed to be fixed by the HVAC contractor.

C.14.4 Site Fourteen - Energy Efficiency Goals and Priorities

All the respondents reported that energy efficiency was one of the developer's top priorities for Site Fourteen. This was part of the developer's "brand" and the key to obtaining CTCAC funding for its projects. Even though they did not require it, the team presented the project to the Housing Authority as one that would target efficiency.

The developer planned from the outset to surpass CTCAC's 15% BTS energy expectations, and tasked the design team with maximizing their compliance margin within their budget. The developer had no specific numeric target, but tested tradeoffs that would maximize efficiency and reliability, settling on the high-efficiency heat pump system and solar DHW for the common areas. Increasing the compliance margin made the project more competitive for CTCAC's 9% tax credits and would lower their operating costs, boost the project's publicity, and support the nonprofit's goal of providing efficient housing to the low-income community. GreenPoint Rated was chosen as a means of compliance with CTCAC rather than LEED because of its lower relative cost.

C.14.4.1 Site Fourteen - Priority of ZNE

The design team considered making Site Fourteen a ZNE project at the energy consultant's suggestion. While the project had sufficient roof space and solar exposure for a large solar PV array, the design team quickly decided that it was outside of their budget.

C.14.5 Site Fourteen - IOU Program Impact

Site Fourteen was a CAHP project. Even so, three key respondents who all had CAHP program experience—the architect, developer, and HERS/GreenPoint Rater—said that the program had virtually no impact[58] on the efficiency of the project because it was already being built to efficiency levels far beyond CAHP requirements in order to be competitive for CTCAC. The bulk of the incentive to build efficiently reportedly came from CTCAC; in the words of one interviewee, "CAHP is just the whipped cream," (i.e., an unnecessary but welcome funding source).

C.14.6 Site Fourteen - Allocating Budget to Energy Efficiency Measures

The developer and architect reported highly prioritizing efficiency over site amenities, focusing on cost-effectively using their limited budget by building a simple site using measures that they thought would be reliable and have low operating costs. All interviewees concurred that the developer made decisions about budget allocation with input from the design team and contractors.

C.14.7 Site Fourteen - Energy Efficiency Drivers and Barriers

Table C-18 presents the key drivers and barriers to the energy efficiency level of Site Fourteen.

Table C-18: Case Study Site Fourteen - Key Drivers and Barriers

Drivers	Major	Minor
CTCAC	✓	
Marketability of energy efficiency to investors/donors	✓	
Reduce operating costs	✓	
Mission-driven developer	✓	
Small design team		✓
Knowledgeable design team		✓
Willingness to undergo IOU program hassles		✓
Barriers	**Major**	**Minor**
Costs	✓	
Equipment reliability concerns		✓
Installation problems		✓
Hassles/costs of working with multiple programs		✓

C.14.7.1 Site Fourteen – Energy Efficiency Drivers

The interviewees provided the following additional details about energy efficiency drivers for Site Fourteen:

- Energy efficiency integrated into standard practices
- Lower operating costs
- Increases prestige of nonprofit among donors

[58] The city investor noted that the IOU asked the design team to benchmark the project's energy performance over time to monitor its real-world energy consumption, but did not otherwise impact the actual efficiency of the project.

- "Harsh" climate creates a greater need for energy efficiency
- Attract investors through demonstrating financial feasibility
- More budget for energy efficiency due to lower priority for aesthetics

C.14.7.2 Site Fourteen – Energy Efficiency Barriers

The design team provided the following additional details about barriers to incorporating energy efficiency in Site Fourteen:

- The available budget dictated levels and type of equipment
- Reliable measures: competing (not necessarily mutually exclusive) goals with EE
- Installation problems: HVAC equipment failed initial refrigerant charge and duct leakage checks
- CTCAC energy efficiency requirements not applicable to common areas
- Hassle/transaction costs of working with multiple programs

C.14.8 Site Fourteen - Key Actors

The interviewees characterized the developer's decision-making tactics as highly focused on energy efficiency, taking into account equipment reliability. They added that these decisions were guided by an "owner advocate" consultant who took a hands-on approach to measure choices that were informed by design team members chosen largely for their experience with energy-efficient construction. The mechanical engineer was reportedly quite focused on energy efficiency and was the person who first encouraged pursuing ZNE status, while the HERS Rater (also the GreenPoint Rater) did not report doing anything to change the project's energy efficiency other than insuring that measures were properly installed during multiple on-site inspections. The HERS Rater verified HERS measures for Title 24 compliance credits and qualified the program for GreenPoint Rated certification, while another company overseeing the engineering and Title 24 modeling commissioned the project for compliance with the IOU MFNC program. The Housing Authority interviewee favored energy efficiency but, as an investor, said that he did not have the authority to require the project to exceed Title 24 efficiency standards; he could only require the developer to demonstrate long-term financial feasibility (which factored in the low operating costs through efficiency).

C.14.9 Site Fourteen - Key Stages Regarding Energy Efficiency

The respondents viewed Site Fourteen as an Integrated Design approach project, in which the developer brought various design team members together early in the design process and laid out the project's emphasis on energy efficiency; the developer described this as the LEED approach. At project conception, the developer had decided to at least meet CTCAC requirements. During the schematic and design development phase, he tried to maximize the compliance margin with Title 24, and then focused on trying to avoid having to value-engineer out his preferred measures while remaining in compliance with his goals though HERS inspections.

Because this was a relatively small project, the architect and developer both reported that it was easy to integrate efficiency throughout the project's design and construction process since they had relatively few decision makers involved in the project.

C.15 Case Study Project: Site Fifteen

Site Fifteen includes between 40 and 59 units for low-income tenants in low-rise buildings. This low-rise project in the greater Sacramento region was built by a nonprofit developer outside of reach code jurisdiction. In pursuit of competitive CTCAC credits (which required above-code efficiency at the time), this project received EGC certification.

For this site, we interviewed the developer, the HERS Rater/engineer, and a consultant who facilitated the project's financing. The HERS Rater/engineer acted as a third-party inspector, performing ENERGY STAR HERS rating after acting as the mechanical engineer on the project during its design and framing phases. The investment consultant's role was to assist this nonprofit developer in securing financing by working closely with financing entities.

Neither the developer nor the investment consultant had experience working in reach code areas, although both had heard of them. The HERS Rater/engineer was very experienced working under them. Both the developer and the HERS Rater/engineer were familiar with the IOU MFNC program and had had projects move through it; the investment consultant was not very familiar with it.

C.15.1 Site Fifteen – Energy Performance

While the developer interviewee reported that Site Fifteen was 25% higher than Title 24 requirements, the affordable housing websites reported that it was 30% higher. However, our research team's modeling estimated that it was right at the 2008 Title 24 requirements (about 1% BTS). The developer felt confident in the 25%, and he even referenced the project's certification signed by the architect.

The developer reported that this project was similar in its energy performance to other low-income low-rise projects that his organization started during that period, saying, "That is pretty much what you have to hit" to secure CTCAC financing. The HERS Rater/engineer, pointing to the fact that this project was built in a rural area with limited new construction in general, assumed that this project was "heads and tails" above other projects from that period.

C.15.2 Site Fifteen – Distinction between Common Areas and Units

According to both the developer and HERS Rater/engineer, they built the common areas and tenant units to the same level of energy efficiency. The developer explained that each building has to meet the same standard, and they do their best to ensure that buildings achieve the minimum requirements needed for certification.

C.15.3 Site Fifteen – Energy Efficiency Features

The HERS Rater/engineer recalled that this project's insulation and HVAC systems allowed it to achieve the energy efficiency that it did; he recalled suggesting that they install a GSHP to save energy as well, but found that it was unrealistic given the limited project budget. The developer also described his perspective on solar PV, where, as with many other sites described in this report, solar PV was considered as a potential project measure but was "on the chopping block" when it came to the budget. He explained that solar is where they "sacrifice" because they do not get points for other certifications besides LEED.

C.15.4 Site Fifteen – Energy Efficiency Goals and Priorities

Site Fifteen's developer pursued EGC certification in an effort to make the project more competitive for CTCAC funding. The developer said that CTCAC was one of a limited number of funding options; as a result, energy efficiency was very important and "a given": "It is just a fact of life you have to deal with."

C.15.4.1 Site Fifteen – ZNE Priority Level

Interviewees confirmed that ZNE was never considered as a potential goal for this project.

C.15.5 Site Fifteen – IOU Program Impact

The developer and HERS Rater/engineer concurred that the IOU MFNC program did not influence Site Fifteen in any way. Neither knew why the project did not apply for the program. However, the developer reported that other projects that he had conducted went through the program. The HERS Rater/engineer, surprised that the project did not go through the program, was under the impression that the developer may not have been aware of the program at the time of Site Fifteen's construction. The developer speculated that if it had been cost-effective and they had needed to obtain additional points for CTCAC, after performing a cost-benefit analysis they would have likely pursued the program.

C.15.6 Site Fifteen – Allocating Budget to Energy Efficiency

The budget was an essential factor in guiding Site Fifteen's approach to energy efficiency. The developer reported that, while he and his construction team were the final decision makers, the CTCAC energy requirements were truly the deciding factor, saying, "It really was not a decision."

C.15.7 Site Fifteen – Energy Efficiency Drivers and Barriers

Table C-19 lists the key drivers and barriers impacting the energy efficiency level of Site Fifteen that the developer and other interviewees cited.

Table C-19: Case Study Site Fifteen – Key Drivers and Barriers

Drivers	Major	Minor
CTCAC	✓	
Utility allowances overcome split-incentive*		✓
Barriers	**Major**	**Minor**
Costs	✓	
Hassles of CTCAC		✓

* The rent paid to the developer/owner can be increased if the developer has lowered the occupant's utility bills by building to above-code standards.

C.15.7.1 Site Fifteen – Energy Efficiency Drivers

In short, obtaining funding was the main driver for advancing Site Fifteen's energy performance above Title 24. This project was not subject to reach code. As a result, the project's high energy efficiency goals were entirely driven by targeting CTCAC funding. The developer also described how utility allowances in affordable housing helped to overcome the split-incentive issue; the rent paid to the developer/owner can be increased if the developer has lowered the occupant's utility bills by building to above-code standards.

C.15.7.2 Site Fifteen – Energy Efficiency Barriers

The interviewees did not list many barriers to energy efficiency besides coping with Site Fifteen's limited budget as an affordable housing project. The developer conveyed that CTCAC was a challenge; however, the team was able to manage their application, especially because of the help of the investor consultant. The HERS Rater/engineer recalled one hurdle where he found that the building caulking needed to be improved, but the team quickly remedied the issue.

C.15.8 Site Fifteen – Key Actors

The interviewees repeatedly reported that their and other market actors' activities had very limited impact when it came to making decisions about the project's energy efficiency. Their experience was that the goal to achieve EGC certification to obtain CTCAC funding made their options very limited. The developer recalled that he ultimately made decisions about the budget, but he explained that, when it comes to energy efficiency, "It is not a decision; it is a given on any project." His decisions were based on the input from the project architect, other contractors, and a construction manager. He added that investors expected the project to meet CTCAC funding requirements, but they did not have their own requirements.

The investment facilitator said that she was not at all involved in any decisions about energy efficiency, but did steer the project toward financing opportunities that required it. The HERS

Rater/engineer reflected that his personal input had limited importance to the project's energy efficiency direction, emphasizing again that the funding requirements were the real driver.

C.15.9 Site Fifteen – Key Stages Regarding Energy Efficiency

During the project conception phase, the Site Fifteen team established their commitment to building an energy-efficient project to obtain CTCAC funding. The developer reported that the CTCAC application was a critical point in the project, because that was when the team had to make commitments about participating in the EGC program, thus obligating them to meet certain above-code practices.

Appendix D Detailed Methodology and Findings from On-Site Visits

D.1 Detailed Methodology for Low-Rise On-Site Visits and Modeling

The Low-Rise Multi-Family New Construction (MFNC) component of the Market Characterization study is an analysis of qualifying California housing developments. The qualifying projects fit within the California definition of low-rise multifamily dwelling units that started construction in the period from January 1, 2010, through December 31, 2012, and did not participate in the IOU MFNC programs. DNV GL performed this research effort through detailed analysis of a sample of 25 developments. The effort consisted of recruiting twenty-five multifamily developments to participate, conducting energy audits on all twenty-five sites, and building and analyzing models of the observed sites using Energy Soft's EnergyPro building energy analysis software. The purpose of the study is to provide baseline measurements of MFNC practices relative to Title 24 code requirements during the 2010 through 2012 period.

D.1.1 Low-Rise Recruitment and Screening Process

A recruiting effort was implemented across the known population of the 303 qualifying low-rise newly constructed multifamily developments that broke ground between 2010 and 2012 and also fell within PG&E, SCE, or SDG&E service territories. As with the developer survey (Appendix E), the evaluation team selected the on-site sample from the four data sources used in the Phase I market characterization report. The data sources used to compile the list of developments were as follows:

- McGraw Hill Construction (MHC) Dodge data, cataloging details of multifamily building construction projects started between 2010 and 2012 in California[59]
- California Tax Credit Allocation Committee (CTCAC)[60] reports that list 4% and 9% tax credit awards[61] for construction of low-income multifamily housing allocated between 2009 and 2011[62]
- A survey of 76 builders and developers involved with projects found in MHC-CTCAC data (survey conducted by NMR Group analysts)

[59] McGraw Hill Construction collects data on new construction starts and provides the data to various market actors involved with building construction (http://www.construction.com/about-us/).
[60] CTCAC is a committee in the California State Treasurer's Office. Among other roles, it allocates and administers federal and state tax credit programs for low-income housing retrofits and new construction projects.
[61] These are the approximate percentage of a project's "qualified basis" that a taxpayer may deduct from his/her annual federal tax liability in each of ten years.
[62] According to CTCAC staff, nearly all projects start construction during the calendar year after they are awarded a tax credit. For example, a project that received an award in 2009 would likely begin construction by 2010.

- IOU MFNC program participant lists (California Advance Home Program [CAHP], California Multifamily New Homes [CMFNH], and Savings by Design [SBD]) in order to remove program participants from the MCH, CTCAC, and survey project lists

The population of qualifying developments was divided into a standard-efficiency requirement group and a high-efficiency group, in which the developments were likely required to be more efficient than a comparable code-compliant project by at least 15% due to receipt of CTCAC tax credit awards or being located in a reach code jurisdiction. For the sampling process, DNV GL chose to follow California IOU distribution strategies established in previous CPUC studies by targeting a 40/40/20 percent site distribution across the three IOU service territories (40% PG&E, 40% SCE, and 20% SDG&E). The initial targeted as well as completed stratification for the low-rise site visits is shown in Table D-1.

Table D-1: Low-Rise On-site Strata
(Green = Quota Filled)

IOU	Standard Title 24 / EE Required	Targeted Number of Sites	Completed Sites
PG&E	Standard	4	4
	Required	6	6
SCE	Standard	5	5
	Required	5	5
SDG&E	Standard	2	1
	Required	3	3
CA Total	**Standard**	***11***	***10***
CA Total	**Required**	***14***	***14***

*A project was defined as being required or likely to have high-efficiency requirements if it received a CTCAC tax credit or started construction in a reach-code community after the reach code was approved.

Table D-2 presents the location and characteristics of the projects included in the low-rise sample, including whether the project was an affordable or market-rate project and whether it was located in a reach code jurisdiction.

Table D-2: Low-Rise On-Sites Locations and Characteristics

Site ID (Case Study #)	NMR Revised Stratum*	Affordable or Market Rate	Reach Code	CA Climate Zone	CA Climate Region	County/ Region**
101992 (7)	PG&E Exceed	Affordable	Yes	3	1	San Francisco
102032	PG&E Exceed	Affordable	Yes	3	1	Alameda
102462 (8)	SCE Favored/ Encouraged	Affordable	No	15	5	Riverside
102472	SCE Baseline	Affordable	No	10	3	Southern California
102662	SCE Baseline	Affordable	No	10	3	Southern California
102682 (9)	PG&E Favored/ Encouraged	Affordable	No	5	1	Central Coast
102742 (10)	SCE Exceed	Affordable	Yes	6	2	Central Coast
102872	SCE Favored/ Encouraged	Affordable	No	10	3	Southern California
103092 (11)	SCE Favored/ Encouraged	Affordable	No	9	3	Los Angeles region
103332 (12)	SDG&E Favored/ Encouraged	Affordable	No	7	2	San Diego
103452	SCE Favored/ Encouraged	Affordable	No	13	4	Central Valley
103572	PG&E Baseline	Affordable	No	5	1	Central Coast
103782	SCE Favored/ Encouraged	Affordable	No	8	3	Orange
103922	SDG&E Exceed	Affordable	No	7	2	San Diego
104062	SDG&E Baseline	Market Rate	No	10	3	San Diego
104172	PG&E Baseline	Market Rate	No	3	1	Central Coast
104342 (13)	PG&E Exceed	Affordable	No	13	4	Central Valley
104492	PG&E Exceed	Affordable	No	12	4	Central Valley
104552	PG&E Exceed	Affordable	Yes	3	1	Alameda
207994	PG&E Favored/ Encouraged	Affordable	No	3	1	San Francisco region
212315	SCE Favored/ Encouraged	Affordable	No	9	3	Los Angeles region
218517 (14)	SDG&E Exceed	Affordable	No	10	3	San Diego
253365	SCE Favored/ Encouraged	Affordable	No	6	2	Los Angeles
284771 (15)	PG&E Exceed	Affordable	No	12	4	Sacramento region

* Favored/Encouraged is a CTCAC site that was encouraged to be energy efficient (by being awarded sustainability points for energy efficient practices) before CTCAC adopted above-code requirements in 2011.
** In order to preserve the anonymity of the MFNC projects, we identify the county or region in which the project is located rather than the city.

The recruiting effort proved to be challenging in many respects. The task of getting an individual on the phone with the authority to commit to a site visit proved to be the most challenging aspect. In addition, recruiting staff found many cases for which the contact name and listed phone number in the source data was incorrect or no longer valid. Many calls to site contact leads, internet searches, and emails to potential site contacts were required to secure the approval to visit the twenty-five sites. Although there was an attempt to recruit every one of the qualifying sites in SDG&E territory, only four of the five targeted SDG&E sites were recruited for participation in the study.

The recruiting team was able to recruit one additional SCE site, bringing the total number of visited SCE sites to eleven. This project was surveyed, but analysts determined that the site was in fact a single-family dwelling unit and did not meet the Title 24 definition of a multifamily dwelling. DNV GL did not continue with the EnergyPro modeling and analysis for the one SCE site. As a result, the analysis is limited to the twenty-four qualifying low-rise multifamily sites that DNV GL visited.

D.1.2 Low-Rise On-Site Data Collection

A team of DNV GL engineers performed the low-rise multifamily site visits between April and July of 2014. All site visits were preceded by a phone call with an individual at the housing complex to gain approval and discuss the activities of the site visit. The evaluation team requested as-built plans and/or Title 24 compliance documentation prior to the site visits, but these materials were not consistently available.

At the start of each site visit, DNV GL engineers met with building staff on site to discuss construction details of the development; arrange for access to dwelling units and mechanical rooms, attic, or crawl-space areas, if present; and to confirm general information about the residential complexes. DNV GL staff utilized the approved low-rise on-site data collection instrument to collect data on the individual units as well as the residential complex as a whole. In completing the site instrument, engineers gathered information on HVAC equipment, including unit types, manufacturer, model number, vintage, size, efficiency, means of distribution, location, and area served. These data points were also collected for all domestic hot water units, which in some cases also provided a heating source for the residential units. Engineers also made detailed observations about the structural attributes of the developments, including wall types and areas, floor types and areas, and roof/ceiling types and areas. To the extent possible, DNV GL engineers inspected these assemblies to determine insulation type and thickness installed, framing size and spacing, and the presence of any cool roof, radiant barrier, or rigid insulation material used in addition to traditional insulating materials. Additionally, engineers collected information on all

perimeter glazing, including area, frame type, number of panes, presence of Low-E coating, and manufacturer. Auditors also recorded any available documentation found on the windows or in site plans regarding U-factor and SHGC ratings. Architectural shading features such as overhangs, side fins, or awnings were documented in relation to the glazing area they affected. Throughout the on-site visits, DNV GL engineers photographed documentation provided by the on-site contacts, mechanical equipment and nameplates, accessible insulation, perimeter walls, any renewable generation present, thermal collectors, unique lighting, or any other unique features observed at the developments. All of the data collected on site were used to build and analyze energy models of the observed developments.

D.1.3 Analysis for Low-Rise Sites

The building energy analysis software EnergyPro is a common Title 24 compliance modeling software used for residential new construction. For that reason, it was selected to be the primary analysis tool for modeling and analyzing the observed low-rise developments visited by DNV GL. DNV GL engineers created unique EnergyPro models for twenty-four of the twenty-five visited sites. (The one site that was deemed to be a single-family development was not modeled.) The modeling process entailed assembling the EnergyPro "building tree" of the observed site using the information collected at the site visit. Engineers would specify general information about the site that included site location (city and associated weather data), number of dwelling units, site orientation, and the Title 24 energy code version governing the development's construction (based on available Title 24 documentation or start dates). For many of the low-rise developments included in the low-rise sample, the original building plans were approved prior to the 2008 Title 24 Standards first effective date of January 1, 2010. EnergyPro allows the user to model the project's compliance relative to different versions of the Title 24 energy code; thirteen of the twenty-four sites were modeled against the 2005 Title 24 code (the applicable energy code for the project), while the remaining sites were modeled against the 2008 Title 24 energy standards.

After entering the general development information, the modeling process involved defining the domestic hot water, heating, cooling, and ventilation equipment serving the apartment units. All of the parameters collected during the site visit on equipment type, size, efficiency, manufacturer, means of distribution, means of control, and presence of renewable supplemental energy sources were entered in the building tree. If multiple types or sizes of domestic hot water or HVAC systems were present at the development, each unique type needed to be modeled separately in conjunction with the area it served.

Once the mechanical systems were defined, the zones and areas served by the systems were then defined. These sections defined the square footage, unit types (in this case, all were multifamily), number of kitchens and bedrooms, and the thermal envelope of the zone and area defined. The thermal envelope was defined by the exterior walls, floors, and roof area of the units. DNV GL engineers used observed characteristics whenever possible in characterizing these building assemblies. However, determining the exact insulation type or R-value was not always possible in these fully constructed, occupied buildings without structurally invasive techniques. Accordingly,

in some instances the engineers deferred to the as-built plans for the specifics of the inaccessible wall, floor, or ceiling assemblies. For window and skylight areas, as well as any overhang or side-fin shading affecting the windows, DNV GL utilized measurements and observations when defining these characteristics in the energy models.

For both the high-rise and low-rise sites, Energy Soft developed unique EnergyPro software versions with add-ons specifically built for this research. These versions provided measure-specific parametric run outputs for the proposed energy simulation models that identify the annual energy savings attributable to each measure. The five measures included in the parametric run outputs were fenestration (including external shading devices), envelope insulation, cool roof, HVAC efficiency (including distribution systems), and domestic hot water. In addition, the team estimated the impacts of other measures/interactive effects, which represent the difference between the sum of savings of the five independent measure-specific parametric runs and the whole-building annual energy savings. The other measures/interactive effects capture the remaining building characteristics that impact energy consumption but are not included in the five parametric measure runs, such as fans, pumps, and other features.

The analysis phase began as soon as the preliminary models were assembled and run through the modeling software. Initially, the software itself performed a series of automatic quality control steps designed to catch any significant errors from the modeling process, then the engineers reviewed the results shown by EnergyPro. Typically, the engineer has a sense of a site's overall performance before the results appear based on the characteristics of the modeled site. After running the calculations, the engineer will then go back into the building tree and review the specified equipment and structures. If the Title 24 compliance data for the site are available, the engineer carefully reviews any disparities between the modeled observed site and the compliance documentation for the site that was created before the building was erected. After making any necessary corrections or modifications to their own model, the engineers then pass off the model for peer review. The reviewer will perform the same series of quality assurance steps to the building tree, making sure the observed development's equipment and structures are modeled as accurately as possible.

D.1.4 Low-Rise On-Sites - Threats to Validity of Analysis

The accuracy of the compliance software EnergyPro has an immeasurable impact on the results of this analysis. It was selected to serve as the foundation for all of the analysis because of its widespread prevalence in the California compliance modeling landscape. Much of the projected results used in this study are derived from energy simulation formulas unknown to parties outside of Energy Soft.

A significant amount of time was spent by the DNV GL engineers testing the results of the contracted "measure isolating parametric run" version of EnergyPro the team received. Several iterations of the software were required to effectively remove the various simulation errors the DNV GL team encountered when testing the initial versions received. Extensive efforts were made

to correct all errors identified, but rerunning all sites multiple times for consistency checks was not possible under the timeline and scope.

D.2 Site-Specific Analyses for Low-Rise On-Site Visits and Modeling

In this section, we present additional summary tables regarding the modeling results of the low-rise on-site visits beyond what was already presented in Section 3.

Each site's overall savings percentage was calculated by subtracting the modeled site's annual kWH and therm usage from the standard Title 24 baseline efficiency annual kWH and therm usage for the code year the site was originally permitted under and dividing the result by the consumption of a hypothetical, standard-efficiency baseline comparison site. The same formula was used to calculate the combined energy savings by taking the kWH and therm consumption for both and converting them to kBTUs.

The following tables display the annual electric, gas, and combined energy savings percentage for the twenty-four modeled low-rise sites for which on-site visits were conducted by the research team. The modeled sites' gas consumption was significantly more efficient than the average electrical consumption. The applicable code year the site was permitted under is listed in the code version column. The Initial Stratum column identifies the IOU jurisdiction of the site, along with whether or not the site was thought to be subject to any above-code requirements, while the NMR Revised Stratum identifies sites whose categorization changed based on additional research conducted after the on-site was complete (for more details, see Section 2.5). In the savings columns, projects found to be more efficient than Title 24 requirements (i.e., those that have annual energy savings) are shaded green, while projects found to be less efficient than Title 24 requirements are shaded red.

Table D-3: Low-Rise On-Sites: Site-Specific Estimated Energy Savings Relative to Applicable Title 24 Codes, by Efficiency Requirements

Site ID (Case Study #)	Initial Stratum (Baseline = no known above-code requirements; Exceed = above-code requirements)	NMR Revised Stratum (Favored/Encouraged = CTCAC site pre above-code requirements)	Code Version	Annual kWH Savings	Annual Therm Savings	Annual Combined Energy Savings
101992 (7)	PG&E Baseline	PG&E Exceed	2008	10.3%	20.8%	18.5%
102032	PG&E Exceed	PG&E Exceed	2005	14.6%	29.5%	28.6%
102462 (8)	SCE Baseline	SCE Favored/Encouraged	2005	-9.3%	40.5%	20.8%
102472	SCE Baseline	SCE Baseline	2005	-12.6%	7.3%	2.7%
102662	SCE Baseline	SCE Baseline	2005	-17.9%	8.5%	3.0%
102682 (9)	PG&E Baseline	PG&E Favored/Encouraged	2005	14.1%	19.3%	18.4%
102742 (10)	SCE Exceed	SCE Exceed	2005	36.6%	51.5%	50.6%
102872	SCE Exceed	SCE Favored/Encouraged	2005	-4.0%	11.7%	8.3%
103092 (11)	SCE Exceed	SCE Favored/Encouraged	2005	7.2%	54.0%	48.0%
103332 (12)	SDG&E Exceed	SDG&E Favored/Encouraged	2008	35.8%	11.5%	12.2%
103452	SCE Baseline	SCE Favored/Encouraged	2005	-15.2%	16.3%	11.9%
103572	PG&E Baseline	PG&E Baseline	2005	-9.9%	29.7%	25.7%
103782	SCE Baseline	SCE Favored/Encouraged	2005	-11.4%	48.3%	38.4%
103922	SDG&E Exceed	SDG&E Exceed	2008	23.6%	9.6%	10.0%
104062	SDG&E Baseline	SDG&E Baseline	2008	11.3%	13.2%	12.6%
104172	PG&E Baseline	PG&E Baseline	2008	52.7%	62.6%	62.0%
104342 (13)	PG&E Exceed	PG&E Exceed	2008	-4.7%	26.0%	21.4%
104492	PG&E Exceed	PG&E Exceed	2008	21.5%	14.9%	15.2%
104552	PG&E Exceed	PG&E Exceed	2008	52.0%	19.6%	20.6%
207994	PG&E Exceed	PG&E Favored/Encouraged	2008	-5.3%	13.4%	12.0%
212315	SCE Exceed	SCE Favored/Encouraged	2005	4.2%	40.1%	37.4%
218517 (14)	SDG&E Exceed	SDG&E Exceed	2008	21.5%	87.9%	66.1%
253365	SCE Exceed	SCE Favored/Encouraged	2005	63.4%	11.3%	14.0%
284771 (15)	PG&E Exceed	PG&E Exceed	2008	-2.2%	2.5%	0.7%
Average (n=24)			N/A	**11.5%**	**27.1%**	**23.3%**

Table D-4 displays the annual energy consumption savings impact each measure had on the site-level performance. The energy savings are displayed as the percent of total kBtu savings. To estimate this value, the measure-specific projected annual natural gas (therm) and electric energy (kWh) consumption are converted to a common unit (kBtu). The combined annual energy usage

in kBtu is then compared against the applicable 2005 or 2008 T24 code minimally compliant baseline usage to estimate the percent savings value.

Table D-4: Low-Rise On-Sites: Estimated Energy Savings Relative to Applicable Title 24 Codes for Individual Measure Types, by Site

Site ID	Initial Strata	NMR Revised Strata	Code Version	Annual Energy Savings					
				Glazing	Envelope Insulation	Cool Roof	HVAC	DHW	Total
101992	PG&E Baseline	PG&E Exceed	2008	-4.4%	3.5%	0.0%	2.7%	16.3%	18.5%
102032	PG&E Exceed	PG&E Exceed	2005	-1.8%	5.2%	0.0%	9.6%	7.7%	28.6%
102462	SCE Baseline	SCE Favored/Encouraged	2005	3.3%	0.1%	0.0%	2.7%	23.0%	20.8%
102472	SCE Baseline	SCE Baseline	2005	-7.4%	0.0%	0.0%	1.9%	5.6%	2.7%
102662	SCE Baseline	SCE Baseline	2005	-6.8%	-1.8%	0.0%	4.1%	6.7%	3.0%
102682	PG&E Baseline	PG&E Favored/Encouraged	2005	0.5%	8.9%	0.0%	-3.8%	15.7%	18.4%
102742	SCE Exceed	SCE Exceed	2005	2.5%	0.5%	0.0%	-0.2%	48.4%	50.6%
102872	SCE Exceed	SCE Favored/Encouraged	2005	1.3%	3.1%	0.0%	0.1%	4.4%	8.3%
103092	SCE Exceed	SCE Favored/Encouraged	2005	2.3%	1.4%	0.0%	3.9%	31.8%	48.0%
103332	SDG&E Exceed	SDG&E Favored/Encouraged	2008	0.0%	3.5%	0.0%	0.1%	8.9%	12.2%
103452	SCE Baseline	SCE Favored/Encouraged	2005	7.1%	-1.0%	0.0%	-0.2%	8.4%	11.9%
103572	PG&E Baseline	PG&E Baseline	2005	1.0%	2.5%	0.0%	-3.7%	26.7%	25.7%
103782	SCE Baseline	SCE Favored/Encouraged	2005	2.2%	-3.0%	0.0%	0.4%	40.3%	38.4%
103922	SDG&E Exceed	SDG&E Exceed	2008	0.4%	0.0%	0.0%	0.1%	8.5%	10.0%
104062	SDG&E Baseline	SDG&E Baseline	2008	0.7%	4.3%	0.0%	0.0%	8.8%	12.6%
104172	PG&E Baseline	PG&E Baseline	2008	-2.1%	22.8%	0.0%	2.8%	38.7%	62.0%
104342	PG&E Exceed	PG&E Exceed	2008	1.7%	4.7%	0.0%	0.0%	10.0%	21.4%
104492	PG&E Exceed	PG&E Exceed	2008	0.4%	0.3%	0.0%	0.0%	13.5%	15.2%
104552	PG&E Exceed	PG&E Exceed	2008	-14.8%	4.4%	0.0%	0.0%	23.2%	20.6%
207994	PG&E Exceed	PG&E Favored/Encouraged	2008	0.3%	3.2%	0.0%	0.1%	3.3%	12.0%
212315	SCE Exceed	SCE Favored/Encouraged	2005	4.7%	0.2%	0.0%	3.0%	31.6%	37.4%
218517	SDG&E Exceed	SDG&E Exceed	2008	0.1%	0.3%	0.0%	3.4%	59.1%	66.1%
253365	SCE Exceed	SCE Favored/Encouraged	2005	2.7%	0.6%	0.0%	0.0%	9.4%	14.0%
284771	PG&E Exceed	PG&E Exceed	2008	0.8%	1.6%	0.0%	3.4%	1.5%	0.7%
Average (n=24)				**-0.2%**	**2.7%**	**0.0%**	**1.3%**	**18.8%**	**23.3%**

D.2.1 Energy Performance and On-Site Findings from Low-Rise On-Site Visits

The following section provides a brief overview and description of each low-rise project for which the team conducted a site visit.

Site 101992/Case Study Site Seven: The site contact who met with us is the property manager that the HOA contracts to maintain the development. Plans were obtained from the site. No air conditioning is present at the site. The heating is supplied by individual heat pump units found inside the units. The DHW is supplied by a high-efficiency boiler that serves the entire facility.

Table D-5: Low-rise Site ID 101992 Characteristics

Site ID	Annual Energy Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
101992; case study Site Seven	18.5%	PG&E Baseline	PG&E Exceed	3	1	2008	20 to 39

Site 102032 (not a case study site): One of the buildings is high-rise and was not included in the model. All of the buildings are served by the same central plant boilers, which provide the hot water for both DHW and heating needs of the complex. There is no air conditioning present at this site due to the temperate climate.

Table D-6: Low-rise Site ID 102032 Characteristics

Site ID	Annual Energy Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
102032	28.6%	PG&E Exceed	PG&E Exceed	3	1	2005	5 to 19

Site 102462/Case Study Site Eight: This site consists of affordable housing units. There are standard efficiency instantaneous DHW units and high-efficiency split HVAC units serving each unit. The site appears to have a cool roof; however, roof access was not available to the engineer at the time of the site visit. As a result, there is some uncertainty regarding the actual thermal emittance of the installed room. According to one press release, this site exceeded T24 baseline compliance requirements by about 30%. Given the press release and the overall combined energy savings falling short of the 30% mark claimed by the press release, DNV GL assumed the cool roof had a high thermal emittance of .95. There were two other sites with thermal emittance ratings of .75 and .85, but this was the lone site that showed measurable savings from the "Cool Roof" parametric run. The HVAC efficiency parametric run for this site showed that it exceeded standard by 29%. DNV GL engineers did not have access to T24 compliance documents or any as-built plans for this site, so they were unable to identify any disparities between the observed modeled site and the approved site plans that achieved 30% savings. There is substantial glazing area at the site. In some cases the windows are close to fully shaded, and in others there is no shading/overhangs for the glazing area whatsoever.

Table D-7: Low-rise Site ID 102462 Characteristics

Site ID	Annual Energy Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
102462; case study Site Eight	20.8%	SCE Baseline	SCE Favored/Encouraged	15	5	2005	40 to 59

Site 102472 (not a case study site): Each unit has one ductless package terminal heat pump unit that is just over baseline efficiency. The building shell is largely built to code, with first and second story windows receiving a high level of shading. There is a significant amount of south- and west-facing glazing area, resulting in higher cooling loads and thus hurting the overall cooling performance of the site. There are two large boilers feeding the DHW demands of the building.

Table D-8: Low-rise Site ID 102472 Characteristics

Site ID	Annual Energy Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
102472	2.7%	SCE Baseline	SCE Baseline	10	3	2005	60 to 79

Site 102662 (not a case study site): The site consisted exclusively of one-bedroom apartments, each of which has one ductless PTHP.

Table D-9: Low-rise Site ID 102662 Characteristics

Site ID	Annual Energy Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
102662	3%	SCE Baseline	SCE Baseline	10	3	2005	60 to 79

Site 102682/Case Study Site Nine: There is a central DHW boiler for each building, with ductless electric resistance wall heaters in units. There is no air conditioning present at this site.

Table D-10: Low-rise Site ID 102682 Characteristics

Site ID	Annual Energy Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
102682; Case Study Site Nine	18.4%	PG&E Baseline	PG&E Favored/ Encouraged	5	1	2005	40 to 59

Site 102742/Case Study Site Ten: The builder did not install heat pumps, as was specified in the original plans. The backup electric resistance heating element specified in the plans to supplement the heat pumps now serves as the only form of heat. There is no AC present at this site. There is one high-efficiency instantaneous DHW unit serving each pair of apartments. The DHW savings accounts for the biggest impact for the mild climate site.

Table D-11: Low-rise Site ID 102742 Characteristics

Site ID	Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
102742; Case Study Site Ten	50.6%	SCE Exceed	SCE Exceed	6	2	2005	40 to 59

Site 102872 (not a case study site): The plans the DNV GL engineer obtained were limited to floor layout and elevation plans. There was no compliance documentation, projected energy usage data, or structural details listed in the plans we obtained. We were forced to make assumptions on the window type and chose a fairly efficient window type based on the observations we made. We did not have access to the attic and were forced to make assumptions about both the attic and the exterior wall insulation levels. We chose R15 for the walls and R38 for the attic. Each unit had a dedicated standard-efficiency heat pump.

Table D-12: Low-rise Site ID 102872 Characteristics

Site ID	Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
102872	8.3%	SCE Exceed	SCE Favored/ Encouraged	10	3	2005	80 to 99

Site 103092/Case Study Site Eleven: The plans we obtained were limited to a floor layout and plans on the domestic hot water system, which included thermal collectors. There was no compliance documentation, projected energy usage data, or structural details listed in the plans we obtained. We were forced to make assumptions on the window type and chose a fairly efficient window type based on the observations we made. We did not have access to the attic and were forced to make assumptions about both the attic and the exterior wall insulation levels. We chose R15 for the walls and R38 for the attic. The units all had high-efficiency furnaces but only 13 SEER ACs. The building did have a thermal collector, which offset 65% of the load based on the CEC calculator we used. That and the high-efficiency furnace accounted for the site's overall high performance.

Table D-13: Low-rise Site ID 103092 Characteristics

Site ID	Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
103092; Case Study Site Eleven	48%	SCE Exceed	SCE Favored/ Encouraged	9	3	2005	20 to 39

Site 103332/Case Study Site Twelve: There are gas storage water heaters in each unit. The storage water heaters supply DHW needs of the units as well as a hot water loop feeding an air handler. The building orientation, walkways, and overhangs were designed with passive characteristics. T24 sheets were provided, but no as-built drawings were available to the DNV GL engineer at the time of the site visit.

Table D-14: Low-rise Site ID 103332 Characteristics

Site ID	Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
103332; Case Study Site Twelve	12.2%	SDG&E Exceed	SDG&E Favored/ Encouraged	7	2	2008	40 to 59

Site 103452 (not a case study site): The as-built plans and on-site observations did not refute the observation that the wall and roofing structures had above-standard insulation values. Instantaneous gas water heaters supply both the DHW and a hot water loop for the air handler in each unit. The same air handlers are served by 14 SEER AC units.

Table D-15: Low-rise Site ID 103452 Characteristics

Site ID	Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
103452	11.9%	SCE Baseline	SCE Favored/ Encouraged	13	4	2005	60 to 79

Site 103572 (not a case study site): The units have ductless electric resistance wall heaters and no cooling systems. The DHW for all units is provided by three high-efficiency tankless water heaters. The building shell was built mainly to meet code requirements, with the wall insulation exceeding code. The biggest impact on site-level savings is a result of the DHW systems.

Table D-16: Low-rise Site ID 103572 Characteristics

Site ID	Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Number of Stories	Number of Units
103572	25.7%	PG&E Baseline	PG&E Baseline	5	1	2	5 to 19

Site 103782 (not a case study site): The units are served by split heat pump HVAC and extremely high-efficiency tankless DHW systems. The building shell was assembled mostly to meet code compliance. The DHW system has the biggest impact on the energy savings for the site.

Table D-17: Low-rise Site ID 103782 Characteristics

Site ID	Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
103782	38.4%	SCE Baseline	SCE Favored/ Encouraged	8	3	2005	80 to 99

Site 103922 (not a case study site): The building shell characteristics for this site all just meet standard T24 efficiency requirements. Ducted split standard-efficiency HVAC systems are not expected to be heavily used in this temperate climate.

Table D-18: Low-rise Site ID 103922 Characteristics

Site ID	Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
103922	10%	SDG&E Exceed	SDG&E Exceed	7	2	2008	20 to 39

Site 104062 (not a case study site): Standard-efficiency heat pumps provide cooling and heating for each unit. Two rooftop boilers with indirect storage tanks provide the DHW for each building. The DNV GL engineer only had access to architectural drawings. No mechanical or T24 documents were available at the time of the site visit.

Table D-19: Low-rise Site ID 104062 Characteristics

Site ID	Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
104062	12.6%	SDG&E Baseline	SDG&E Baseline	10	3	2008	100 to 199

Site 104172 (not a case study site): The site has a solar thermal collector array on the roof to supplement the two high-efficiency boilers. The boiler serves the DHW and the heating/hot water loads for the site. There is no AC present at this mild-climate site. The thermal collector impact was calculated using the CEC Solar Water Heating Calculation Form CF-SR. The resulting savings associated with the DHW and heating loads for the site were very pronounced.

Table D-20: Low-rise Site ID 104172 Characteristics

Site ID	Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
104172	62%	PG&E Baseline	PG&E Baseline	3	1	2008	20 to 39

Site 104342 (Case Study Site Thirteen): The site's T24 documentation reported that the majority of walls had R-5 continuous insulation in addition to R-19 walls. Each building has a large high-efficiency gas storage water heater that serves both the DHW and heating loads for the units. Baseline efficiency ACs serve each unit and have a slight negative effect on the site's performance, but the heating and DHW saving overshadow the negative cooling performance.

Table D-21: Low-rise Site ID 104342 Characteristics

Site ID	Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
104342; Case Study Site Thirteen	21.4%	PG&E Exceed	PG&E Exceed	13	4	2008	60 to 79

Site 104492 (not a case study site): A fairly high-efficiency gas storage water heater is present in each unit, which serves both the DHW and heating load for the unit. A hot water coil feeds a split system air handler unit that is also fed by a 13 SEER (baseline efficiency) AC. The insulation levels in the walls and roof are slightly higher than T24 standards.

Table D-22: Low-rise Site ID 104492 Characteristics

Site ID	Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
104492	15.2%	PG&E Exceed	PG&E Exceed	12	4	2008	20 to 39

Site 104552 (not a case study site): Each unit has an instantaneous gas water heater that serves the DHW needs and also feeds fan coil units. There is no AC for this site. The windows are all dual-pane metal with no Low-E coating. There were no plans or documentation of any kind available for this site.

Table D-23: Low-rise Site ID 104552 Characteristics

Site ID	Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
104552	20.6%	PG&E Exceed	PG&E Exceed	3	1	2008	20 to 39

Site: 207994 (not a case study site): This is a large apartment complex. The engineers who visited this site did not have any plans or compliance documentation and had to make assumptions for window types that matched their observations. Each unit was served by a 13 SEER AC. The buildings also had fairly extensive non-shaded glazing area on south and west exposures.

Table D-24: Low-rise Site ID 207994 Characteristics

Site ID	Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
207994	12%	PG&E Exceed	PG&E Favored/ Encouraged	3	1	2008	200+

Site 212315 (not a case study site): The units are served by high-efficiency instantaneous DHW units and split HVAC units. The observed SEER and AFUE for the HVAC units were higher (more efficient) than what was listed in the T24 documentation.

Table D-25: Low-rise Site ID 212315 Characteristics

Site ID	Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
212315	37.4%	SCE Exceed	SCE Favored/ Encouraged	9	3	2005	60 to 79

Site 218517/Case Study Site Fourteen: The site includes solar thermal collectors that supplement the DHW. The thermal impact of the solar thermal collectors was calculated using the CEC Solar Water Heating Calculation Form CF-SR. Each unit is served by a high-efficiency split system heat pump. This site did have a cool roof, but the DNV GL engineer was not able to confirm the thermal emittance of the roof. The compliance documentation listed the thermal emittance rate at 0.75, which was used by the DNV GL engineers for the energy modeling. The cool roof did not result in any measurable savings in the cool roof-specific parametric run.

Table D-26: Low-rise Site ID 212315 Characteristics

Site ID	Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
218517; Case Study Site Fourteen	66.1%	SDG&E Exceed	SDG&E Exceed	10	3	2008	20 to 39

Site 253365 (not a case study site): Each unit has a forty-gallon gas storage DHW unit that serves the DHW load and provides a heating/hot water feed to the split-system AC HVAC unit. All units had 14 SEER AC units. The wall and ceiling insulation was slightly above code. The compliance documentation indicated the windows had low (high-efficiency) U-factor and SHGC ratings. On-site observations did not discover any labels or manufacturer information that would refute the low SHGC and U-factor ratings, so the DNV GL engineer modeled the site's fenestration to match the fenestration found in the compliance documentation. Windows and glass doors on the porch have lots of shading from overhead and balcony side walls. There was also a fairly low level of glazing for this site that falls into a somewhat mild coastal Southern California climate. All of these factors combined lead to a site with extremely low cooling loads relative to the standard-efficiency sites.

Table D-27: Low-rise Site ID 253365 Characteristics

Site ID	Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
253365	14%	SCE Exceed	SCE Favored/ Encouraged	6	2	2005	20 to 39

Site 284771/Case Study Site Fifteen: Each unit is served by a high-efficiency heat pump. There is one high-efficiency central water heater per building, serving ten units. Some shading features originally planned for the project were removed after occupancy. Overall, the structural and mechanical characteristics for this site are fairly efficient. The measure-specific parametric runs all show positive savings. DNV GL engineers spent a considerable amount of time working with Energy Soft support in an effort to identify a possible reason why this site's observed model performed as poorly as it did, but they could not reach a reasonable conclusion.

Table D-28: Low-rise Site ID 284771 Characteristics

Site ID	Savings	Initial Stratum	NMR Revised Stratum	CA Climate Zone	CA Climate Region	Permitted T24 Version	Number of Units
284771; Case Study Site Fifteen	0.7%	PG&E Exceed	PG&E Exceed	12	4	2008	40 to 59

D.3 Detailed Methodology for High-Rise On-Site Visits and Modeling

The evaluation team selected primary data collection and whole-building energy simulation as the evaluation approach for this study. The team recruited four new construction high-rise multifamily buildings in California to conduct site visits, collect detailed data, and create energy simulation models for each building using these primary data. The team then estimated the energy performance of these buildings relative to the 2008 Title 24 energy code requirements under which they were constructed. In choosing the evaluation team's data-gathering techniques, the team sought to balance the certainty gained with project resources spent. The evaluation team prioritized and focused more heavily on the measures that could significantly impact the energy consumption of the building, and therefore could potentially result in large uncertainty of estimates, in order to optimize the project resources. Through this approach, the evaluation team verified whether the applicable energy-related measures (1) were in compliance with the 2008 Title 24 code, (2) exceeded the code requirements, or (3) did not meet the code requirements.

The scope of this energy analysis study was constrained to the residential units located in these multifamily buildings; common areas and public amenities of the building (such as offices, lobby, hallways, and fitness centers) were excluded from the analyses.

D.3.1 High-Rise Recruitment and Screening Process

The evaluation team conducted research to identify eligible sample and recruit new construction high-rise multifamily building sites relevant for this study within the sampling population.

Building permits are issued by local plan review jurisdictions for authorization to construct a new building or make alterations to an existing building. The evaluation team requested multifamily building permit data for the sampled sites to ensure that they had been built under the 2008 Title

24 energy code, which became effective on January 1, 2010. Building permit records may consist of the following information:

- Permit type and number
- Building address
- Owner's name and contact information
- Project valuation
- Work/job description or category
- Plan submittal and/or issue date

The evaluation team conducted on-site data collection for recruited eligible sites that agreed to participate in this study. The field auditors conducted additional research and provided field data, photos, and any available building plans and Title 24 documentation to the analysis team.

The evaluation team conducted preliminary screening of projects based on all data that were available prior to contacting the sites to recruit them. To be considered potentially eligible for the study, permit records were required to meet the data and phone screening criteria illustrated in Table D-29. The evaluation team cleaned the list based on criteria 1-5.

Table D-29 Criteria for Recruiting Eligible High-Rise On-Sites

Permit Type	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5
New Construction	Permitted per 2008 Title 24 code	Have more than 3 stories	Construction completed and site accessible	Non-Participant in IOU MFNC Program	Construction started during 2010-12 time period

The recruiters navigated each multifamily site's contacts to determine the appropriate point of contact, through which they could determine whether a site was eligible for the study and if the property owner or manager would consent to participate. Recruiters called through the list until it was exhausted. Ultimately, the evaluation team successfully recruited four sites to participate in the study.[63]

Two of the four sites were located in San Francisco, one was located in Orange County, and one was located in Los Angeles County. The sites located Orange and Los Angeles Counties were participating in the state Low-Income Housing Tax Credit programs administered by the California Tax Credit Allocation Committee (CTCAC), while the sites located in San Francisco were market-rate projects.

Among these three jurisdictions, San Francisco established above-code green building requirements in 2008 for new residential and commercial buildings, as well as renovations to

[63] The team recruited a number of other sites which did not participate in the study for a variety of reasons. In some cases, the site contact respondent canceled the site visit. In other instances, the sites were disqualified due to the site's participation in the IOU MFNC program or found to be ineligible during the site visit because the site was not built under 2008 Title 24 or the site was still under construction.

existing buildings, that included stricter local requirements. However, since the scope of the data collection and analysis was limited to the interior spaces of the residential units, it was not possible to assess where the building as a whole (including the common areas and amenities) was standing in terms of energy performance compared to the above-code performance requirements.

Table D-30 presents the location and characteristics of the projects included in the high-rise sample, including whether the project was an affordable or market-rate project and whether it was located in a reach code jurisdiction.

Table D-30: High-Rise On-Sites' Locations and Characteristics

Site ID (Case Study #)	Affordable or Market Rate	Reach Code	CA Climate Zone	CA Climate Region	County/ Region*
101452 (2)	Market-Rate	Yes	3	1	San Francisco
101042 (1)	Market-Rate	Yes	3	1	San Francisco
268355 (6)	Affordable	No	9	3	Orange
267860 (5)	Affordable	No	8	3	Los Angeles

D.3.2 High-Rise On-Site Data Collection

The objectives of the evaluation team's field data collection included the following: (1) to perform rigorous data collection based on the specifications of the measures covered by the Title 24 energy code, (2) to inform the analysis by incorporating all building parameters and characteristics that impact the energy consumption associated with those measures in a measurable way, (3) to help characterize the high-rise multifamily new construction market through a number of case studies, and (4) to identify opportunities for improving the energy efficiency of high-rise multifamily new construction projects.

The evaluation team deployed a range of methods and tools to achieve these objectives through a consistent, integrated, and transparent approach. The evaluation team determined the appropriate measurement and verification (M&V) methods for each measure type by performing an in-depth review of the code compliance requirements. From the code review, the evaluation team identified the building and measure parameters that affect the compliance of a particular measure with the code; this informed the development of a custom data collection form for this study. For example, ratings of U-value and Solar Heat Gain Coefficient (SHGC) for glazing of the windows are determined by code requirements (based on climatic zone). The evaluation team ensured that these parameters were verified and documented as part of the on-site data collection effort since they informed the compliance of the fenestration measure type with the Title 24 energy code and its impact on the overall energy performance of the site.

The evaluation team performed the following three steps to inform the assessment of the energy performance of each site: research of building department records, site measurement and verification, and interviews with facility personnel.

D.3.2.1 Research of Building Department Records

The evaluation team researched all available documents kept by the building department or building's management related to the plan review and permitting process for each surveyed site. The documentation included but was not limited to the following:

- Architectural, electrical, and mechanical drawings
- Construction details and specification books
- Title 24 documentation (envelope, lighting, and mechanical)
- Cool Roof Rating Certification (CRRC)

D.3.2.2 Site Measurement and Verification

The evaluation team conducted site visits to physically verify the building's parameters and characteristics for four sites. The data collected in the field informed the input values that were specified in the whole-building energy modeling on a per-site basis.

While on site, the field engineer documented accessible details regarding the building's construction. This information included:

Overall Building Characteristics

Through a combination of publicly available data, building architectural records, and aerial data, the evaluation team determined each building's age, configuration, footprint dimensions, orientation, and general systems. After collecting this basic information, the team visited each site and examined building systems as described in the following sections.

HVAC

The evaluation team collected data on the following data points related to the HVAC units using nameplates installed on units, unit manufacturer's cut sheets, and data extracted from mechanical units' schedules and Title 24 documentation filed for the site:

- HVAC equipment and distribution system type and specifications
- Size of the unit
- Fuel type
- Quantities
- Efficiency rating and characteristics

D.3.2.3 Building Envelope

While on site, the field engineer documented accessible details regarding the facility's construction. The team physically verified key construction characteristics of the building shell for each site, including floor, roof, ceiling, wall, and foundation construction type and insulation R-values, as well as window glazing and frame specifications. Table D-31 presents the types of data we collected and the verification methods used.

Table D-31: Shell Parameters/Characteristics and Method of Verification

Shell Parameters/Characteristics	Method of Verification
Construction material type (wall, roof/ceiling, floor and foundation)	• Physical observation • Architectural drawings
Insulation material type and thickness (R-value) of walls, roof/ceiling and floor/crawlspace	• **Enclosed insulated areas/assemblies:** Thermal cameras • **Visible or accessible insulated areas/assemblies:** Physical observation of the insulation material type and measurement of thickness • Construction details reflected in architectural drawings
Window glazing and frame specifications (frame material, number of panes, thickness of pane, U-value and SHGC), and surface areas	• NFRC[1] documents from construction manuals or drawings • Architectural drawings and specification books • Professional judgment based on the color/appearance of glazing and frame as well as vintage of the building

[1] National Fenestration Rating Council

D.3.2.4 Interviews with High-Rise Facility Personnel

As part of the data collection process, the evaluation team interviewed building staff familiar with the building. The evaluation team's data collection tools included a set of questions to ask building personnel to confirm any items that had significant impact on the energy consumption of the residential units. This allowed the team to further verify the accuracy of the assumptions that related to energy calculations. To maintain consistency across sites and assess compliance in accordance with the code-modeling requirements, the evaluation team did not collect and use data on occupancy rates or schedules of the units and instead used EnergyPro's default residential schedules as certified by California Energy Commission (CEC).

To inform the analysis, the evaluation team also referred to manufacturers' cut sheets of installed equipment, when manufacturers' names and/or product numbers were provided, and satellite images of each site, where relevant. Where the evaluation team found discrepancies between the as-built drawings and project documentations and the data collected on site, the physically verified data supplanted the as-designed documentation.

D.3.3 Analysis Using Whole-Building Energy Simulation for High-Rise Sites

Similar to many other energy codes, the Title 24 building energy code offers two paths for compliance: prescriptive or performance. A prescriptive code requires that each component or measure is built to a certain standard. For example, a prescriptive code may require a minimum R-value of 19 for wall insulation. A performance code requires that the building as a whole performs equal to or better than the same building built to prescriptive code by using the same amount of energy or less energy.

For the purpose of this evaluation, the team looked at both prescriptive (measure-level compliance) and whole-building (performance-based compliance) to assess the state of the market in terms of energy-efficient construction practices and equipment installations at both measure and site levels.

The evaluation team determined energy consumption using a simulation model approach based on site measurements and observations. To create these simulation models, the team used EnergyPro version 5.1.9.9, a DOE-2[64] engine modeling software developed by EnergySoft, LLC, using California Energy Commission's weather data sets for each climate zone. Energy consumption for weather-sensitive measures is typically estimated using building simulation modeling, as it is capable of producing hourly energy consumption estimates by applying location-specific historical weather information contained in the weather data sets. These data sets represent typical rather than extreme conditions and are intended to represent the range of weather phenomena specific to that location with annual averages that are consistent with the location's long-term weather conditions.

The evaluation team's analysis focused on the following:

- Quantifying the as-built building characteristics and energy-efficient measure characteristics (for example, quantities, capacities, and efficiencies)
- Comparing the as-built model energy use results with the 2005 Title 24 and 2008 Title 24 compliant baseline models of the same building configuration to determine individual building annual electricity, gas, and demand savings

The evaluation team calculated the site-level and measure-level energy savings by taking the difference between the modeled energy use of each building for two scenarios—if built to just meet the 2008 Title 24 code and if built to just meet the prior code, 2005 Title 24. Site visits and as-built project documentation, including architectural drawings and Title 24 energy code compliance documentation from building code jurisdictions, provided the building parameters and characteristics for modeling. The parameters and characteristics were used as input values for the baseline building to reflect the building as if it were built to minimum requirements of the prior code. The evaluated 2005 and 2008 energy savings are the difference in annual energy use between the as-built and 2008 Title 24 code and the as-built and 2005 Title 24 code building, respectively.

The lighting throughout the residential units was modeled identically in the baseline and the proposed cases at an LPD[65] of 0.5 Watts/sq.ft. This is in accordance with the residential lighting

[64] The DOE-2 software was developed by James J. Hirsch & Associates (JJH) in collaboration with Lawrence Berkeley National Laboratory (LBNL), with LBNL DOE-2 work performed mostly under funding from the United States Department of Energy (USDOE) and other work performed mostly under funding from a wide range of industry organizations. DOE-2 is a widely used and accepted freeware building energy analysis program that can predict the energy use and cost for all types of buildings. DOE-2 uses a description of the building layout, constructions, operating schedules, conditioning systems (lighting, HVAC, etc.) and utility rates provided by the user, along with weather data, to perform an hourly simulation of the building and to estimate utility bills.

[65] Lighting Power Density (LPD) is a lighting power requirement defined in North America by the American National Standards Institute (ANSI), American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE),

standard requirement that "lighting energy is not part of the energy budget for the whole building performance method, except as part of the standard assumption on internal heat gains that is assumed to be the same for all buildings," as described in the Title 24 2008 Residential Compliance Manual.

In cases where no cooling was provided for the residential unit spaces, the evaluation team followed Section 151(c) 1-B of the 2008 Title 24 energy code, which requires authors of compliance documentation to include the energy required for building cooling even if the building plans or construction do not indicate that air conditioning is installed. In order to meet this protocol, the evaluation team let EnergyPro calculate minimum cooling-related consumption using default cooling system specifications. Therefore, the evaluation team captured the impact of weather-sensitive measures on reducing consumption per cooling load in the energy savings estimations. This prevented the team from deducting the entire cooling-related consumption in the as-built model and claiming that toward energy savings of the building compared to a baseline model (the ultimate goal of this protocol). It also facilitated an apples-to-apples comparison across different buildings.

D.4 Site-Specific Findings for High-Rise On-Sites

D.4.1 Case Study Site One

Building Rise(s): High-Rise

Location: San Francisco area

Total Area of Interior Space of Residential Units:
More than 10,000 and less than 25,000 sq. ft.

Compliance Date: 2011

Title 24 Baseline: Title 24 (2008) is the relevant code at the time of permit application for this project. Therefore, Title 24 (2008) energy codes were applied to determine the baseline energy consumption.

and the Illuminating Engineering Society of North America (IESNA) Lighting subcommittee. Lighting Power Density technically represents the load of any lighting equipment in any defined area, or the watts per square foot of the lighting equipment. California's Title 24 building energy code regulates the intensity of installed lighting in different activity area types by placing limits on the LPD.

Compliance Margin Compared to the 2008 Title 24 Energy Code:

- 1.5% BTS (electricity)
- 41.4% BTS (gas)
- 20.9% BTS (electricity and gas combined)

Energy Efficiency Level: GreenPoint Rated; built to LEED standards, but certification not pursued

Project Summary:

This project is a multifamily building located in Climate Zone 3 that is shorter than ten stories. The building consists of between 15,000 to 20,000 sq.ft. and fewer than 20 units. The walls include R-19 insulation. The roof construction includes R-30 insulation and does not have a cool roof membrane. The floor construction is uninsulated raised floor. The interior spaces of residential units are only heated, and no space cooling is provided. Space heating is provided through a hydronic heating system. Domestic hot water is provided with gas-fired, on-demand, instantaneous tanks with 0.93 Energy Factor.

In this case, as with other cases for which no cooling was provided for the residential unit spaces, the evaluation team followed Section 151(c) 1-B of the 2008 Title 24 energy code, which requires authors of compliance documentation to include the energy required for building cooling even if the building plans or construction do not indicate that air conditioning is installed.

The lighting throughout the residential units has been modeled identically in the baseline and the proposed cases at a Lighting Power Density[66] (LPD) of 0.5 Watts/sq.ft. This is in accordance with the residential lighting standard requirement that "lighting energy is not part of the energy budget for the whole building performance method, except as part of the standard assumption on internal heat gains that is assumed to be the same for all buildings," as described in the Title 24 2008 Residential Compliance Manual.

[66] Lighting Power Density technically represents the load of any lighting equipment in any defined area, or the watts per square foot of the lighting equipment.

Table D-32 presents a description of measures with the most significant impacts on energy consumption of the units.

Table D-32: Case Study Site One: Significant Measures from On-Site Analysis

Measure Type	Measure Description	Level of 2008 Code Compliance
Fenestration	• **U-factor:** 0.288 • **Solar Heat Gain Coefficient (SHGC):** 0.26	Above code
Envelope Insulation	• **Roof:** R-30 exterior • **Wall:** R-19 • **Floor type and insulation level:** Uninsulated raised floor	All right at code
HVAC Efficiency	• **Heating:** Gas-fired boiler with 0.923 Energy Factor • **Cooling:** No space cooling provided	Right at code
Domestic Hot Water	Gas tankless water heater with 0.93 EF	Above code

Results

The evaluation team estimated that annual energy consumption for this project was 71,595 kWh. The average annual per-unit consumption was estimated at 4,773 kWh per average unit size of 1,177 sq.ft. The overall Energy Use Intensity (EUI) for the residential portion of the building was estimated at 4.10. The summary of savings results is presented in the Table D-33.

Table D-33: Case Study Site One: Summary of Savings Results

Baseline	Measure Type	Annual Electric Savings (kWh)	Percentage of Annual kWh Savings	Demand Savings (kW)	Annual Gas Savings (Therms)
2005	Envelope Insulation	500	0.7 %	0.91	81.62
	Domestic Water Heater	-	-	-	1.24
Total 2005 Title 24 Savings		500	0.7%	0.91	82.86
2008	Envelope Insulation	1,069	1.5%	0.02	-130.34
	Domestic Water Heater	-	-	-	1.24
Total 2008 Title 24 Savings		1,069	1.5%	0.02	-129.10

D.4.2 Case Study Site Two

Building Rise(s): High-Rise

Location: San Francisco area

Total Area of Interior Space of Residential Units:
200,000+ square feet

Permit Issued Date: 2013

Title 24 Baseline: Title 24 (2008) was the relevant code at the time of permit application for this project. Therefore, Title 24 (2008) energy codes were applied to determine the baseline energy consumption.

Compliance Margin Compared to the 2008 Title 24 Energy Code:

- 0.4% BTS (electricity)
- 55.9% BTS (gas)
- 29.2% BTS (electricity and gas combined)

Energy Efficiency Level: LEED

Project Summary:

This project is a 10+-story multifamily building located in Climate Zone 3. The building consists of more than 200 residential units and has over 200,000 square feet of residential space. The walls are made of spandrel panels with 0.3 aged solar reflectance index (SRI) and 0.75 thermal emittance (equal to R-17.4). The roof construction includes R-38 exterior insulation and R-18 interior insulation (3" rigid) and has a Cool Roof Rating Council (CRRC)-1 certified cool roof membrane. The floor construction is a raised floor with R-10 insulation. The interior spaces of residential units are only heated, and no space cooling is provided. Space heating is provided through electric baseboards. Domestic hot water is provided with gas-fired, on-demand, instantaneous tanks with 0.95 Energy Factor (EF).

In this case, as with other cases for which no cooling was provided for the residential unit spaces, the evaluation team followed Section 151(c) 1-B of the 2008 Title 24 energy code, which requires authors of compliance documentation to include the energy required for building cooling even if the building plans or construction do not indicate that air conditioning is installed.

The lighting throughout the residential units has been modeled identically in the baseline and the proposed cases at a Lighting Power Density[67] (LPD) of 0.5 Watts/sq.ft. This is in accordance with the residential lighting standard requirement that "lighting energy is not part of the energy budget

[67] Lighting Power Density technically represents the load of any lighting equipment in any defined area, or the watts per square foot of the lighting equipment.

for the whole building performance method, except as part of the standard assumption on internal heat gains that is assumed to be the same for all buildings," as described in the Title 24 2008 Residential Compliance Manual.

Envelope insulation savings are achieved with higher-than-code insulation R-value in the walls and roof. Due to the HVAC system type (baseboard heating only), direct digital controls (DDC) were not installed.[68]

Table D-34 presents a description of measures with the most significant impacts on the energy consumption of the units.

Table D-34: Case Study Site Two: Summary of Significant Measures

Measure Type	Measure Description	Level of 2008 Code Compliance
Fenestration	• **U-factor:** 0.288 • **Solar Heat Gain Coefficient (SHGC):** 0.26	Above code
Envelope Insulation	• **Roof:** R-38 exterior and R-18 interior • **Wall:** Spandrel panels with 0.3 aged solar reflectance and 0.75 thermal emittance (equal to R-17.4) • **Floor type and insulation level:** Raised with R-10	All above code
HVAC Efficiency	• **Heating:** 3.55 HSPF* electric baseboard heater • **Cooling:** No space cooling provided	Right at code
Domestic Hot Water	Gas tankless water heater with 0.95 EF (solar DHW for common spaces)	Above code

* Heating Season Performance Factor

[68] DDC is a type of HVAC control system automated by a digital device or computer.

Results

The evaluation team estimated that annual energy consumption for this project was 950,241 kWh. The average annual per-unit consumption was estimated at 3,481 kWh per average unit. The overall Energy Use Intensity (EUI) for the residential portion of the building was estimated at 4.16. The summary of savings results is presented in Table D-35.

Table D-35: Summary of Savings Results

Baseline	Measure Type	Annual Electric Savings (kWh)	Percentage of Annual kWh Savings	Demand Savings (kW)	Annual Gas Savings (Therms)
2005	Envelope Insulation	23,330	2.5%	10.78	-
	Cool Roof Expansion	1,091	0.1%	0.68	-
	Domestic Water Heater	-	-	-	20.62
Total 2005 Title 24 Savings		24,422	2.6%	11.45	20.62
2008	Envelope Insulation	3,015	0.3%	3.71	-
	Cool Roof Expansion	1,162	0.1%	0.67	-
	Domestic Water Heater	-	-	-	20.62
Total 2008 Title 24 Savings		4,177	0.4%	4.38	20.62

D.4.3 Case Study Site Five

Building Rise(s): High-Rise

Location: Los Angeles County

Total Area of Interior Space of Residential Units:
40,000 to less than 65,000 sq.ft.

Construction Completion Date:
2012

Title 24 Baseline: Title 24 (2008) was the relevant code at the time of permit application for this project. Therefore, Title 24 (2008) energy codes were applied to determine the baseline energy consumption.

Compliance Margin Compared to the 2008 Title 24 Energy Code:

- 7.2% BTS (electricity)
- 19.8% BTS (gas)
- 20.5% BTS (electricity and gas combined)

Energy Efficiency Level: Higher-tier LEED

Project Summary:

The project is a high-rise residential building located in Climate Zone 9. The building has fewer than 10 stories and has between 60 and 79 dwelling units. The typical units are approximately 600 sq.ft., with one bedroom/one bathroom, and the manager's unit is approximately 1,200 sq.ft., with two bedrooms/two bathrooms. The building also includes common spaces and commercial space on the first floor. (Only the residential dwelling units are considered in this energy analysis.)

The envelope is wood-framed construction. The roof assembly includes R-38 rafter insulation attic. The wall assembly is 2x6-framed R-21 insulated walls. The windows are insulating glass of U-0.29 and SHGC-0.38 with vinyl frames. The roof is flat and has a CRRC-Rated Cool Roof surface.

The lighting throughout the residential units has been modeled identically in the baseline and the proposed cases at an LPD of 0.5 Watts/sq.ft. This is in accordance with the residential lighting standard requirement that "lighting energy is not part of the energy budget for the whole building performance method, except as part of the standard assumption on internal heat gains that is assumed to be the same for all buildings," as described in the Title 24 2008 Residential Compliance Manual.

The space conditioning is provided by one hydronic heat DX cool air handler for each residential unit. The typical air conditioner (AC) unit is 1.5 tons, and the manager's apartment AC unit is 3 tons. Domestic hot water is provided by a gas-fired storage tank water heater in each unit, which serves both the space heating and domestic hot water loads. One split DX AC unit provides cooling for each apartment.

The main source of energy savings for this project is in the HVAC category, as the DX cooling efficiency exceeds the code minimum. Energy savings are also derived from the envelope, as the roof insulation exceeds the code requirements and the Cool Roof also increases the effectiveness of the building envelope insulation.

Table D-36 presents a description of measures with the most significant impacts on the energy consumption of the units.

Table D-36: Case Study Site Five: Summary Significant Measures

Measure Type	Measure Description	Level of 2008 Code Compliance
Fenestration	• **U-factor:** 0.29 • **Solar Heat Gain Coefficient (SHGC):** 0.38	Above code
Envelope Insulation	• **Roof:** R-38 exterior • **Wall:** Wood-framed R-21 • **Floor type and insulation level:** Uninsulated slab on grade	Roof and wall insulations are above code, floor insulation is right at code
HVAC Efficiency	14.5 SEER/12 EER	Above code
Domestic Water Heater	Gas-fired storage water heater with Energy Factor of 0.67	Slightly above code

Results

The evaluation team estimated that annual energy consumption for this project was 195,731 kWh. The average annual per-unit consumption was estimated at 2,837 kWh per average unit. The overall Energy Use Intensity (EUI) for the residential portion of the building was estimated at 4.85. The summary of savings results is presented in Table D-35.

Table D-37: Summary of Savings Results

Baseline	Measure Type	Annual Electric Savings (kWh)	Percentage of Annual kWh Savings	Demand Savings (kW)	Annual Gas Savings (Therms)
2005	Envelope Insulation	1,180	0.6%	6.08	-
	Cool Roof Expansion	3,328	1.7%	0. 80	-
	HVAC Efficiency	7,567	3.9%	4.03	
	Domestic Water Heater	-	-	-	2.17
Total 2005 Title 24 Savings		12,075	6.2%	10.90	2.17
2008	Envelope Insulation	4,291	2.2%	1.21	-
	Cool Roof Expansion	3,325	1.7%	0.80	-
	HVAC Efficiency	7,545	3.9%	4.02	
	Domestic Water Heater	-	-	-	2.17
Total 2008 Title 24 Savings		15,161	7.7%	6.03	2.17

D.4.4 Case Study Site Six

Building Rise(s): High-Rise

Location: Orange County

Total Area of Interior Space of Residential Units:
65,000 to less than 100,000 sq.ft.

Construction Completion Date:
2013

Title 24 Baseline: Title 24 (2008) was the relevant code at the time of permit application for this project. Therefore, Title 24 (2008) energy codes were applied to determine the baseline energy consumption.

Compliance Margin Compared to the 2008 Title 24 Energy Code:

- 8.9% BTS (electricity)
- 39.2% BTS (gas)
- 25.9% BTS (electricity and gas combined)

Energy Efficiency Level: LEED

Project Summary:

The project is a high-rise residential multifamily building located in Climate Zone 8. The building has fewer than ten stories and between 60 and 79 affordable housing units. The project has three bedroom types, ranging from about 650 square feet to 1,200 square feet. The building also includes common areas and commercial space, but only the residential dwelling units are within the scope of this energy analysis.

The envelope is wood-framed construction. The roof assembly is an R-30 insulated vented attic. The wall assembly is mainly 2x6-framed R-19 insulated walls, with some 2x4-framed R-13 walls. The glazing is vinyl-framed windows with COG properties of U-0.29 and SHGC-0.27. The roof is flat and has a CRRC-Rated Cool Roof surface.

The lighting throughout the residential units has been modeled identically in the baseline and the proposed cases at an LPD of 0.5 Watts/sq.ft. This is in accordance with the residential lighting standard requirement that "lighting energy is not part of the energy budget for the whole building performance method, except as part of the standard assumption on internal heat gains that is assumed to be the same for all buildings," as described in the Title 24 2008 Residential Compliance Manual.

The conditioning to the space is provided by split[69] direct expansion[70] (DX) heat pumps, one for each residential unit. The heat pump cooling capacities range from 1.5 to 2.5 tons. There is also one tankless gas domestic water heater with Energy Factor of 0.82 serving each residential unit.

The building envelope and HVAC efficiency meet the minimum 2008 Title 24 code requirements. The main source of energy savings for this project is the Cool Roof measure, which also increases the effectiveness of the building envelope insulation. This is due to envelope insulation working more effectively as the heating or cooling load of the building decreases and the fact that the cool roof reduces the cooling load through reflecting sun radiation away from the building.

Table D-38 presents a description of measures with the most significant impacts on the energy consumption of the units.

Table D-38: Description of Significant Measures

Measure Type	Measure Description	Level of 2008 Code Compliance
Fenestration	• **U-factor:** 0.29 • **Solar Heat Gain Coefficient (SHGC):** 0.27	Above code
Envelope Insulation	• **Roof:** R-30 with cool roof membrane (ASR – 0.63, TE – 0.90) • **Wall:** R-19 Wood-framed • **Floor type and insulation level:** Uninsulated slab on grade	Cool Roof is above code,* the rest are right at code
HVAC Efficiency	**Heat Pump:** 13 SEER/11 EER/7.7 HSPF	Right at code
Domestic Water Heater	Gas-fired Tankless with 0.82 Energy Factor	Above code

* Minimally code compliant cool roof membrane is not CRRC-Rated, ASR-0.55, TE 0.75

Results

The evaluation team estimated that annual energy consumption for this project was 357,852 kWh. The average annual per-unit consumption was estimated at 5,112 kWh per unit. The overall Energy Use Intensity (EUI) for the residential portion of the building was estimated at 5.30. The summary of savings results is presented in Table D-39**Error! Reference source not found.**.

[69] Split systems have an indoor section and a matching outdoor section that are connected by refrigerant tubing (hence the name "split"). The indoor section consists of a fan, indoor cooling coil, heating section, and filter, while the outdoor section houses the compressor and condenser.

[70] DX systems (both packaged and split) directly cool the air supplied to the building because the evaporator is in direct contact with the supply air.

Table D-39: Case Study Site Six: Summary of Savings Results

Baseline	Measure Type	Annual Electric Savings (kWh)	Percentage of Annual kWh Savings	Demand Savings (kW)	Annual Gas Savings (Therms)
2005	Envelope Insulation	16,109	4.5%	12.60	-
	Cool Roof Expansion	14,800	4.2%	4.59	-
	HVAC Efficiency	770	0.2%	3.06	
	Domestic Water Heater	-	-	-	4.95
Total 2005 Title 24 Savings		31,679	8.9%	20.25	4.95
2008	Envelope Insulation	19,358	5.4%	0.55	-
	Cool Roof Expansion	14,766	4.2%	4.58	-
	HVAC Efficiency	770	0.2%	3.06	
	Domestic Water Heater	-	-	-	4.95
Total 2008 Title 24 Savings		34,894	9.8%	8.19	4.95

Appendix E Detailed Methodology and Findings from Developer Survey

This appendix presents the detailed methodology and findings from a survey of developers of multifamily projects in California.

E.1 Detailed Methodology from Developer Survey

The research team conducted 33 surveys from November 2014 through January 2015 with developers of multifamily projects not included in the case studies. Some of the survey questions pertained to all projects started by each respondent from 2010-2012, while others pertained to the largest project started by each respondent during that period. The research team offered respondents an incentive of $100 for completing the survey. Developers who said it was not a good time and/or they were too busy to complete the survey over the telephone were emailed a link to complete the survey online; otherwise, the survey was completed over the telephone.

Survey topics included the following:

- Awareness and understanding of the IOU MFNC program
- Awareness, understanding, and adoption of energy-efficient building practices and technologies
- Awareness of ZNE building practices
- Key decision makers and decision criteria for energy efficiency decisions
- Market demand for energy efficiency and differences in demand among market segments
- Training received on energy-efficient construction and design practices
- Reasons for not participating in the IOU MFNC program (non-participants only)
- Relative importance of the numerous green programs and certifications in California

The research team developed the survey sample frame from the data set they had compiled for the Phase I Report to account for the population of multifamily new construction projects started in California from 2010 through 2012. This data set was compiled from the following four data sources:

- McGraw Hill Construction (MHC) Dodge data
- California Tax Credit Allocation Committee (CTCAC) reports
- IOU MFNC program data
- CATI Survey data

The population data included 763 multifamily new construction projects started from 2010 through 2012. The data set included the developer name and contact information, the project location, the number of units in the project, whether the project was high-rise or low-rise, and whether the project had any low-income units. The research team identified 385 developers associated with the 763 projects. These 385 developers represent the sample frame for the survey. For each developer,

the largest multifamily project started from 2010 through 2012 was designated as the one on which project-specific survey questions would focus and is referred to as "the sampled project" throughout this section.

Several quotas were put into place for the survey, including a maximum of 20 low-rise projects, 20 high-rise projects, and 5 projects that participated in the IOU MFNC program. Table E-1 displays the targets and final survey completes.

Table E-1: Sample Targets and Completed Surveys

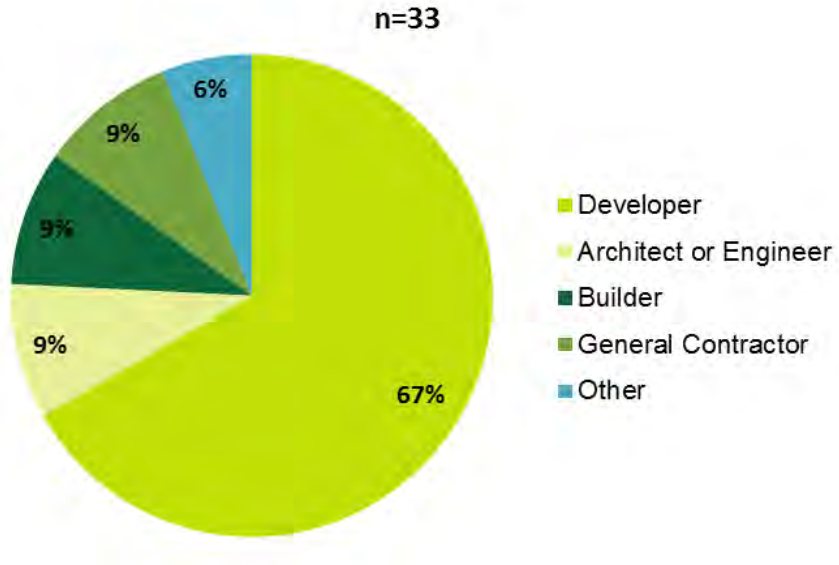
	Target	Completed Surveys
High-Rise	Up to 20	9
Low-Rise	Up to 20	20
Participated in IOU MFNC program	Up to 5	3
Total	**35**	**33**

The survey results are presented in the remainder of this appendix.

E.2 Developer and Project Characteristics

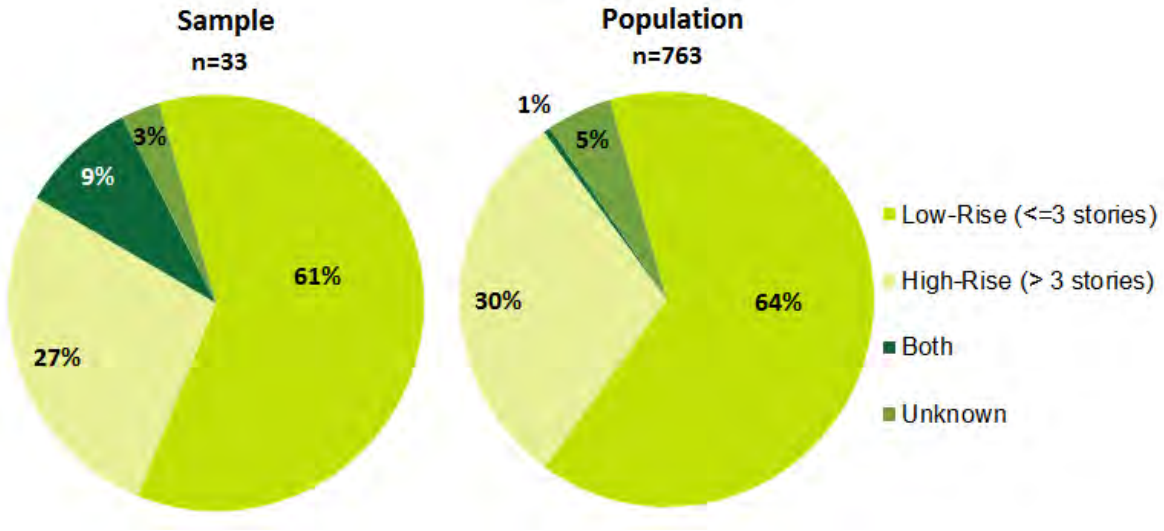
The majority (67%) of the respondents who completed the survey were the developer for the sampled project. Nine percent each were the architect or engineer, builder, or general contractor.

Figure E-1: Respondent Position



The research team asked respondents to describe the sampled project as either high-rise (more than three stories), low-rise (three stories or fewer), or as having both low-rise and high-rise buildings in the project. Figure E-2 displays the distribution of high- and low-rise projects among both the sample of respondents' projects and the population of 763 multifamily projects started from 2010 through 2012. The majority (61%) of respondents described the project as low-rise, 27% described it as high-rise, and 9% said it had both high- and low-rise buildings.

Figure E-2: Distribution of High- and Low-Rise Buildings



The research team asked respondents if the sampled project participated in the IOU MFNC program as well as the IOUs' New Solar Homes Partnership (NSHP) solar incentive program (Table E-2).[71] Over three-quarters (76%) of the respondents said that the sampled project participated in neither the IOUs' NSHP program nor the IOU MFNC program. Fifteen percent said the project participated in the solar incentive program only, 6% said the project participated in the IOU MFNC program only, and 3% said the project participated in both programs.

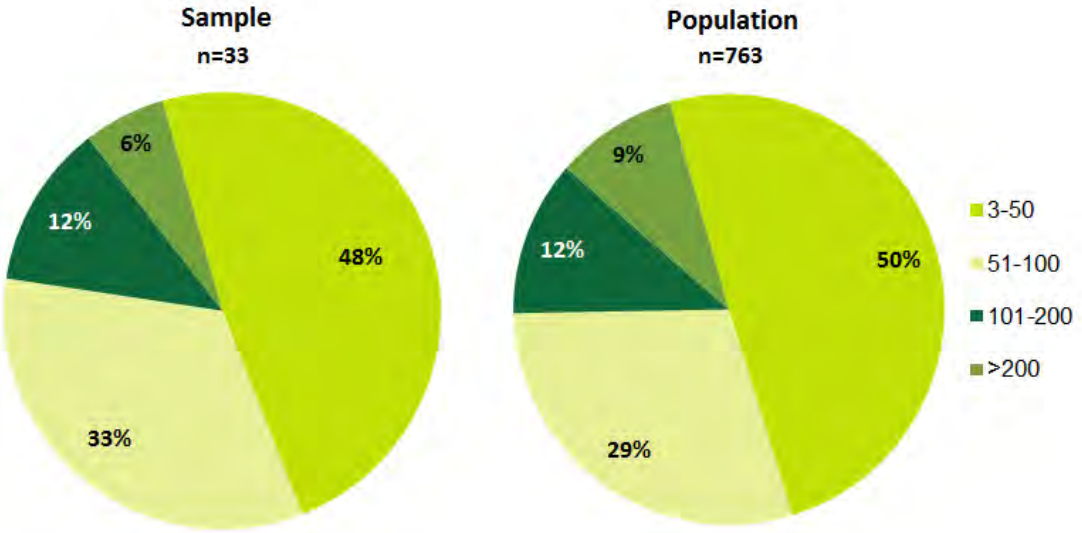
Table E-2: IOU Program Participation Among Sampled Projects

Sampled Project Participated in…	Percent of Respondents (n=33)
Neither program	76%
IOU NSHP program only	15%
IOU MFNC program only	6%
Both IOU NSHP and MFNC programs	3%

[71] During the case study research, the team learned that a number of projects that did not participate in the IOU MFNC program did participate in the NSHP program. The NSHP program has the same minimum efficiency requirement of 15% better than Title 24 standards as the IOU MFNC program during the 2010 through 2012 period.

Figure E-3 displays the distribution of multifamily projects in terms of the number of units per project, both for the sampled projects and the population of MFNC projects started in California from 2010 through 2012. Almost one-half (48%) of the sampled projects have 50 or fewer units. One-third (33%) of the sampled projects have 51 to 100 units, 12% have 101 to 200 units, and 6% have more than 200 units.

Figure E-3: Number of Units per Project



The research team asked respondents to estimate the total number of MFNC projects their companies started in California from 2010 through 2012. As shown in Table E-3, most respondents (73%) started between one and five projects during this period.

Table E-3: Multifamily Projects Started by Respondents (2010-2012)

Number of Projects	Percent of Respondents (n=33)
1-5	73%
6-10	24%
>10	3%
Total Projects Started by Respondents	**132**
Average Number of Projects Started per Respondent	**4**

Next, the research team asked respondents to estimate the total multifamily *units* companies started in California from 2010 through 2012. As shown in Table E-4, about two-fifths (39%) of respondents started 9-100 units, about one-quarter (24%) started 101-250 units, and almost one-fifth (18%) started 251-500 units during this period. The sum of the total multifamily units started

from 2010 through 2012 across all respondents is 9,383. The average units started per respondent is 284.

Table E-4: Multifamily Units Started by Respondents (2010-2012)

Number of Units	Percent of Respondents (n=33)
9-100	39%
101-250	24%
251-500	18%
501-1,000	15%
1,001-2,000	3%
Total Units Started by Respondents	**9,383**
Average Units Started per Respondent	**284**

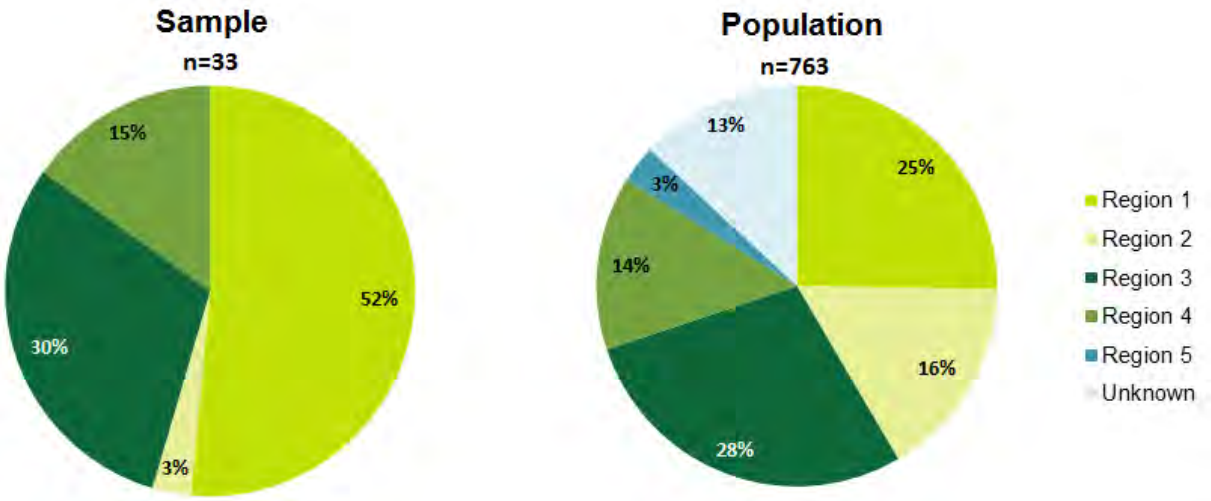
Over one-half (61%) of the sampled projects are in the PG&E service territory (Table E-5). Over two-fifths (42%) of sampled projects are in the SCG service territory, 12% are in the SCE service territory, and 3% are in the SDGE service territory.

Table E-5: Distribution of Multifamily Projects Among IOU Service Territories

IOU	Sampled Projects (n=33)	Population of Projects (n=763)
PG&E	61%	41%
SCG	42%	52%
SCE	12%	28%
SDGE	3%	9%

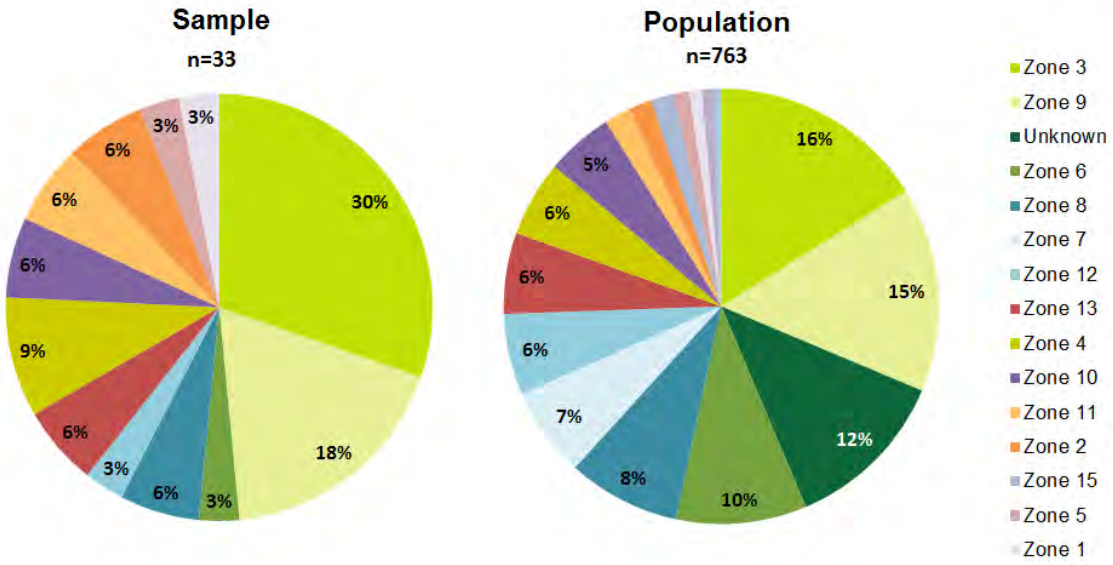
Over one-half (52%) of the sampled projects are in Climate Region 1. Just under one-third (30%) of sampled projects are in Climate Region 3, 15% are in Climate Region 4, and 3% are in Climate Region 2 (Figure E-4).

Figure E-4: Distribution of Multifamily Projects Among Climate Regions



Over one-half of sampled projects are located in Climate Zones 3 (30%), 9 (18%), or 4 (9%) (Figure E-5).

Figure E-5: Distribution of Multifamily Projects Among Climate Zones



Over one-half of sampled projects are located within the Los Angeles-Long Beach-Anaheim (27%) or San Francisco-Oakland-Hayward (27%) metropolitan statistical areas (Table E-6).

Table E-6: Distribution of Multifamily Projects Among Metropolitan Statistical Areas

	Sampled Projects (n=33)	Population Projects (n=763)
Metropolitan Statistical Area		
Los Angeles-Long Beach-Anaheim	27%	30%
San Francisco-Oakland-Hayward	27%	14%
San Jose-Sunnyvale-Santa Clara	9%	6%
San Diego-Carlsbad	3%	8%
Riverside-San Bernardino-Ontario	3%	6%
Santa Maria-Santa Barbara	3%	2%
Fresno	3%	2%
Salinas	3%	2%
Visalia-Porterville	3%	1%
San Luis Obispo-Paso Robles-Arroyo Grande	3%	1%
Redding	3%	--
Napa	3%	--
Yuba City	3%	--
Vallejo-Fairfield	3%	--
Sacramento-Roseville-Arden-Arcade	--	4%
Bakersfield	--	2%
Oxnard-Thousand Oaks-Ventura	--	2%
Chico	--	1%
Santa Rosa	--	1%
Modesto	--	1%
El Centro	--	1%
Madera	--	1%
Santa Cruz-Watsonville	--	1%
Unknown	--	12%
Micropolitan Statistical Area		
Eureka-Arcata-Fortuna	3%	1%

Almost one-half (48%) of respondents said that 100% of the total multifamily units their companies started in California from 2010 through 2012 were affordable or low-income units (Table E-7). Almost one-quarter (24%) of respondents said that they did not start any affordable units during this period. Fifteen percent of respondents said that 1% to 25% of the total units they

started from 2010 through 2012 were affordable units, while 12% said that 51% to 99% were affordable units.

Table E-7: Percent of Respondents' Total Units Started 2010-2012 that are Affordable

Percent of Total Units	Percent of Respondents (n=33)
100%	48%
76-99%	9%
51-75%	3%
26-50%	0%
1-25%	15%
0%	24%

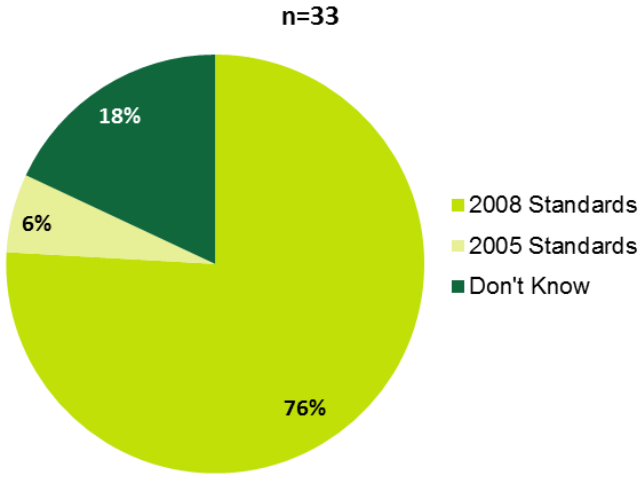
Over one-half (52%) of respondents were unaware of the IOU MFNC program, while another 9% of respondents said that none of the multifamily projects their companies started in California from 2010 through 2012 participated in the program (Table E-8). About one-quarter (24%) of respondents said that some of their projects participated in the program during this period, and six percent said that all of their projects participated in the program from 2010 through 2012.

Table E-8: Percent of Respondents' Projects Started 2010-2012 that Participated in IOU Program

Percent of Projects	Percent of Respondents (n=33)
100%	6%
76-99%	6%
51-75%	6%
26-50%	9%
1-25%	3%
0%	9%
Not aware of program	52%
Don't know how many participated	9%

Over three-quarters (76%) of respondents said that the project in question was built under the 2008 Title 24 energy efficiency standards (Figure E-6). Almost one-fifth (18%) of respondents did not know which Title 24 energy efficiency standards the project was built under, and the rest (6%) said it was built under the 2005 Title 24 energy efficiency standards.

Figure E-6: Title 24 Standard for Sampled Projects



The research team asked the respondents who did not know which version (2005 or 2008) of the Title 24 energy efficiency standards under which the sampled project was built to provide the title of the person who would know this information. All five (18%) identified the architect as the individual who would know which version of the Title 24 energy efficiency standards the project was built under.

Ten of the 33 projects were located in localities that had adopted efficiency standards that exceed Title 24 (reach codes). Five of the ten respondents with projects in these localities confirmed that the more efficient, local standards were in effect when the project started and the project was required to meet the standards (Table E-9). Two of these five respondents said that the local energy ordinance exceeded the statewide Title 24 energy efficiency requirements by 15%.

Table E-9: Reach Code in Effect for Sampled Projects

Project Required to Meet More Efficient Local Standards?	Count (n=10)
Yes	5
No	2
Not familiar with these standards	2
Don't know	1
Percentage by Which Local Energy Ordinance Exceeds Title 24	**Count (n=5)**
15%	2
Don't know	3

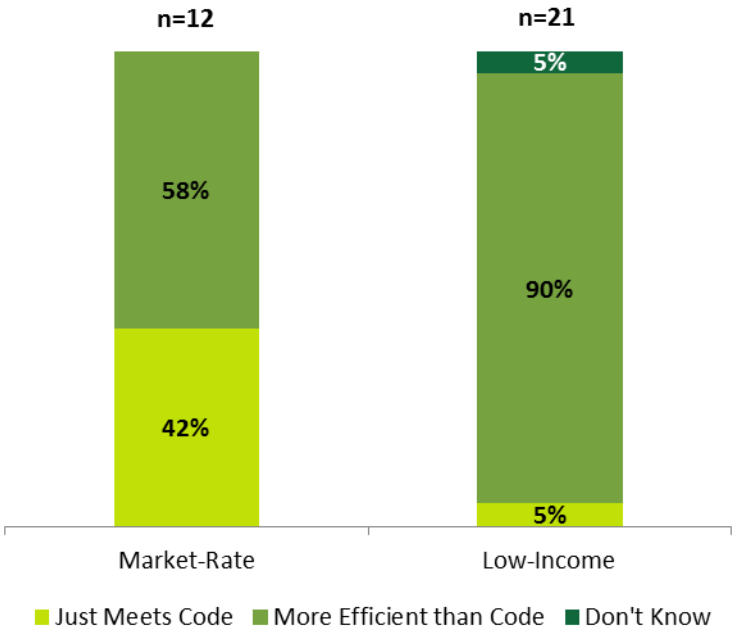
The research team asked respondents how the energy efficiency of the sampled project compared to the applicable energy standards. As shown in Table E-10, over four-fifths (86%) of the respondents whose sampled projects were required to adhere to standard Title 24 energy efficiency standards said that their project was more efficient than required by Title 24. On average, this group of respondents estimated that their sampled project was 24% more efficient than the Title 24 requirements. Two of the five respondents who confirmed that their project was built in a reach code locality said that their project was more efficient than the applicable energy efficiency requirements (reach code, in their case). Overall, 79% of respondents said that was more efficient than the applicable energy efficiency requirements.

Table E-10: Energy Efficiency of Sampled Projects

	Title 24 Standards (n=28)		Reach Code (n=5)	All Sampled Projects (n=33)	
Energy Efficiency in Relation to Applicable Code	**Percent of Respondents**	**Count**	**Count**	**Percent of Respondents**	**Count**
More efficient than code	86%	24	2	79%	26
Just meets code	11%	3	3	18%	6
Don't know	4%	1	-	3%	1
Projects That Were More Efficient Than Applicable Code					
	Title 24 Standards (n=24)		**Reach Code (n=2)**	**All Sampled Projects (n=26)**	
Percentage More Efficient Than Applicable Code	**Percent of Respondents**	**Count**	**Count**	**Percent of Respondents**	**Count**
1-10%	17%	4	1	19%	5
11-20%	42%	10	1	42%	11
21-30%	13%	3	-	12%	3
31-40%	8%	2	-	8%	2
41-50%	4%	1	-	4%	1
>50%	4%	1	-	4%	1
Don't know	13%	3	-	12%	3
Average	**24%**		**18%**	**23%**	

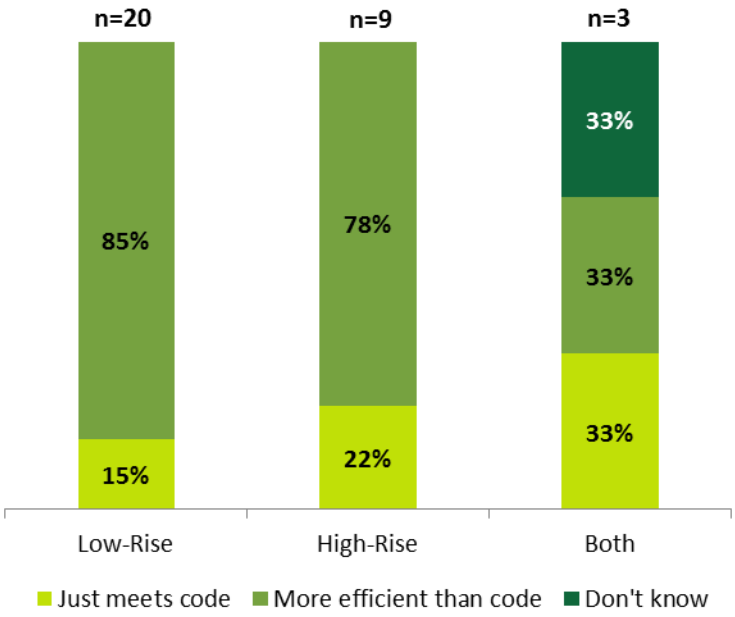
Twenty-one (64%) of the sampled projects were designated as affordable or low-income, while the remaining twelve (36%) sampled projects were market-rate. As shown in Figure E-7, 90% of sampled low-income projects were estimated to be more efficient than code, compared to 58% of sampled market-rate projects. Sampled projects that just met the applicable code were more likely to be market-rate than low-income, and this difference is statistically significant at the 90% confidence level.

Figure E-7: Energy Efficiency of Sampled Projects by Affordability



Twenty (61%) of the sampled projects were low-rise, nine (27%) were high-rise, and three (9%) were a combination of low- and high-rise buildings.[72] Figure E-8 shows that 85% of sampled high-rise projects and 78% of sampled low-rise projects were estimated to be more efficient than code. There are no statistically significant differences between high-rise and low-rise sampled projects in terms of energy efficiency relative to code.

Figure E-8: Energy Efficiency of Sampled Projects by Building Rise

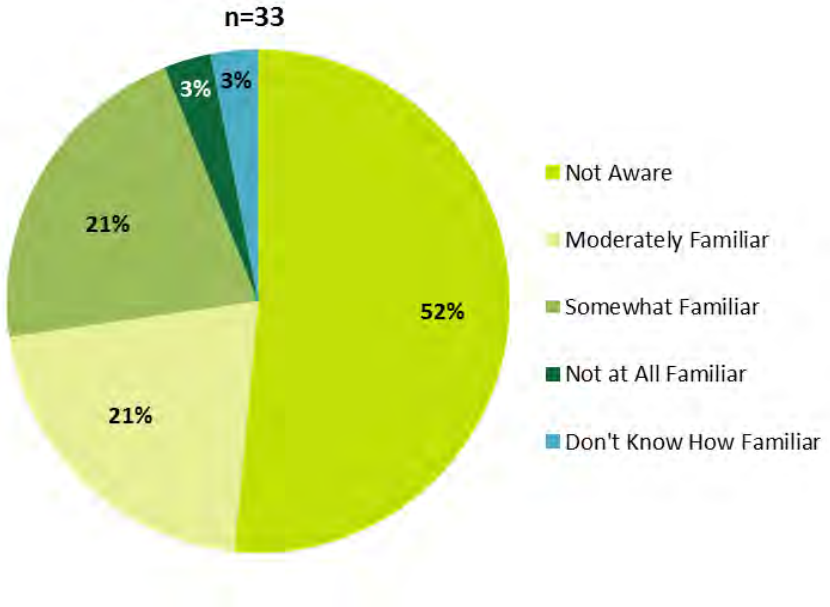


[72] One respondent did not know whether the sampled project was high-rise, low-rise, or both.

E.3 Awareness, Participation, and Understanding of IOU MFNC Program

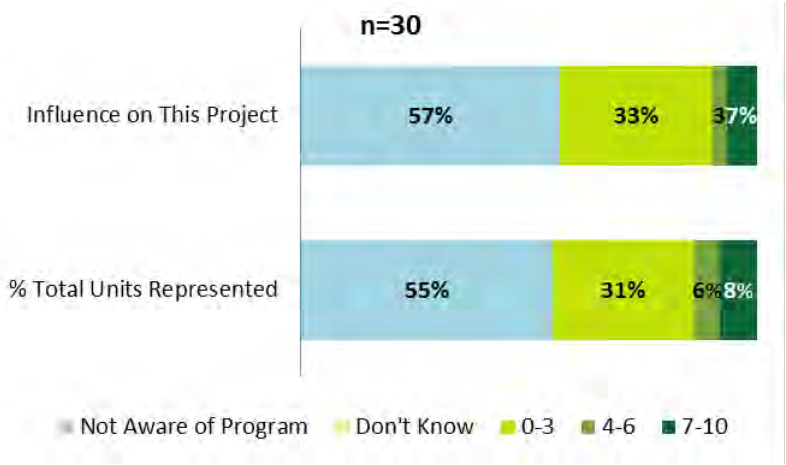
Just over one-half (52%) of respondents were not aware of the IOU MFNC program (Figure E-9). Most of the respondents who were aware of the program said that they were at least somewhat familiar with it.

Figure E-9: Awareness and Familiarity with IOU MFNC Program



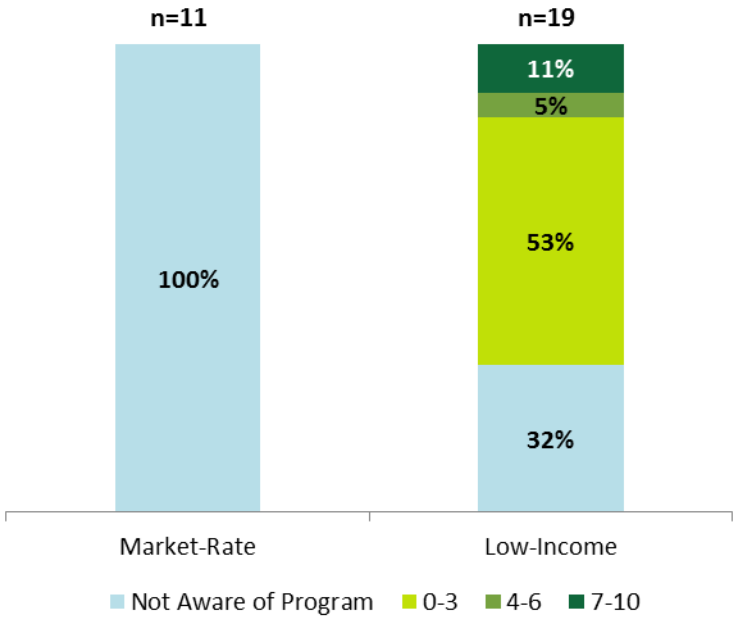
The research team asked respondents who were aware of the program to rate the program's influence on the efficiency level of the sampled project using a scale of zero to ten, where zero is "no influence" and ten is "a great deal of influence." Excluding the three respondents for whom the sampled project participated in the program, Figure E-10 displays the influence of the program along with the percentage of total multifamily units started from 2010 through 2012 by the respondents in each response category. For example, the 57% of respondents who were not aware of the program started 55% of the multifamily units started by the 30 respondents during this period. Seven percent of the respondents indicated that the IOU MFNC program was very influential with respect to the efficiency level of the non-program sampled project by assigning a rating of seven to ten. Three percent indicated that the program was somewhat influential (four to six), and one-third (33%) indicated that the program had little to no influence (zero to three) on the efficiency level of the non-program project. Of the three program participants, two rated the program as being very influential (seven to ten rating) and one indicated the program was somewhat influential (four to six).

Figure E-10: Program Influence on Respondents' Sampled Project



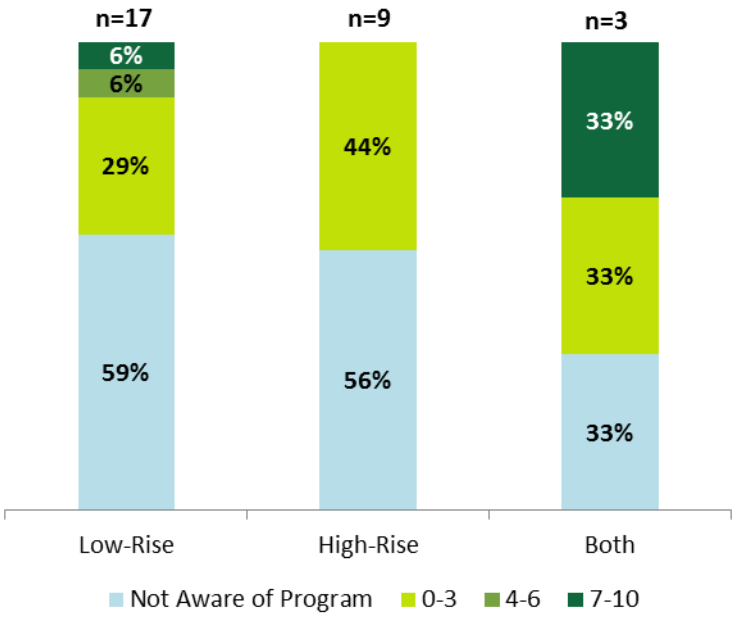
Excluding the three respondents for whom the sampled project participated in the program, Figure E-11 displays the program's influence on the efficiency level of the sampled project by whether the project was market-rate or low-income. All (100%) of the respondents for whom the sampled project was market-rate were unaware of the program, compared to 32% of the respondents for whom the sampled project was low-income. The difference between 100% and 32% is statistically significant at the 90% confidence level. Among the sampled projects, the program's influence on the efficiency level of multifamily new construction was limited to low-income projects.

Figure E-11: Program Influence by Affordability on Respondents' Sampled Project



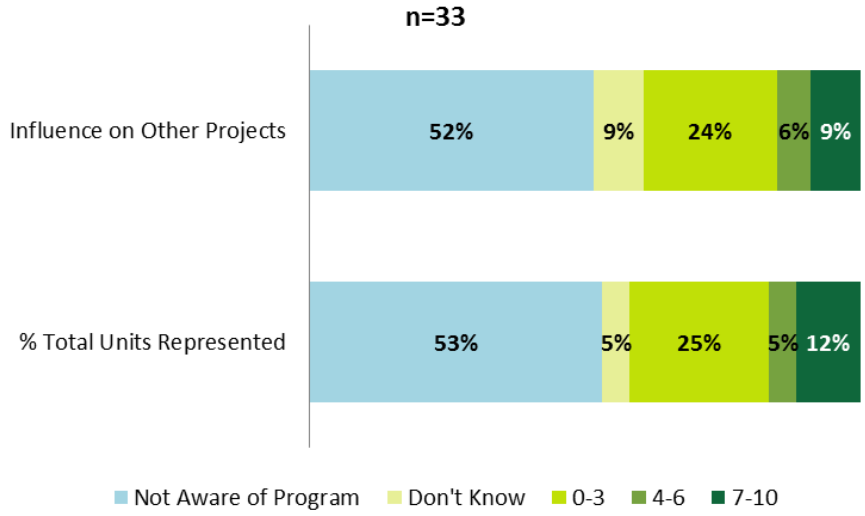
Excluding the three respondents for whom the sampled project participated in the program and the respondent who did not know the project rise, Figure E-12 displays the program's influence on the efficiency level of the sampled project by the project's rise. The only projects for which respondents indicated that the program was somewhat or very influential with respect to the efficiency level of the non-program sampled project were low-rise projects and one project with both low- and high-rise buildings. There were no statistically significant differences in the level of program influence based on project rise.

Figure E-12: Program Influence by Rise on Respondents' Sampled Project



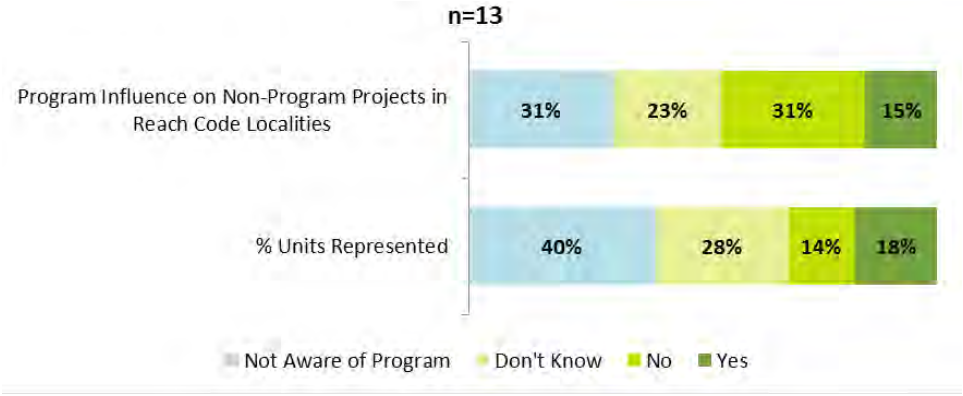
Next, the research team asked respondents to rate the program's influence on the efficiency level of all their other (i.e., non-sampled), non-program projects that started construction from 2010 through 2012 (Figure E-13). Just under one-tenth of all respondents (9%) indicated that the IOU MFNC program was very influential (7-10). Less than one-tenth (6%) indicated that the program was somewhat influential (4-6), and just under one-quarter (24%) indicated that the program had little to no influence (0-3) on the efficiency level of their other non-program projects.

Figure E-13: Program Influence on Other Non-Program Projects



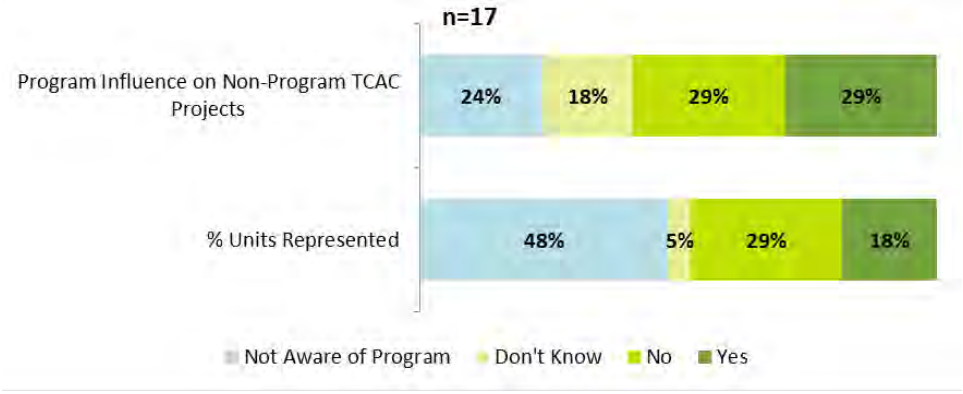
Thirteen of the 33 respondents built multifamily projects from 2010 through 2012 in jurisdictions where mandatory local energy ordinances that exceed Title 24 were adopted. Those among this group of 13 who were aware of the IOU MFNC program were asked if their familiarity with the program affected the energy efficiency of their non-program projects in reach code localities. Two of the 13 respondents (15%) said that their familiarity with the program affected the energy efficiency of their non-program projects in reach code localities. As shown in Figure E-14, these two (15%) respondents represent 18% of the multifamily units started by the 13 respondents who built in reach code localities from 2010 through 2012. The research team asked these two respondents how much more efficiently, on average, they built their non-program projects in reach code localities due to the influence of the program. One respondent replied that the projects were 15% more efficient than local code requirements, and the other respondent did not know.

Figure E-14: Program Influence on Non-Program Projects in Reach Code Localities



Seventeen of the 33 respondents built multifamily projects in California that received an award from TCAC. Those among this group of 17 who were aware of the IOU MFNC program were asked if their familiarity with the program affected the energy efficiency of their non-program projects that received TCAC awards. Five (29%) of the 17 respondents said that their familiarity with the program affected the energy efficiency of their non-program TCAC projects. These five respondents represent 18% of the multifamily units started by the 17 respondents who built multifamily projects in California that received an award from TCAC (Figure E-15). The research team asked these five respondents how much more efficiently, on average, they built their non-program TCAC projects due to the influence of the program. On average, four of these five respondents built their non-program TCAC projects 16% more efficiently due to the influence of the program; the fifth respondent did not know.

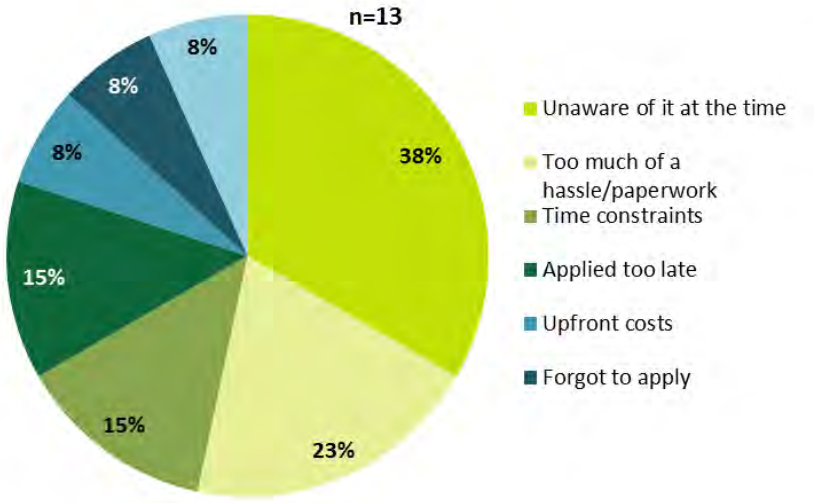
Figure E-15: Program Influence on Non-Program TCAC Projects



Respondents who were aware of the IOU MFNC program and for whom the sampled project did not participate in the program were asked why they thought the project did not participate. As shown in Figure E-16, the most frequently mentioned reason for not participating in the program

was being unaware of it at the time (38%), followed by too much hassle/paperwork (23%), time constraints (15%), and having applied too late (15%).

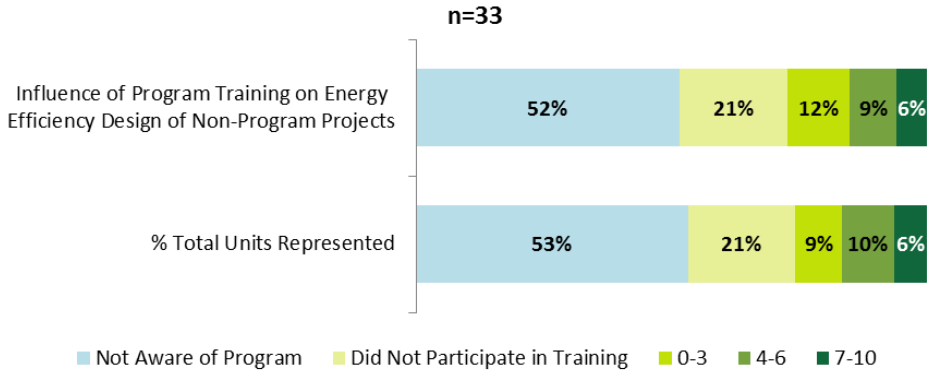
Figure E-16: Reasons Project Did Not Participate in Program (multiple responses)



E.4 IOU Training

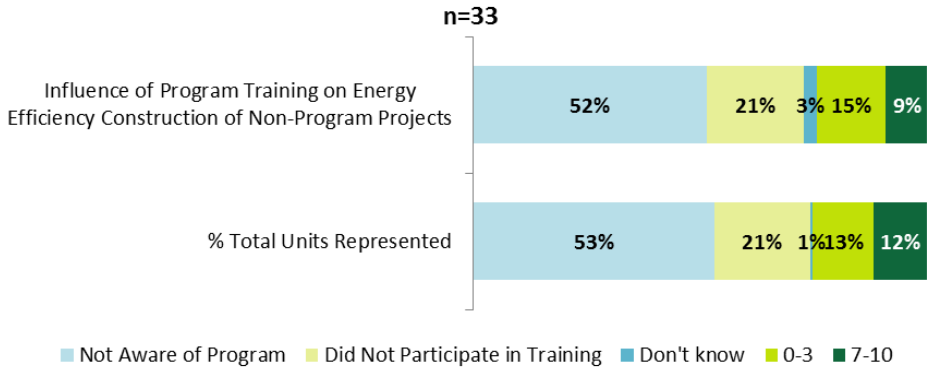
The research team asked respondents who were aware of the IOU MFNC program if they had ever participated in any utility multifamily new construction trainings on energy-efficient design or construction practices. The team asked those who had participated in this training to rate the influence that the training had on the efficiency level of their design practices on non-program projects that started construction from 2010 through 2012. The team asked respondents to use a scale of zero to ten, where zero is "no influence" and ten is "a great deal of influence." As shown in Figure E-17, 6% of respondents indicated that the utility training was very influential by assigning a rating of 7 to 10. Just under one-tenth (9%) indicated that the training was somewhat influential (4-6), and just over one-tenth (12%) indicated that the training had little to no influence (0-3) on the efficiency level of their design practices on non-program projects started from 2010 through 2012.

Figure E-17: Influence of Utility Training on Energy Efficiency Design of Non-Program Projects



Next, the research team asked respondents to rate the influence that the training had on the efficiency level of their construction practices on non-program projects that started construction from 2010 through 2012. As shown in Figure E-18, just under one-tenth (9%) of respondents indicated that the utility training was very influential by assigning a rating of 7 to 10. Respondents who assigned a rating of 7 to 10 started 12% of the 9,383 total multifamily units started by respondents from 2010 through 2012. Fifteen percent of respondents indicated that the training had little to no influence (0-3) on the efficiency level of their construction practices on non-program projects started during this period.

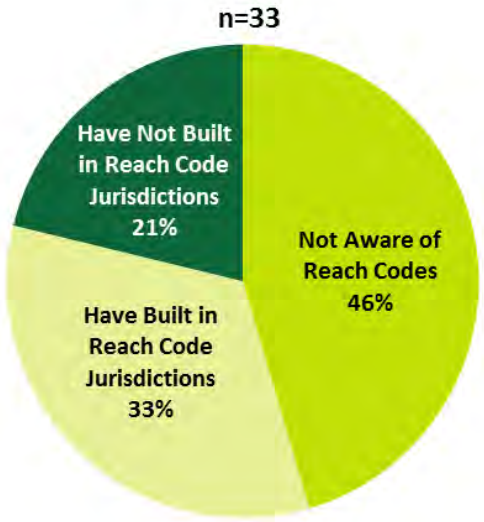
Figure E-18: Influence of Utility Training on Energy Efficiency Construction of Non-Program Projects



E.5 Influence of Reach Codes on Building Practices

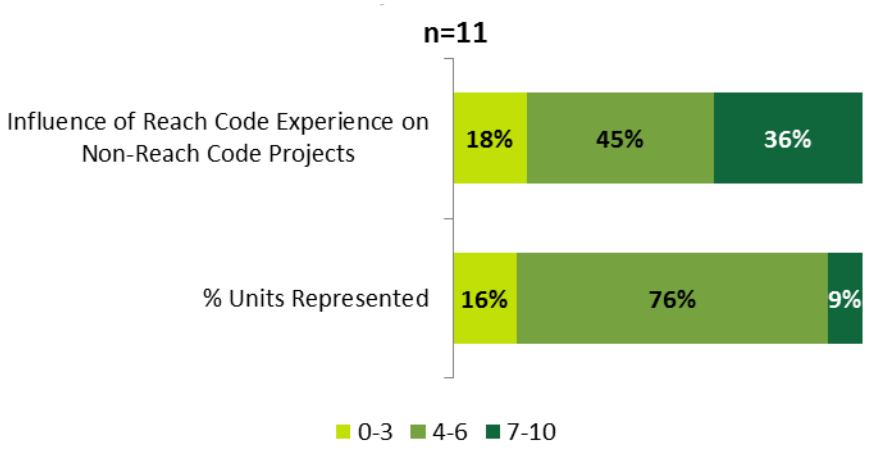
The research team asked respondents if they were aware of local energy ordinances that exceed Title 24 and are in place in some parts of California (reach codes). Just over one-half (54%) of respondents were aware of these reach codes (Figure E-19). In addition, one-third (33%) of respondents had built multifamily projects in California reach code localities from 2010 through 2012.

Figure E-19: Experience with Reach Codes



The research team asked respondents who had built in reach code localities if they ever apply the multifamily new construction practices they use in these areas to their work outside of reach code localities. Respondents who built both within and outside of reach code localities (11 respondents) were asked to rate the influence that their experience working in reach code localities had on non-program projects outside of reach code localities. As shown in Figure E-20, over one-third (36%) of respondents who work both within and outside of reach code localities indicated that that their experience working in reach code localities was very influential (7 to 10); this represents 12% of all 33 respondents. However, these 36% of respondents represent only 9% of the multifamily units started by all eleven respondents who work both within and outside of reach code localities. Just under one-half (45%) of these respondents indicated that their experience working in reach code localities was somewhat influential (4-6); these respondents represented over three-quarters (76%) of the multifamily units started by all 11 respondents who work both within and outside of reach code localities. Nearly one-fifth (18%) of respondents who work both within and outside of reach code localities indicated that that their experience working in reach code localities had little to no influence (0-3) on their non-program projects outside of reach code localities.

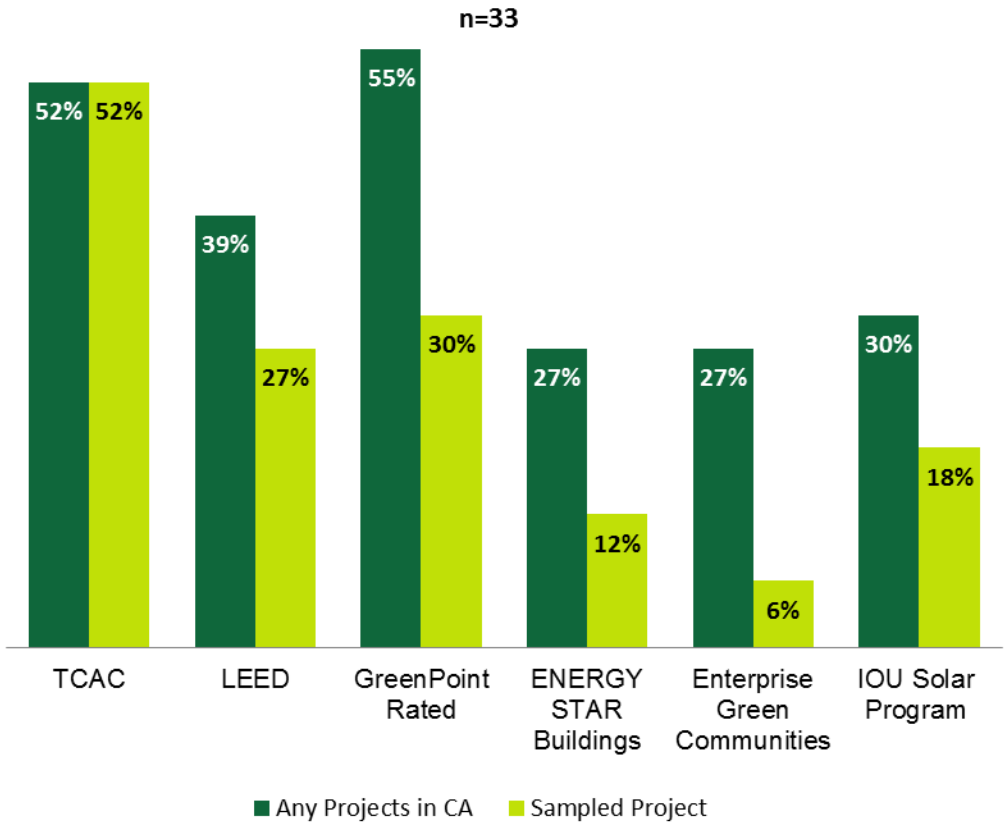
Figure E-20: Reach Code Market Effects



E.6 Participation with and Influence of other Green Programs

The research team asked respondents if any of their multifamily projects in California had received awards or certifications from the programs displayed in Figure E-21. Respondents who said that any of their projects had received awards or certifications from a given program were then asked if the project in question received an award or certification from that program. Over one-half of respondents had built multifamily projects that obtained GPR certification (55%) or received an award from TCAC (52%). Nearly two-fifths of respondents (39%) had built projects that obtained LEED certification, and almost one-third (30%) had built projects that participated in the IOUs' solar incentive program. Just over one-quarter (27%) of respondents had built projects that obtained ENERGY STAR Buildings or Enterprise Green Communities certification.

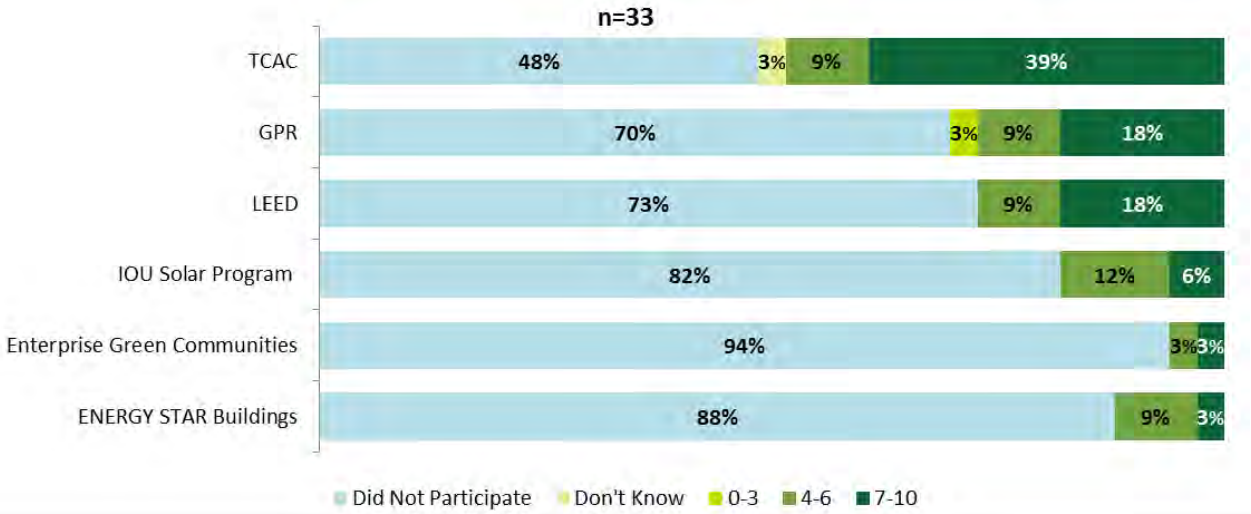
Figure E-21: Green Programs and Certifications



Over one-half (52%) of the sampled projects received an award from TCAC. Less than one-third of sampled projects received GPR (30%) or LEED (27%) certification. Less than one-fifth (18%) of the sampled projects participated in the IOUs' solar incentive program. Around one-tenth (12%) of the sampled projects obtained ENERGY STAR Buildings certification, and 6% obtained Enterprise Green Communities certification.

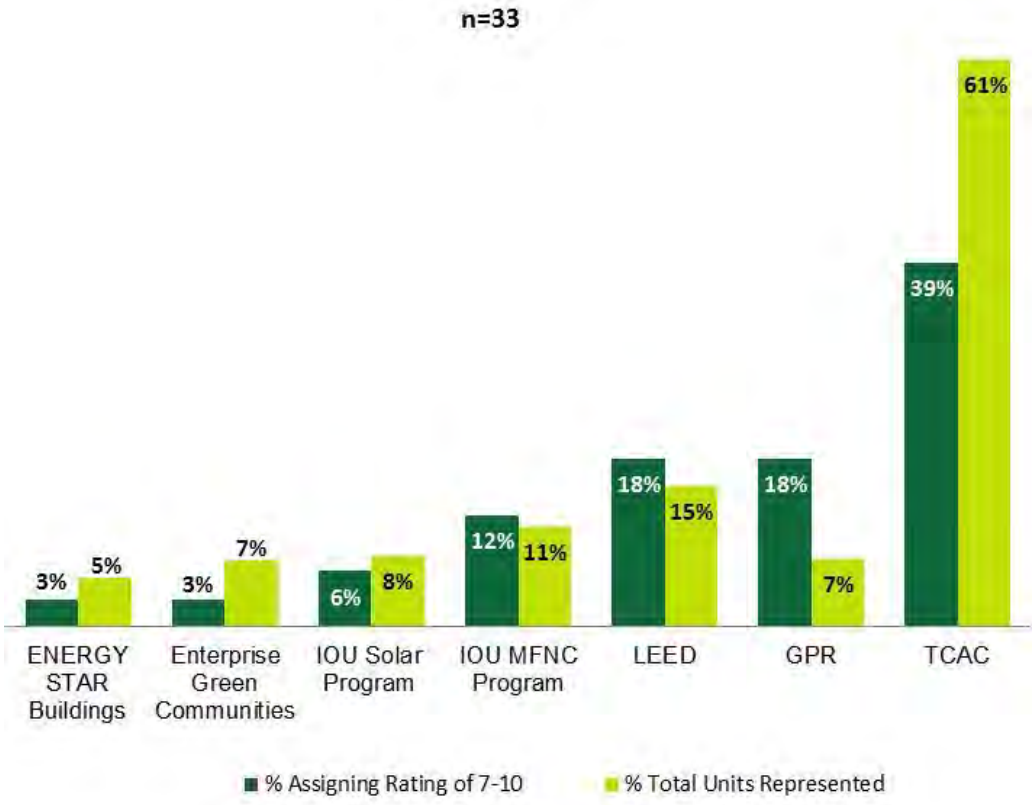
For each program in which a sampled project participated, the research team asked respondents to rate the influence that the program had on their decision to build the project more efficiently than Title 24. As shown in Figure E-22, nearly two-fifths (39%) of respondents indicated that TCAC was very influential (7-10) in their decision to build the project in question more efficiently than Title 24. Nearly one-fifth of respondents indicated that GPR (18%) or LEED (18%) was very influential in this decision. Less than one-tenth of respondents indicated that the IOUs' solar incentive program (6%), Enterprise Green Communities (3%), or ENERGY STAR Buildings (3%) was very influential in the decision to build the project in question more efficiently than Title 24.

Figure E-22: Influence of Green Programs and Certifications on Efficiency Level of Sampled Project



Like Figure E-22, Figure E-23 displays the percentage of respondents indicating that a particular program was very influential (7-10) on their decision to build the project in question more efficiently than Title 24. (For the IOU MFNC program, we report the influence of the program on the sampled project regardless of participation in the IOU program.) In addition, Figure E-23 displays the percentage of the total multifamily units started by respondents who rated a program as very influential (7-10). In most cases, the proportion of multifamily units is within a few percentage points of the proportion of respondents representing those units. However, there are some exceptions. For example, the 39% of respondents who indicated that TCAC was very influential (7-10) on their decision to build the project in question more efficiently than Title 24 represent 61% of the 9,383 total multifamily units started by respondents from 2010 through 2012. Additionally, the 18% of respondents who indicated that GPR was very influential represent only 7% of the total units started by respondents.

Figure E-23: Proportion of Multifamily Units Represented by High Program Influence Ratings



The research team asked respondents if some green programs or certifications have more cachet than others with renters, if some have more cachet with homeowners, and which ones have more cachet with each group. Overall, 30% of respondents reported that some green programs have more cachet with homeowners, while 21% of respondents reported the same for renters (48% of respondents thought that some green programs have more cachet with either buyers or renters). When asked to identify which programs have more cachet, more often than not, respondents did not know if certain green programs or certifications had more cachet with homeowners or renters (Table E-11). Respondents who thought that some programs and certifications do have more cachet than others were most likely to mention LEED, both for homeowners (mentioned 7 times) and renters (mentioned 6 times).

Table E-11: Green Programs and Certifications with More Cachet

Do some green programs or certifications have more cachet than others with…	Homeowners n=33	Renters n=33
Yes	30%	21%
No	24%	30%
Don't know	46%	49%
Programs that have more cachet than others with…	**Homeowners n=10**	**Renters n=7**
	(Count, Multiple Responses)	
LEED	7	6
ENERGY STAR Buildings	3	1
GPR	2	1
Enterprise Green Communities	1	-
TCAC	-	1
IOU solar incentive program	1	1

E.7 Energy Efficiency Decisions

Respondents were asked a series of questions related to how they made decisions about energy efficiency upgrades. They were asked to identify the project's key decision makers and the most important stage in the project cycle in terms of making decisions that affected the final energy efficiency of the project. Additionally, respondents were asked about the major drivers involved in determining the energy efficiency level of the project, as well as how they decide between using budget on energy efficiency upgrades as opposed to spending that money on other, non-energy components of the project.

E.7.1 Decision Makers

Respondents were asked to identify the *key decision makers* regarding energy efficiency for the sampled project (Table E-12). Nearly all of the respondents (97%) said the developer was a key decision maker, and over three-fourths of respondents (79%) said that the architect was another key decision maker. Other common decision makers reported by respondents included the engineer (27%), the financer/investor (27%), the builder (18%), and the general contractor (18%).

Respondents were then asked to specify the *primary decision maker* for the project, with close to half of respondents (48%) reporting that the developer was the primary decision maker. Additionally, respondents were asked if there was anyone else affiliated with the project that had a particularly large influence on the efficiency-related decisions made by the primary decision maker. Over two-fifths of respondents (42%) said there was no one else that had an influence, and close to one-fifth of respondents (18%) mentioned that the developer had a large influence.

Table E-12: Energy Efficiency Decision Makers (Multiple Response)

Decision Makers	Key Decision Makers (n=33)	Primary Decision Maker (n=33)	Other Decision Makers (n=33)
Developer	97%	48%	18%
Architect	79%	18%	3%
Engineer	27%	3%	12%
Financer/Investor	27%	6%	12%
Builder	18%	12%	3%
General Contractor	18%	3%	3%
Title 24 Consultant	9%	3%	-
City	3%	-	-
TCAC	3%	-	-
The Construction Project Manager	3%	-	-
Director of Real Estate	-	3%	-
Energy Consultant	-		3%
Overall Design Team	-	3%	-
Owner	-	-	3%
No One Else	-	-	42%
Don't know	-	-	3%

E.7.2 Most Important Stage of Project Cycle

Respondents were asked to identify the most important stage of the project cycle in terms of making decisions that affected the final energy efficiency of the project (Table E-13). Close to one-half of respondents (48%) reported that the project design development phase was the most important stage of the project cycle, and about one-fourth of respondents (21%) said the most important stage was when they were applying for financing. A small percentage of respondents (15%) said that the project feasibility assessment was the most important stage. Other responses included project conception (mentioned by 6% of respondents), when construction documents are being drawn up (mentioned by 6% of respondents), and during the permitting phase (mentioned by 3% of respondents).

Table E-13: Most Important Stage of Project Cycle

Project Cycle Stages	% of Respondents (n=33)
Project Design Development	48%
Applying for Financing	21%
Project Feasibility Assessment	15%
Construction Documents	6%
Project Conception	6%
Permitting	3%

E.7.3 Drivers of Energy Efficiency

Respondents were asked about the major drivers involved in determining the energy efficiency level of the project (Table E-14). The most common driver that respondents reported was the mandatory, local energy efficiency requirements or ordinances that they must comply with (70% of respondents). Of the respondents who mentioned this as a major factor, close to two-fifths had their sampled project located in reach code communities (39%).

Other major drivers involved in determining the energy efficiency of a project included low-income tax credit requirements (55% of respondents), green certification requirements (33%), and company commitments to being energy efficient or "green" (24%).

Table E-14: Energy Efficiency Drivers (Multiple Response)

Drivers of Energy Efficiency	% of Respondents (n=33)
Mandatory, Local Energy Efficiency Requirements / Ordinances	70%
Low-income Tax Credit Requirements	55%
Green Certification Requirements	33%
Company/Organization Commitment	24%
Budget Availability	18%
Investors or Finance Requirements (Other than Low-income Tax Credits)	18%
Reducing Operating Costs	18%
Market Demand	9%
Energy Efficiency	3%

The team examined drivers of energy efficiency from the perspective of the primary target market for the sampled project (Table E-15). Market-rate projects most commonly reported mandatory, local energy efficiency requirements and ordinances (10 out of 12 respondents) as a primary driver of energy efficiency for their projects. Low-income projects most commonly reported that the low-income tax credit requirements were primary drivers of energy efficiency for their projects (81% of respondents).

Table E-15: Energy Efficiency Drivers and Target Markets

Drivers of Energy Efficiency	Market-Rate (n=12)*	Low-Income (n=21)
Mandatory, Local Energy Efficiency Requirements / Ordinances	10	62%
Company/Organization Commitment	3	24%
Market Demand	3	-
Green Certification Requirements	2	43%
Low-income Tax Credit Requirements	1	81%
Budget Availability	1	24%
Investors or Finance Requirements (Other than Low-income Tax Credits)	-	29%
Reducing Operating Costs	1	24%
Energy Efficiency	1	-

*The number of responses is shown where the sample size is less than 20

Drivers of energy efficiency were also examined from the perspective of building height (also known as "rise"; Table E-16). The ten high-rise projects (more than three stories) most commonly reported that mandatory, local energy efficiency requirements and ordinances were key drivers, as were green certification and low-income tax credit requirements (five respondents each). Similarly, more than three-fourths of respondents (80%) whose sampled projects were low-rise (three stories or less) reported mandatory, local energy efficiency requirements and ordinances as key drivers. One-half of the low-rise respondents (50%) also reported that low-income tax credit requirements were also important drivers of energy efficiency. The three respondents whose building projects classified as both high-rise and low-rise all reported low-income tax credit requirements as an important driver of energy efficiency for their projects.

Table E-16: Energy Efficiency Drivers and Building Rise

Factors/Drivers	High-Rise (n=10)*	Low-Rise (n=20)	Both High- and Low-Rise (n=3)*
Mandatory, Local Energy Efficiency Requirements / Ordinances	5	80%	2
Green Certification Requirements	5	20%	2
Low-income Tax Credit Requirements	5	50%	3
Company/Organization Commitment	2	25%	1
Reducing Operating Costs	2	15%	1
Budget Availability	1	20%	1
Market Demand	1	10%	-
Investors or Finance Requirements (Other than Low-income Tax Credits)	-	20%	2
Energy Efficiency	-	5%	-

*The number of responses is shown where the sample size is less than 20

E.7.4 Trade-offs Between Energy Efficiency and Other Features

The evaluation team asked respondents how they decide between using budget on energy efficiency upgrades as opposed to spending that money on other, non-energy parts of the project (Table E-17). Close to one-third of respondents (27%) said their decisions are based on meeting funding requirements, close to one-fifth said it was their company policy to include energy efficiency in their building practices, and a small percentage of respondents said they chose energy efficiency when it was cost-effective (12%).

There was a wide array of other responses, including one respondent who said that, in addition to it being company policy to choose energy efficiency, they also do so to encourage other developers to do the same. He stated:

> *Our project team is committed to striving toward energy-efficient developments and aims to set an example for other developers by doing so.*

Table E-17: Deciding on Energy Efficiency Upgrades (Multiple Response)

Decision Making Processes	% of Respondents (n=33)
To Meet Funding Requirements	27%
Company Policy to Choose Energy Efficiency	18%
Chose Energy Efficiency Where it was Cost-Effective	12%
Build to Code	9%
Anticipated Benefit for Tenants	9%
Just Followed Project Specifications	9%
Had Extra Funding Available	6%
Marketability to Prospective Tenants	6%
Meet Building's General Needs First, then Energy Efficiency	6%
To Reduce Operating Cost	6%
Choose Energy Efficient Materials for Longevity	3%
Product Availability	3%
Provide Example for Other Developers	3%
To Exceed Title 24 Requirements	3%
Wanted to Include Some "Green" Products	3%

E.8 Target Segments and Demand for Energy Efficiency

Respondents were asked about the target market segments for their projects, as well as what type of demand their prospective occupants have for energy efficiency. The evaluation team also asked respondents to speak from their own experiences about the demand that market-rate renters and market-rate buyers have for energy efficiency in general. Finally, respondents were asked to identify market segments in the multifamily market that seek out energy efficiency more than others.

E.8.1 Target Market Segments

Respondents were asked to identify the market segment(s) they had in mind for their project (Table E-18). Two-thirds of respondents (67%) said they had low-income occupants in mind, just over one-fourth of respondents (27%) said they had high-income market-rate occupants in mind, and a small percentage (15%) said they had moderate-income market-rate occupants in mind for the project. One respondent said she had no market segment in mind, another respondent said he had all three of the target segments in mind, and two respondents reported targeting both moderate and market-rate high-income occupants with their projects.

Table E-18: Target Segments (Multiple Response)

Target Segments	% of Respondents (n=33)
Low-Income	67%
Market-Rate, Moderate Income	15%
Market-Rate, High Income	27%
No Market Segment Identified	3%

E.8.2 Demand for Energy Efficiency - Prospective Occupants

Respondents were asked to assess the level of demand for energy efficiency compared to other factors they expected from the prospective occupants of their projects (Table E-19). Respondents were asked to use a scale of zero to ten, where zero is "No demand" and ten is "A great deal of demand." A high percentage of respondents with market-rate projects or projects with no target market segment (87%) expected their prospective occupants to have moderate or high demand for energy efficiency. In comparison, fewer respondents with low-income projects expected their prospective occupants to have a moderate or high level of demand for energy efficiency (55%). When analyzed as a whole group, about three-fourths of respondents (77%) expected their prospective occupants to have moderate or high demand for energy efficiency.

Table E-19: Demand for Energy Efficiency - Prospective Occupants by Project Type

Demand for Energy Efficiency	Low-Income Projects (n=22)	Market-Rate Projects (n=15) **	Total (n=33)*
Very Little Demand (Ranking of 0 to 3)	45%†	13%	27%
Moderate Demand (Ranking of 4 to 6)	32%	47%	36%
High Demand (Ranking of 7 to 10)	23%	40%	36%

* Note that the n for total respondents is less than the combination of respondents who reported Low-Income and Market-Rate/No requirements because of multiple response option.

** Includes projects with no target market identified by the developer.

† Differences are statistically significant at the 90% confidence level

Demand for energy efficiency was also analyzed by whether a project was classified as high-rise or low-rise (Table E-20). Seven out of ten respondents with high-rise projects expected their prospective occupants to have moderate or high demand for energy efficiency. A somewhat lower percentage of respondents of low-rise projects (65%) expected their prospective occupants to have a moderate or high level of demand for energy efficiency. Of the three projects that respondents reported as being classified as both high- and low-rise buildings, two were considered to have very little demand, and one was considered to have moderate demand.

Table E-20: Demand for Energy Efficiency – Prospective Occupants by Building Rise

Demand for Energy Efficiency	High-Rise (n=10)*	Low-Rise (n=20)	Both High- and Low-Rise (n=3)*	Total (n=33)
Very Little Demand (Ranking of 0 to 3)	3	35%	2	27%
Moderate Demand (Ranking of 4 to 6)	5	30%	1	36%
High Demand (Ranking of 7 to 10)	2	35%	0	36%

*The number of responses is shown where the sample size is less than 20.

E.8.3 Demand for Energy Efficiency - Market-Rate Renters and Buyers

Respondents were asked to estimate the level of demand for energy efficiency compared to other factors they expected from prospective renters and buyers of market-rate multifamily homes (Table E-21). Respondents were again asked to use a scale of zero to ten, where zero is "No demand" and ten is "A great deal of demand." Respondents expect higher levels of demand from prospective buyers than from renters; 45% of respondents estimated high levels of demand for energy efficiency from buyers compared to 15% for renters. Close to one-quarter of respondents (24%) did not know what type of demand their renters have for energy efficiency, and one-third (33%) of respondents did not know what type of demand buyers have for energy efficiency.

Table E-21: Demand for Energy Efficiency – Market-Rate Renters and Buyers

Demand for Energy Efficiency	Market-Rate Renters (n=33)	Market-Rate Buyers (n=33)
Very Little Demand (Ranking of 0 to 3)	27%†	9%
Moderate Demand (Ranking of 4 to 6)	33%†	12%
High Demand (Ranking of 7 to 10)	15%†	45%
Don't know	24%	33%

† Differences are statistically significant at the 90% confidence level

E.8.4 Market Segments that Seek Out Energy Efficiency

Finally, respondents were asked to identify segments in the multifamily market that seem to seek out energy efficiency more than others (Table E-22). Close to half of respondents (48%) reported that they expect high-income market-rate occupants to seek out energy efficiency most frequently. Fewer respondents (24%) expected moderate-income market-rate occupants to seek out energy efficiency most often, and an even lower percentage of respondents (6% each) expected low-income occupants and owners to seek out energy efficiency. Over one-fourth of respondents (27%) reported that they did not know which target segment might seek out energy efficiency more than others.

Table E-22: Target Segments Seeking Energy Efficiency

Target Segments	% of Respondents (n=33)
Market-Rate, High-Income	48%
Market-Rate, Moderate-Income	24%
Low-income	6%
Owners	6%
Not a Common Factor	6%
Educated Owners and Renters	3%
Don't know	27%

E.9 Zero Net Energy

Respondents were asked to estimate their level of familiarity with Zero Net Energy (ZNE) building practices. Those who were familiar were then asked to estimate the number of ZNE buildings they expect to build in California within the next three years as well as within the next four to five years.

E.9.1 Familiarity with Zero Net Energy

Most respondents reported having some degree of familiarity with the idea of ZNE building practices (Table E-22). A small percentage of respondents reported being very familiar (6%), but most respondents were either moderately familiar (30%) or somewhat familiar (55%). A small percentage of respondents reported no familiarity with ZNE building practices at all (9%).

Table E-23: Familiarity with Zero Net Energy

Familiarity with ZNE	% of Respondents (n=33)
Very Familiar	6%
Moderately Familiar	30%
Somewhat Familiar	55%
Not at All Familiar	9%

E.9.2 Future Zero Net Energy Projects

Respondents who were familiar with ZNE building practices were then asked to estimate the number of ZNE buildings that they expect to build in California in the coming years (Table E-24). In the next three years, the vast majority of respondents (94%) do not expect to build any ZNE projects. One outlier expects to build about 50 ZNE projects in the next three years. Within the next four to five years, over three-fifths of respondents (64%) still expect to have no ZNE projects completed. Nine percent of respondents expect to build between one and ten ZNE projects in the next four to five years, 15% expect to build between 15 and 25 projects, and 12% expect to build between 50 and 100 ZNE projects in that period.

Table E-24: Anticipated Zero Net Energy Projects

Number of Projects	In the Next Three Years (n=33)	In the Next Four to Five Years (n=33)
No projects	94%	64%
1 to 10 Projects	3%	9%
15 to 25 Projects	-	15%
50 to 100 Projects	3%	12%

Appendix F Data Collection Instruments and Survey/ Interview Guides

F.1 Developer Survey Guide

F.1.1 Variables and Quotas

Variable Name	Purpose (Type)	Description
CONTACT	Read-in (Sample variable)	Contact name (not always present)
PROJECT_NAME	Read-in (Sample variable)	Project name
ADDRESS	Read-in (Sample variable)	Project's street/general address (not always present)
CITY	Read-in (Sample variable)	Project's city
RISE	For quotas (Sample variable)	Rise determined in Phase I
V_RISE	Quota variable (Generated during survey)	Verified rise based on survey response in screening module
SURVEY_1	For skips (Sample variable)	Project was asked about during first survey round last fall = 1
AWARE	For skips (Generated during survey)	Based on survey response; if respondent is aware of the program = 1
EFFICIENT	For skips (Generated during survey)	Based on survey response; if the project was built to above T24 code = 1
V_PARTIAL	For skips (Generated during survey)	Based on survey response; if respondent had a project that participated in the program = 1
ORDINANCE	For skips (Sample variable)	If project was within a reach code = 1
ORDINANCE_LOCATION	Read-in (Sample variable)	Location of reach code
ORDINANCE_DATE	Read-in (Sample variable)	Date reach code was approved

Quota Group	Maximum Number of Completes
V_RISE = LOW RISE	20
V_RISE = HIGH RISE	20
TOTAL	35

F.1.2 Introduction

[IF <CONTACT> NOT BLANK] May I please speak with <CONTACT> or the person who is most knowledgeable about the <PROJECT_NAME> multifamily project located <ADDRESS> in <CITY>?

[IF <CONTACT>=BLANK] May I please speak with the person who is most knowledgeable about the <PROJECT_NAME> multifamily project located <ADDRESS> in <CITY>?

Hello, my name is _____ from NMR Group. I am calling on behalf of the California Public Utilities Commission, or the CPUC. The CPUC has asked us to conduct interviews with builders and developers in order to better understand the multifamily new construction market. We are offering an incentive of $100 in the form of a check to individuals that complete this survey.

(IF NEEDED: This survey will last about 20 to 30 minutes)

(IF NEEDED: We obtained information about your project from either a McGraw-Hill Construction database of new construction starts in California or from the annual reports of the California Tax Credit Allocation Committee.)

(IF NEEDED: For more information about this study's sponsorship, you can contact Cathy Fogel from CPUC at (415) 703-1809)

[IF *BOTH* PROJECT NAME AND ADDRESS ARE INCORRECT, THANK AND TERMINATE]

F.1.3 Screening (4 minutes)

Let's first make sure that you're eligible for the study.

SC0a. Were you in any way involved with the <PROJECT_NAME> multifamily project located <ADDRESS> in <CITY>

1. Yes
2. No **[THANK AND TERMINATE]**
-7. Don't know **[THANK AND TERMINATE]**
-9. Refused **[THANK AND TERMINATE]**

SC0. What was your role in the <PROJECT_NAME>? Are you the…

[FOR EACH: YES = 1, NO = 2, DON'T KNOW = -7, REFUSED = -9]

a. Builder?
b. Developer?
c. Architect or Engineer?
d. General contractor?
e. Property manager?

[IF PROPERTY MANAGER ONLY, THANK AND TERMINATE]

SC1. Do you have a working knowledge of the California Title 24 energy efficiency requirements for multifamily new construction projects?

1. Yes
2. No **[THANK AND TERMINATE]**
-7. Don't know **[THANK AND TERMINATE]**
-9. Refused **[THANK AND TERMINATE]**

[ASK FOR CONTACT INFORMATION OF OTHER INDIVIDUAL AT ORGANIZATION WHO MIGHT BE KNOWLEDGEABLE BEFORE TERMINATING]

SC2. **[IF SURVEY_1 = YES, SKIP]** Do you consider the <PROJECT_NAME> multifamily project to be ANY of the following types of projects…residential care or nursing home facility, hotel or motel, or dormitory?

1. Yes **[THANK AND TERMINATE]**
2. No
-7. Don't know **[THANK AND TERMINATE]**
-9. Refused **[THANK AND TERMINATE]**

SC3. **[IF SURVEY_1 = YES, SKIP]** Does each unit have its own kitchen and bathroom?

1. Yes
2. No **[THANK AND TERMINATE]**
-7. Don't know **[THANK AND TERMINATE]**
-9. Refused **[THANK AND TERMINATE]**

SC4. Which of the following best describes this project: all buildings in this project are low rise, meaning three stories or fewer; all buildings in this project are high rise, meaning more than three stories; or there are both low rise and high rise buildings in this project?

I am only asking about buildings with residential units. Please do not count stories if they include only parking garages.

(IF NEEDED: I'm only referring to levels above grade; floors with commercial or office space do count as floors)

1. Low rise **only** (three stories or fewer)
2. High rise **only** (more than three stories)
3. **Both** low rise and high rise
-7. Don't know
-9. Refused

[GENERATE VARIABLE "V_RISE"]

IF	THEN
SC4 = 1	V_RISE = LOW RISE
SC4 = 2 OR 3	V_RISE = HIGH RISE
SC4 = -7 OR -9 AND RISE = LOW OR HIGH	V_RISE = RISE (Sample variable)
SC4 = -7 OR -9 AND RISE = UNKNOWN	THANK AND TERMINATE

[THANK AND TERMINATE IF V_RISE QUOTA GROUP HAS REACHED MAXIMUM]

SC6. Are you aware of the multifamily new homes incentive programs offered by the California investor owned utilities (the 'utilities')? These programs are referred to as the California Advanced Homes Program or the California Multifamily New Homes Program. **I am not referring to the utility companies' solar incentive program.**

(IF NEEDED: The California Advanced Homes Program is sponsored by Southern California Edison, Southern California Gas, and San Diego Gas & Electric and is a program for both multifamily homes and single family homes; the California Multifamily New Homes Program is sponsored by Pacific Gas & Electric)

1. Yes
2. No
-7. Don't know
-9. Refused

[GENERATE VARIABLE "AWARE": IF SC6=1, AWARE=1; ELSE AWARE=0]

SC7. **[ASK IF AWARE=1]** From here forward I will refer to this program as the utility multifamily new construction program… Did <PROJECT_NAME> participate in the utility multifamily new construction program?

1. Yes
2. No
-7. Don't know
-9. Refused

[LIMIT TO FIVE COMPLETED SURVEYS WHERE SC7=1 (PARTICIPANT)]

SC7A. Did this project participate in the investor owned utilities' solar incentive program?

1. Yes
2. No
-7. Don't know
-9. Refused

SC8. **[ASK IF AWARE=1]** Including <PROJECT_NAME>, what percentage of all of the multifamily new construction projects you started during the 2010 through 2012 time period participated in the utilities' multifamily new construction program?

(IF NEEDED: By started, I mean broke ground, began excavation, or built the foundation)

[ACCEPT 0 - 100]

-7. Don't know
-9. Refused

[IF SC8=100, THANK AND TERMINATE]

TERMINATE SCREEN: Unfortunately, you are not eligible to participate in our study. I'm very sorry. Thank you for your willingness to participate, anyhow.

[GENERATE VARIABLE "V_PARTIAL": IF SC8 = 1 THROUGH 99, V_PARTIAL=1; ELSE V_PARTIAL=0]

Excellent, you're eligible for the survey.

SC9. About how many multifamily new construction projects did your company start in California from 2010 through 2012? Only think about standard multifamily projects, not assisted living facilities, hotels, or dormitories.

(If NEEDED: Would you be able to provide a single number for your response?)

[RECORD NUMBER OF PROJECTS]

SC10. Could you estimate how many units were in all of those projects?

[RECORD NUMBER OF UNITS]

SC11. Roughly what percentage of those units were affordable housing units?

[RECORD PERCENTAGE OF AFFORDABLE HOUSING UNITS]

F.1.4 Codes and Standards (2 minutes)

Many of my questions today will focus on <PROJECT_NAME>. However, I will also ask you about, what I'll refer to just as "projects"; as I'm asking these questions, please, think of only multifamily projects that started construction from 2010 through 2012 in California.

C1. Was this project built under the 2005 Title 24 Energy Efficiency Standards or the 2008 Title 24 Energy Efficiency Standards?

1. 2005 Standards
2. 2008 Standards
3. (Other)

-7. Don't know

-9. Refused

C2. **[IF C1 = -7 (DON'T KNOW)]** What is the title of the person who would know the version of Title 24 Energy Efficiency Standards to which this project was built?

[RECORD VERBATIM]

C3. Are you aware of local energy ordinances that exceed Title 24 that are in force in some parts of California?

(IF NOT IMMEDIATELY FAMILIAR READ: These local energy ordinances, sometimes referred to as "reach codes," are codes that are passed by municipalities that require all new construction projects in their jurisdictions to achieve energy efficiency levels that are greater than the statewide Title 24 energy efficiency requirements.)

1. Yes
2. No

-7. Don't know

-9. Refused

C4. **[IF ORDINANCE = 1]** According to the California Energy Commission, the <ORDINANCE_LOCATION> adopted efficiency standards that exceed Title 24 on <ORDINANCE_DATE>. Our records show that the <PROJECT_NAME> multifamily project was located in <ORDINANCE_LOCATION>. Do you know if it was required to meet these more efficient standards?

1. Yes
2. No
3. (Not familiar with reach codes)
-7. Don't know
-9. Refused

[IF C3 = 1 OR C4 = 1, CONTINUE TO C5. OTHERWISE, SKIP TO C11]

C5. **[SKIP IF C4 = 1]** From 2010 through 2012, did you build any multifamily projects in jurisdictions where mandatory local energy ordinances that exceed Title 24 were in effect in California?

1. Yes
2. No
-7. Don't know
-9. Refused

C6. **[ASK IF C4 = 1 OR C5 = 1]** Do you ever apply the multifamily new construction practices that you use in areas with those local energy ordinances that exceed Title 24 to your work in areas that do not have any local energy ordinances that exceed Title 24?

1. Yes
2. No
3. (All work is conducted in reach code areas)
-7. Don't know
-9. Refused

C7. **[ASK IF C6 = 1]** Using a scale of 0 to 10, where 0 is "No influence" and 10 is "A great deal of influence," how much of an influence did your experience working in areas with local energy ordinances that exceed Title 24 influence your practices [**IF V_PARTIAL = 1, READ:** for your projects that did NOT go through the utility multifamily program] in areas without local energy ordinances?

[ACCEPT 0 - 10]

-7. Don't know

-9. Refused

C8. **[ASK IF C4 = YES, SUBJECT TO REACH CODE**] How does the energy efficiency of <PROJECT_NAME> project compare to the local energy ordinance standards? Would you say that it JUST meets the local energy ordinance or is it MORE efficient than the local energy ordinance?

1. Just meets reach code

2. More efficient than reach code

-7. Don't know

-9. Refused

C9. **[ASK IF C8 = 2 (MORE EFFICIENT THAN REACH CODE)]** What percentage more efficient than the local energy ordinance was this project?

[ACCEPT 1 - 500]

-7. Don't know

-9. Refused

C10. **[ASK IF C4 = YES, SUBJECT TO REACH CODE]** By what percentage did the local energy ordinance in the area exceed the statewide Title 24 energy efficiency requirements?

[RECORD PERCENT]

C11. **[ASK IF NOT SUBJECT TO REACH CODE (C4 < > 1)]** How does the energy efficiency of <PROJECT_NAME> project compare to the statewide Title 24 standards? Would you say that it JUST meets Title 24 code or is it MORE efficient than Title 24?

1. Just meets Title 24 code

2. More efficient than Title 24 code

-7. Don't know

-9. Refused

C12. **[ASK IF C11 = 2 (MORE EFFICIENT THAN CODE)]** What percentage more efficient than Title 24 standards was this project?

[ACCEPT 1 - 500]

-7. Don't know

-9. Refused

[GENERATE VARIABLE "EFFICIENT": IF C8 = 1 OR 2, OR C11 = 2, EFFICIENT = 1; ELSE EFFICIENT = 0]

F.1.5 Energy Efficiency Dynamics (6 minutes)

E1. Thinking of the decision process for this project, who were the key decision-makers regarding energy efficiency for <PROJECT_NAME>?

[READ IF NECESSARY; MULTIPLE RESPONSES]

1. Respondent (will back-code this based on screener question)
2. Builder
3. Developer
4. Architect
5. Engineer
6. General contractor
7. Financer/Investor
8. Other **[SPECIFY]**

-7. Don't know

-9. Refused

E2. **[ASK IF ANY E1 > -7 AND MORE THAN ONE RESPONSE TO E1]** Who was the PRIMARY decision maker regarding the energy efficiency of this project?

[READ IF NECESSARY; ACCEPT ONE]

1. Respondent (will back-code this based on screener question)
2. Builder
3. Developer
4. Architect
5. Engineer
6. General contractor
7. Financer/Investor
8. Other
-7. Don't know
-9. Refused

E3. Did anyone else affiliated with the project have a particularly large influence on the efficiency-related decisions made by the primary decision maker?

[READ IF NECESSARY; ACCEPT ONE]

1. Respondent (will back-code this based on screener question)
2. Builder
3. Developer
4. Architect
5. Engineer
6. General contractor
7. Financer/Investor
8. Other
-7. Don't know
-9. Refused

E4. What was the most important stage of the project cycle in terms of making decisions that affected the final energy efficiency of this project?

[READ IF NECESSARY]

1. Project conception
2. Project feasibility assessment
3. Applying for financing
4. Project design development
5. Construction documents
6. Zoning and/or Entitlement
7. Permitting
8. Other **[SPECIFY]**

-7. Don't know

-9. Refused

E5. What were the MAJOR factors involved in determining the energy efficiency level of this project?

[READ IF NECESSARY; ACCEPT MULTIPLE RESPONSES]

1. Mandatory, local energy efficiency requirements / ordinances
2. Low-income tax credit requirements
3. Investors or finance requirements [other than low-income tax credits]
4. Green certification requirements
5. Budget availability
6. Market demand
7. Company/organization commitment
9. Reducing operating costs
10. Other **[SPECIFY]**

-7. Don't know

-9. Refused

E5A. How did you decide between using budget on energy efficiency upgrades as opposed to spending that money on other, non-energy parts of the project?

[RECORD VERBATIM RESPONSE]

E6. What consumer segment(s) did you have in mind for this project]?

[READ IF NECESSARY]

1. Low Income
2. Market rate, moderate income
3. Market rate, high-income
4. Other **[SPECIFY]**

-6. No specific segments

-7. Don't know

-9. Refused

E7. Thinking about this project, compared to other factors, how much demand did you expect that prospective occupants of the project would have for energy efficiency? Use a scale of 0 to 10, where 0 is "No demand" and 10 is "A great deal of demand."

[ACCEPT 0 - 10]

-7. Don't know

-9. Refused

E8. How much demand do prospective renters of market rate multifamily homes have for energy efficiency? Use a scale of 0 to 10, where 0 is "No demand" and 10 is "A great deal of demand."

[ACCEPT 0 - 10]

-7. Don't know

-9. Refused

E9. How about buyers? How much demand do prospective buyers of market rate multifamily homes have for energy efficiency? Please use the same 0 to 10 scale [IF NEEDED: where 0 is "No demand" and 10 is "A great deal of demand."]

[ACCEPT 0 - 10]

-7. Don't know

-9. Refused

E10. In your experience, which consumer segments in the multifamily market seem to seek out energy efficiency more than others?

[READ IF NECESSARY]

1. Low Income
2. Market rate, moderate income
3. Market rate, high-income
4. Other **[SPECIFY]**

-7. Don't know

-9. Refused

F.1.6 Program Participation (4 minutes)

[IF AWARE=0, SKIP TO NEXT MODULE]

P0. You mentioned that you were aware of the utility multifamily new construction program [IF NECESSARY: the California Advanced Homes Program or the California Multifamily New Homes Program]. How familiar are you with the goals, requirements, and rules of the program? Are you…

1. Very familiar,
2. Moderately familiar,
3. Somewhat familiar, OR
4. Not at all familiar?
-7. Don't know
-9. Refused

P1. **[ASK IF AWARE = 1]** Using a scale of 0 to 10, where 0 is "No influence" and 10 is "A great deal of influence," how much influence did the utilities' multifamily new construction programs have on the efficiency level of this project?

[ACCEPT 0 - 10]

-7. Don't know
-9. Refused

P2. **[ASK IF AWARE = 1]** Using a scale of 0 to 10, where 0 is "No influence" and 10 is "A great deal of influence," how much influence did the utilities' multifamily new construction programs have on the efficiency level of your other multifamily projects that started construction from 2010 through 2012 but did NOT go through the utility program?

[ACCEPT 0 - 10]

-7. Don't know
-9. Refused

P3. Have you or your staff participated in any utility multifamily new construction program trainings on energy efficient construction or design practices?

1. Yes
2. No
-7. Don't know
-9. Refused

P4. **[ASK IF P3 = 1]** Using a scale of 0 to 10, where 0 is "No influence" and 10 is "A great deal of influence," how much of an influence did the utility multifamily new construction program training have on the efficiency level of your DESIGN practices on projects that started construction from 2010 through 2012 [**IF V_PARTIAL = 1, READ:** that did NOT go through the program]?

[ACCEPT 0 - 10]

-6. Did not receive training on design practices
-7. Don't know
-9. Refused

P5. **[ASK IF P3 = 1]** Using that same scale, how much of an influence did the utility multifamily new construction program training have on the efficiency level of your CONSTRUCTION practices on projects that started construction from 2010 through 2012 [**IF V_PARTIAL = 1, READ:** that did NOT go through the program]?

(IF NEEDED: Use a scale of 0 to 10, where 0 is "No influence" and 10 is "A great deal of influence.")

[ACCEPT 0 - 10]

-6. Did not receive training on construction practices
-7. Don't know
-9. Refused

P6.a **[ASK IF AWARE=1 and (ORDINANCE = 1 OR C5 = 1); SKIP IF C4=3]** For this question, think only about your projects that did NOT go through the utility multifamily new construction program but WERE located in jurisdictions where local energy ordinances that exceed Title 24 were in effect. Did your familiarity with the utility program affect the energy efficiency of your projects in those areas?

1. Yes
2. No
-7. Don't know
-9. Refused

P6.b. **[ASK IF P6a = 1]** On average, how much more efficiently did you build these non-utility program projects built in areas with above-code energy requirements due to the influence of the utility program?

[ACCEPT 0 – 500%]

-6. No experience with the program
-7. Don't know
-9. Refused

P6.c **[ASK IF AWARE=1 and SC11 > 0]** Please think only about your affordable housing projects that did NOT go through the utility multifamily new construction program but DID receive an award from TCAC [PRONOUNCE: tee-kack] (IF NEEDED: The California Tax Credit Allocation Committee]. Did your familiarity with the utility program affect the energy efficiency of those TCAC projects?

1. Yes
2. No
-7. Don't know
-9. Refused

P6.d. **[ASK IF P6c = 1]** On average, how much more efficiently did you build these non-utility program TCAC projects due to the influence of the utility program?

[ACCEPT 0 – 500%]

-6. No experience with the program
-7. Don't know
-9. Refused

P6.e **[ASK IF AWARE=1]** From 2010 through 2012, did you build any market rate multifamily projects that both did NOT go through the utility program, AND were built in areas WITHOUT mandatory local energy ordinances that exceed Title 24?

1. Yes
2. No
-7. Don't know
-9. Refused

P6.f. **[ASK IF P6e = 1]** Did your familiarity with the utility program affect the energy efficiency of those market rate projects?

1. Yes
2. No
-7. Don't know
-9. Refused

P6.g. **[ASK IF P6f = 1]** On average, how much more efficiently did you build these market rate projects due to the influence of the utility program?

[ACCEPT 0 – 500%]

-6. No experience with the program

-7. Don't know

-9. Refused

P7. Why do you think that <PROJECT_NAME> did not participate in the multifamily new construction program?

[DO NOT READ; ACCEPT MULTIPLE RESPONSES]

1. Unaware of it at the time
2. Application was rejected
3. Not energy efficient enough
4. Too much of a hassle/paperwork
5. Time constraints
6. Upfront costs
7. Other **[SPECIFY]**

-7. Don't know

-9. Refused

F.1.7 Green Programs (4 minutes)

[LOOP THROUGH G1 AND G2 FOR A THROUGH F]

G1. Have any of your multifamily projects in California **[A - F]**?

G2. **[ASK IF CORRESPONDING G1 = 1]** Did the <PROJECT_NAME> project do so?

[FOR EACH: YES = 1, NO = 2, DON'T KNOW = -7, REFUSED = -9]

a. Received an award from TCAC (PRONOUNCE: tee-kack)

(IF NEEDED: The California Tax Credit Allocation Committee)

b. Obtained LEED for Homes certification

c. Obtained GreenPoint Rated certification

d. Obtained ENERGY STAR Buildings certification

e. Obtained Enterprise Green Communities certification

f. Received incentives from investor owned utility solar program for homes

(If NEEDED: The New Solar Homes Partnership Program or NSHP)

G3. [**ASK IF CORRESPONDING G2 = 1 AND IF EFFICIENT = 1; RANDOMIZE**] Using a scale of 0 to 10, where 0 is "No influence" and 10 is "A great deal of influence," how much of an influence did **[A - F]** have on your decision to build <PROJECT_NAME> more efficiently than Title 24?

[FOR EACH ACCEPT 0 – 10, DON'T KNOW = -7, REFUSED = -9]

a. TCAC (PRONOUNCE: tee-kack)

b. LEED for Homes

c. GreenPoint Rated

d. ENERGY STAR Buildings

e. Enterprise Green Communities

f. The utility solar program for homes

G3aa. Do some green programs or certifications have more cachet than others with renters?

1. Yes
2. No
-7. Don't know
-9. Refused

G3bb. **[IF YES TO G3aa]** Which ones? **[ACCEPT MULTIPLE RESPONSE]**

a. TCAC
b. LEED for Homes
c. GreenPoint Rated
d. ENERGY STAR Buildings
e. Enterprise Green Communities
f. The utility solar program for homes

G3cc. How about for homeowners? Do some green programs or certifications have more cachet than others with homeowners?

1. Yes
2. No
-7. Don't know
-9. Refused

G3dd. **[IF YES TO G3cc]** Which ones? **[ACCEPT MULTIPLE RESPONSE]**

a. TCAC

b. LEED for Homes

c. GreenPoint Rated

d. ENERGY STAR Buildings

e. Enterprise Green Communities

f. The utility solar program for homes

G4. How familiar are you with the idea of Zero Net Energy building practices? Are you…

1. Very familiar,
2. Moderately familiar,
3. Somewhat familiar, OR
4. Not at all familiar?
-7. Don't know
-9. Refused

G5. **[SKIP TO NEXT MODULE IF G4 < > 1, 2 OR 3]** Over the next 3 years, what percentage of your multifamily new construction projects in California do you expect to be Zero Net Energy projects?

[RECORD PERCENTAGE]

G6. How about projects you start four or five years from now? What percentage of the multifamily new construction projects in California you start in four or five years do you expect to be Zero Net Energy projects?

[RECORD PERCENTAGE]

F.1.8 Payment Information (1 minute)

Those are all of my questions. I'll need to collect information about where to send your incentive payment.

M1. Whom should the check be payable to?

(IF NEEDED: This can be respondent, company, or charitable organization)

[IF PAYMENT IS TO BE MADE TO A CHARITABLE ORGANIZATION TRY TO COLLECT AS MUCH MAILING INFORMATION AS POSSIBLE, WE CAN DO ONLINE SEARCHES IF THEY DON'T KNOW]

M2. STREET:

M3. CITY:

M4. ZIP:

M5. In case we need to follow up about the payment, what is the best number to call you?

We will send you your check as soon as possible. If it doesn't arrive within three weeks, you can call the following number: 617-284-6230 ext. 9. Thank you very much for your time. Have a great day.

F.2 Case Study Respondent Interview Guides

F.2.1 Developer Interview Guide

Introduction

[Note: introduction may differ from this wording as most builders will have been already contacted about the nature of the interviews via email or phone prior to the actual interview date.]:

Hi, this is _____ from NMR Group. I am calling on behalf of the California Public Utilities Commission (CPUC). [As we have discussed previously] The CPUC has asked us to conduct interviews with builders in order to better understand the multifamily new construction market, energy efficiency, and the California Investor Owned Utilities' (the 'utilities') multifamily new construction programs. We chose specific projects started from 2010 through 2012 in order to help us better understand the market.

The interviews will discuss the multifamily new construction market generally, but we are going to focus on your project at [ADDRESS]. We're particularly interested in learning about how decisions were made about the project's energy efficiency. Can you confirm that you were responsible for making design and construction decisions affecting energy use for that project?

[IF YES, CONTINUE]

[IF NO, SET UP CALLBACK]

Great. We are offering $150 for you to talk to us about your experience on that project related to energy efficiency decisions, and we expect the interview will take about 30 minutes. All your responses will be held confidential - that is, we never link any information to a particular person or company. Is now a good time to talk?

[IF YES, CONTINUE]

[IF NO, PROBE TO FIND CORRECT CONTACT]

[QUESTIONS ABOUT STUDY'S SPONSORSHIP, REFER TO Cathy Fogel of the CPUC, at (415) 703-1809]

Warm-Up Questions

First I have a few questions about you and about your company's residential construction practices.

PRIOR TO INTERVIEW

I. What is your job title?

II. Is your company a for-profit or a non-profit developer?

III. Do you have a working knowledge of the Title 24 energy efficiency requirements for multifamily new construction in California?

IF NOT KNOWLEDGABLE OF T24

Contact with working knowledge of CALIFORNIA Title 24

(the energy folks – private consultants like HERs raters, developer hires – could be on staff, modeling and paperwork that goes to building department; for this specific project – probably will be the project manager, not CEOs or head of marketing):

_____

Title: _____

Phone: _____

Other: _____

IV. Are you aware of the IOUs' multifamily new construction program?

[**IF NEEDED**: California Advanced Homes Program (CAHP) SPONSORED BY SCE, SDG&E AND SCG or California Multifamily New Homes Program (CMFNH) SPONSORED BY PG&E]

1. How would describe your role at your company?

[READ CATEGORIES IF NECESSARY]

Purchasing agent,

Field supervisor,

Executive,

Sales agent,

Designer,

Or something else?

2. About how many multifamily new construction projects did your company start in California from 2010 through 2012? Only think about standard multifamily projects, not assisted living facilities, hotels, or dormitories.
   a. Could you estimate how many units were in all of those projects?
   b. Roughly what percentage of those units were affordable housing units?

IF BUILDER NOT INCLUDED IN PARTICIPATION DATA

3. Did any of the multifamily new construction projects that your company started in California from 2010 through 2012 participate in the utilities' multifamily new construction program?
   a. IF YES: How many projects?
   b. How many total units did they have?
   c. Did your project at [ADDRESS] participate in the utilities' multifamily new construction program? **[IF YES, TERMINATE INTERVIEW]**
   d. In a sentence or two, can you describe your understanding of the utility program's energy efficiency requirements?
   e. Before 2010, had any of your multifamily new construction projects participated in the utilities' multifamily new construction program?

IF BUILDER INCLUDED IN PARTICIPATION DATA

4. According to utility program records, you had [INSERT COUNT] projects participate in their multifamily new construction program from 2010 through 2012. Is that correct?
   a. Did your project at [ADDRESS] participate in the Utilities' multifamily new construction program?
   b. In a sentence or two, can you describe your understanding of the utility program's energy efficiency requirements?
   c. Before 2010, had any of your multifamily new construction projects participated in the utilities' multifamily new construction program?

1.1 RNC Program Awareness and Participation

5. Now I'm going to read you the names of some programs that encourage the installation of energy-efficient features in multifamily homes, and I'm going to ask you if you have *ever* participated in them:

	Have any of your MF projects ever participated in [PROGRAM]
California Tax Credit Allocation Committee (CTCAC) affordable housing programs	
LEED for Homes	
GreenPoint Rated	
ENERGY STAR Certified Buildings	
Enterprise Green Communities	

a. Did your project at [ADDRESS] go through any of these programs, or any other energy efficiency of 'green programs'

    i. Which ones?

IF CTCAC PARTICIPANT

b. How easy or challenging was it to comply with CTCAC's efficiency requirements?

    i. Why?

6. Are you aware of the reach codes that are in force in some parts of California?

[IF NEEDED: *Subject to CEC approval, municipalities in California may enforce efficiency standards that exceed Title 24, typically by 15%]*

IF AWARE OF REACH CODES

a. From 2010 through 2012, did you build any MF projects in jurisdictions where Reach Codes were in effect?

b. How easy or challenging was it to comply with the reach codes?

    i. Why?

c. Is it easier to comply with reach code in some municipalities than others?

    i. How so?

    ii. Where?

d. Was your project at [ADDRESS] required to meet reach codes?

Above-Code Practices and Decision Process – Case Study Project

7. How does the energy efficiency of your [NAME OF PROJECT] project compare to the statewide Title 24 standards?

a. Much more efficient than code?

b. Moderately more efficient than code?

c. Just meeting code?

IF MORE EFFICIENT

d. Could you estimate how much more efficient the project was compared to Title 24 standards?

8. How efficient is it compared to your other projects from around the same time period?

IF RESPONDENT ESTIMATE IS MORE EFFICIENT THAN MODELING

9. You estimated that your [NAME OF PROJECT] project is [INSERT BUILDER ASSESSMENT OF EFFICIENCY] but our site visit suggests that the project is less efficient than you expected.
    a. Why do you think that is?

[PROBE ON BUILDING CHARACTERISTICS FROM ONSITE DATA THAT ARE RESPONSIBLE FOR LOWER EFFICIENCY]

IF MORE EFFICIENT THAN TITLE 24 (Based on interview response or modeling results)

10. We're really interested in understanding the decision process that developers go through in building to the efficiency standards that they do, and whether there is some person, or program, or requirement driving their decisions.
    b. What was your role in determining the energy efficiency of the project?
    c. Why did you decide to build your [NAME OF PROJECT] project to the efficiency standard that you did?
    d. To what extent did this project integrate energy efficiency considerations throughout the entire planning and design process?
        i. How did you decide between using budget on energy efficiency upgrades as opposed to spending that money on other, non-energy parts of the project? [PROBE ON BUILDING CHARACTERISTICS THAT ARE RESPONSIBLE FOR HIGHER EFFICIENCY]
        ii. Who made the decision about using budget on energy efficiency upgrades?
        iii. Did you build the common areas and individual units to different efficiency levels?

IF YES:

1. How are they different, efficiency-wise?
2. Why did you make such a differentiation between the common areas and individual units?
3. Who made the decision to do so?

    e. During what stage of the project cycle did you first start making key decisions about the project's energy efficiency?
        i. Could the building have been made more efficient if these decisions regarding energy efficiency had been made at another stage?
            i. **[IF YES]** At what stage and why?
        ii. Were there other key stages in the project cycle when energy-efficiency decisions were made?

i. **[IF YES]** What were they?

EXAMPLES OF STAGES:

1. Project Concept,
2. Project Feasibility Assessment,
3. Securing Financing,
4. Applying for CTCAC,
5. Zoning and Permitting,
6. Design (design team selection, Design / building plan),
7. Pre-construction (contractor selection, construction plans),
8. Construction (construction plans, materials and equipment procurement, construction),
9. Commissioning and inspections

iii. ASK FOR EACH STAGE MENTIONED

i. What was the nature of the energy efficiency decision at this stage?

ii. Who in your organization made that decision?

1. **[IF MULTIPLE PEOPLE]** Was there somebody who was the primary decision-maker? Who?

iii. Were there any other people or entities outside your organization who were significant influencers of the decision at this stage? Who?

iv. Did you have to decide between using budget on energy efficiency upgrades as opposed to spending that money on other, non-energy parts of the project at this stage?

1. **[IF YES]** What criteria or rationale did you use in making the decision to choose energy efficiency?

f. Did investors or your lenders have any input into the energy efficiency of this project?

i. Did they ask for energy efficiency above Title 24 code?

g. For this project, did your firm decide how efficient you wanted the project to be before or after you went out to secure financing?

i. Is that your standard practice?

ii. Do you have any rules of thumb for estimating the additional costs of building more efficient than Title 24?

i. **[IF YES]** What are those rules of thumb?

iii. What do you do if your energy efficiency goals for a project are different than what lenders or investors want?

h. Compared to other factors, how important did you expect energy efficiency to be to your target market for this [NAME OF PROJECT] project?

i. What consumer segment(s) did you have in mind [for this project]?

i. Are there specific consumer segments that seek out energy efficient construction in your market rate projects?

i. Which ones are those? [PROBE: Higher end / luxury? Green?]

ii. Why are they more inclined to seek out energy efficient construction?

ii. Are there green programs or certificates that have more cachet and are asked about by homeowners or renters?

j. Compared to standard efficiency buildings, how much of a premium do you charge on the sale prices or rents for the energy efficiency of this project?

k. Did any of the programs or policies that we have discussed have an impact on how efficiently you build?

i. Which programs?

ii. How so?

IF AWARE OF IOU MFNC PROGRAM

l. Did the utility program affect how efficiently you built this project? How so?

m. Why did you not participate in the utilities' incentive program for this project?

i. Probe: too expensive? Too difficult?

STANDARD EFFICIENCY

11. We're really interested in understanding the decision process that developers go through in building to the efficiency standards that they do, and whether there is some person, or program, or requirement driving their decisions.

a. What was your role in determining the energy efficiency of the project?

b. Why did you decide to build your [NAME OF PROJECT] project to the efficiency standard that you did?

i. How did you decide between using budget on energy efficiency upgrades as opposed to spending that money on other, non-energy parts of the project?

i. IF NEEDED/EXAMPLE: Why did you decide to spend your money on EE instead of granite countertops; what factors determined the priority?

ii. PROBE ON BUILDING CHARACTERISTICS THAT ARE STANDARD EFFICIENCY BUT COMMONLY HIGHER EFFICIENCY IN PROGRAM PROJECTS

c. To what extent did this project integrate energy efficiency considerations throughout the entire planning and design process?

i. Did you build the common areas and individual units to different efficiency levels?

IF DIFFERENT EFFICIENCY LEVELS

1. How are they different, efficiency-wise?
2. Why did you make such a differentiation between the common areas and individual units?
3. Who made the decision to do so?

d. During what stage of the project cycle did you first start making key decisions about the project's energy efficiency?

EXAMPLES OF STAGES:

1. Project Concept,
2. Project Feasibility Assessment,
3. Securing Financing,
4. Applying for CTCAC,
5. Zoning and Permitting,
6. Design (design team selection, Design / building plan),
7. Pre-construction (contractor selection, construction plans),
8. Construction (construction plans, materials and equipment procurement, construction),

ii. Could the building have been made more efficient if the decision regarding its energy efficiency had been made at another stage?

i. **[IF YES]** At what stage? and why?

iii. Were there other key stages in the project cycle when energy-efficiency decisions were made?

i. **[IF YES]** What were they?

FOR EACH STAGE MENTIONED

ii. What was the nature of the energy efficiency decision at this stage?

iii. Who in your organization made that decision?

1. **IF MULTIPLE PEOPLE**: Was there somebody who was the primary decision-maker? Who?

iv. Were there any other people or entities outside your organization who were significant influencers of the decision at this stage? Who?

e. Did investors or your lenders have any input into the energy efficiency of this project?

i. Did they ask for energy efficiency above Title 24 code?

f. For this project, did your firm decide how efficient you wanted the project to be before or after you went out to secure financing?

i. Is that your standard practice?

ii. Do you have any rules of thumb for estimating the additional costs of building more efficient than Title 24?

i. **[IF YES]** What are those rules of thumb?

iii. What do you do if your energy efficiency goals for a project are different than what lenders or investors want?

g. Compared to other factors, how important did you expect energy efficiency to be to your target market for this [NAME OF PROJECT] project?

h. What consumer segment(s) did you have in mind for this project?

i. Are there specific consumer segments that seek out energy efficient construction in your market rate projects?

i. Which ones are those? [PROBE: Higher end / luxury? Green?]

ii. Why are they more inclined to seek out energy efficient construction?

ii. Are there green programs or certificates that have more cachet and are asked about by homeowners or renters?

i. Compared to standard efficiency buildings, how much of a premium do you charge on the sale prices or rents for energy-efficient projects?

j. Did any of the programs or policies that we have discussed have an impact on how efficiently you build?

i. Which programs?

ii. How so?

IF AWARE OF IOU MFNC PROGRAM

k. Did the utility program affect how efficiently you built this project? How so?

l. Why did you not participate in the utilities' incentive program for this project?

i. Probe: too expensive? Too difficult?

Above-Code Practices and Decision Process – Other Projects (Spillover)

Next, I have a few questions about the other multifamily projects you started from 2010 through 2012. **[IF PARTIAL PARTICIPANT]** Please think about the projects that did **NOT** participate in the utilities' new construction incentive programs.

12. How does the energy efficiency of your typical, non-program project compare to the statewide Title 24 standards?

13. Why do you typically build to this level of energy efficiency?

    a. What factors affect the energy efficiency of a typical project?

IF AWARE OF IOU MFNC PROGRAM

14. Did the utilities' programs have any influence on the efficiency level of your other non-program projects?

15. **[IF YES]** What was the influence of the utilities' programs on the efficiency level of your other non-program projects? Please use a scale of 0 to 10 where 0 is 'no influence' and 10 is 'a great deal of influence'

    a. Why did you rate the utility program in this way?

    b. How many other projects did the utilities' programs influence?

    c. Approximately how many units total were in all of those projects?

    d. [If > 0]: On average, how much more efficient were your non-program projects because of the utilities' programs?

16. Have you or your staff participated in any utility training on energy efficient construction or design practices?

    a. **[IF YES]** To what extent have you applied the design and construction techniques that you learned from utilities' trainings into your non-program?

    b. [**IF PARTIAL PARTICIPANT]** To what extent have you applied the design and construction techniques that you learned from the programs' design assistance into your non-program projects?

    c. [**IF RECEIVED TRAINING**] Does the training make it easier for you to meet the requirements of future code cycles?

    d. **[IF PARTIAL PARTICIPANT]** Does the design assistance make it easier for you to meet the requirements of future code cycles?

IF AWARE OF OTHER PROGRAMS/POLICIES

17. **REACH CODE BUILDER**: To what extent do you carry over your EE practices from reach code areas to your work in non-reach code areas?
18. **CTCAC PARTICIPANT**: To what extent do you carry over your EE practices from CTCAC projects to other projects?
19. **PARTICIPATED IN ANY OTHER PROGRAMS**: To what extent do you carry over your EE practices from other programs, such as LEED or GPR, to other projects? [PROBE FOR SPECIFIC PROGRAMS]

Awareness and understanding of ZNE building practices

20. Are you familiar with the idea of Zero Net Energy building practices?

IF NEEDED: ZNE buildings use no more energy over the course of the year than they produce. These buildings achieve ZNE first through high levels of energy efficiency, and then through the addition of clean, on-site renewable power generation, typically solar PV.

IF FAMILIAR

a. To what extent did ZNE play in your efficiency goals for this project?
b. What is the consumer demand for ZNE?

Contact information – decision makers and influencers

21. Earlier you mentioned several individuals who were key decision makers or influencers of the energy efficiency of this project.

Could you provide the contact information for these individuals**? [RECORD NAME, PHONE NUMBER, EMAIL ADRESS]**

We would like to speak with the key people involved in affecting the project's energy efficiency

a. Architects,
b. HERS raters,
c. Title 24 Consultants
d. etc.

Conclusion

22. Those are all the questions I have. Do you have any final thoughts to add that would help us better understand the main factors that affect how efficiently you build your multifamily projects?

Thank you so much for your time, etc.

F.2.2 Architect/Engineer Interview Guide

Introduction

[Note: introduction may differ from this wording as most design professionals will have been already contacted about the nature of the interviews via email or phone prior to the actual interview date. Those initial contacts will provide much of the below context prior to the interview, and the entirety of the info below will not have to be repeated at the start of every interview.]:

Hi, this is _____ from [COMPANY]. I am calling on behalf of the California Public Utilities Commission (CPUC). [As we have discussed previously] The CPUC has asked us to conduct interviews with members of the building design and construction industry in order to better understand the multifamily new construction market, energy efficiency, and the California Investor Owned Utilities' (the 'utilities') multifamily new construction programs. We're looking at the effects of the California utilities multifamily new construction program, and we're trying to focus on the 2010 through 2012 time period.

The interviews will discuss the multifamily new construction market generally, but will focus on a particular multifamily new construction project that you worked on, built by [DEVELOPER] at [ADDRESS] called [PROJECT NAME] that was chosen to serve as a case study. This was a [TYPE OF PROJECT: PROVIDE DESCRIPTION – STORIES, DATE STARTED/COMPLETED, etc.]. We are particularly interested in learning more about your recollection of that project's energy efficiency.

Can you confirm that you were the architect or engineer who worked on that multifamily project?

[IF YES, CONTINUE]

[IF NO, SET UP CALLBACK]

Great. We are offering $150 for you to talk to us about your experience on that project related to its energy efficiency, and we expect the interview will take between 30 minutes and an hour. All your responses will be held confidential - this is, we never link any information to a particular person or company. Is now a good time to talk?

[IF YES, CONTINUE]

[IF NO, RESCHEDULE, OR PROBE TO FIND CORRECT CONTACT AS NECESSARY]

[IF INTERVIEWEE ASKS ABOUT THE STUDY'S SPONSORSHIP, REFER TO Cathy Fogel of the CPUC, at (415) 703-1809]

Respondent Background

First I have a few questions about you and your company's residential construction practices.

1. What is your job title and role at your company?

2. Do you have a working knowledge of the Title 24 energy efficiency requirements for multifamily new construction in California?

[IF RESPONDENT DOES NOT HAVE WORKING KNOWLEDGE OF TITE 24, ASK TO SPEAK TO COLLEAGUE WHO IS FAMILIAR WITH BOTH THE CASE STUDY PROJECT AND TITLE 24]

3. For the purpose of this interview, when I talk about multifamily projects, we're just interested in standard residences, not assisted living facilities, hotels, or dorms. About how many multifamily new construction projects did your firm design or consult on in California from 2010 through 2012?

4. Could you estimate how many units were in all of those projects?

5. Roughly what percentage of those units were affordable housing units?

6. What percentage of your California multifamily new construction projects in that time frame were low-rise and what percentage of the projects were high-rise?

IOU Program Awareness and Participation

7. Do you have experience working with the utility companies' multifamily new construction program?

[IF NEEDED]: California Advanced Homes Program (CAHP) SPONSORED BY SCE, SDG&E AND SCG or California Multifamily New Homes Program (CMFNH) SPONSORED BY PG&E

[IF NEEDED] The program offers training and pays incentives for building more efficiently than Title 24 requires

[IF YES]

i. How many program projects did you work on from 2010 through 2012?

ii. How many total units did they have?

8. In a sentence or two, can you describe your understanding of the utility CAHP/MFNH program's energy efficiency requirements?

9. Now I'm going to read you the names of some programs that encourage the installation of energy-efficient features in multifamily homes, and I'm going to ask you if you have ever worked on projects that participated in them:

	Have any of your MF projects ever participated in [PROGRAM]
California Tax Credit Allocation Committee (CTCAC) affordable housing programs	
LEED for Homes	

GreenPoint Rated	
ENERGY STAR Certified Buildings	
Enterprise Green Communities	

10. [IF PARTICIPATED IN NON-IOU PROGRAMS] My understanding is that your project at [ADDRESS] went through the [NAME OF PROGRAMS] program. How did the decision to pursue that certification come about?

11. [IF PARTICIPATED IN CTCAC PROGRAMS] How easy or challenging was it to comply with CTCAC's efficiency requirements?

a. Why?

Role in Case Study Project

12. What were your main responsibilities on the project at [ADDRESS]?

13. Who hired you to work on this project? The builder? The general contractor? Somebody else?

14. Over the course of the project, did you primarily report to the builder, the general contractor or somebody else?

15. Was this a design-bid-build or a design build project? Or something else?

a. Does the type of project, such as design-bid-build or a design build, affect the energy efficiency of a project? How so?

Energy Efficiency Performance and Decision Making

16. As you may know, some municipalities in California enforce Reach Code energy efficiency standards that exceed Title 24, typically by 15%. Our understanding is that the project at [ADDRESS] [WAS/WAS NOT] subject to reach code requirements. How did the energy efficiency of the [NAME] project compare to what was required by code in that area when it was being built?

a. Was it right at code,

b. a little more efficient, or

c. a lot more efficient?

17. [INCLUDE PROJECT DETAILS HERE; PROBE ON ANY EE FEATURES NOT MENTIONED BY INTERVIEWEE] Were there any particular practices that you think allowed it to achieve that level of energy efficiency?

18. PLACEHOLDER FOR QUESTION(S) THAT DRAW ON BUILDER AND OTHER INTERVIEWS

19. [ASK IF ARCHITECT/ENGINEER ASSESSMENT OF EFFICIENCY DIFFERS SUBSTANTIALLY FROM ONSITE RESULTS]

You estimated that your [NAME OF PROJECT] project is [INSERT RESPONDENT'S ASSESSMENT OF EFFICIENCY] but our site visit suggests that the project is less efficient than you expected.

Why do you think that is?

[PROBE ON BUILDING CHARACTERISTICS FROM ONSITE DATA THAT ARE RESPONSIBLE FOR LOWER EFFICIENCY]

20. Why did the design team decide to build it to the efficiency level you/they did?

a. Were there any particular programs or policies that drove them to do that?

21. How much of a priority was energy efficiency for the builder on this project?

22. How did the builder and design team develop their efficiency goals?

23. To what extent were your efficiency goals on the project in line with the builder's?

24. Did the builder approach you with clear energy efficiency goals for the project already in place?

25. To what extent did the builder have clear preferences for the specific types of design and construction practices to meet their efficiency targets?

a. What input did you have on the energy efficiency measures installed in this project?

b. Did you push for them to adopt certain practices, or did they know what they wanted to do already?

c. At what stages in the project cycle was your input sought?

d. Could the project have been more energy efficient if your input had been sought at an earlier stage? In what way?

e. Were there any barriers that limited your ability to advise the project team on improving the project's energy efficiency?

f. Did the project change its approach to energy efficiency or the measures installed as a result of your input? In what way?

26. To what extent were energy efficiency considerations integrated throughout the entire planning and design process, as opposed to just at specific project stages?

27. How did the design team make decisions about whether to use budget on energy efficiency upgrades as opposed to spending that money on other, non-energy parts of the project?

a. Who made those kinds of decisions?

28. During what stage of the project cycle do you think that key decisions about the project's energy efficiency started being made?

[IF ANY DECISIONS MADE AFTER START]

a. Could the building have been made more efficient if those decisions about energy efficiency had been made at a different stage in the project?

    i. At what stage and why?

29. During what other stages of the project cycle were key decisions about the project's efficiency made?

[FOR EACH STAGE MENTIONED]

1. What kind of decisions, and who was making them?

30. Did your team differentiate between this project's common areas and individual units when making decisions about energy efficiency?

[IF YES]

i. In what way?

ii. Why did the project make such a differentiation?

iii. Who made the decision to do so?

31. This was a [LOW/HIGH] rise, [MARKET-RATE/AFFORDABLE] project. How efficient was it compared to similar projects started in the area from around the same time period?

a. **[IF DIFFERENT]** Why do you think this project differed from others?

Reach Code [IF FAMILIAR WITH REACH CODES]:

32. From 2010 through 2012, did you work with any MF projects in jurisdictions where Reach Codes were in effect? **[IF YES]**

a. How easy or challenging is it for design teams to comply with the reach codes for multifamily projects?

b. How so?

c. Is there any difference between municipalities regarding how easy it is to comply with reach code?

    i. What and where are the differences?

d. How about the enforcement of reach codes…

    i. Are there differences between jurisdictions in terms of enforcement of reach codes?

    ii. Are there more hassles in some jurisdictions?

Program [IF AWARE OF THE PROGRAM]

33. Did the utility CAHP/MFNH program affect the energy efficiency of this project? How so?

34. Why did this project not participate in the utilities' CAHP/MFNH incentive program? (Probe: too expensive? Too difficult? Who decided that?)

Above-Code Practices and Decision Process – Other Projects (Spillover)

[IF AWARE OF THE PROGRAM] I have a few questions about the other multifamily projects you started from 2010 through 2012. Please think about the projects you worked on that did **NOT** participate in the utilities' CAHP/MFNH incentive programs.

35. In general, to what extent, if any, have the utilities' MFNC programs influenced your energy efficiency practices in non-program multifamily projects? In what way?

36. How does the energy efficiency of a typical, non-CAHP/MFNH utility program project that you might work on compare to the statewide Title 24 standards?

a. Who is making the decisions about energy efficiency on those projects?

37. Do you ever work on multifamily projects with builders who have never worked on projects going through the utilities' CAHP/MFNH incentive programs?

a. **[IF YES]** Do they think about the energy efficiency of their projects differently than builders who have gone through the utility CAHP/MFNH program? How so?

b. **[IF DIFFERENCE]** To what extent is that difference attributable to the CAHP/MFNH utility program as opposed to other programs, like LEED, or GreenPoint Rated, or the CTCAC affordable housing programs?

c. **[IF NOT ANSWERED ABOVE]** To what extent do the builders who HAVE worked with the utilities' CAHP/MFNH incentive programs carry over their EE practices to non-program projects?

d. Do you ever work on multifamily projects with builders who have never worked on projects going through the CTCAC affordable housing program?

i. **[IF YES]** Do they think about the energy efficiency of their projects differently than builders who have gone through the CTCAC affordable housing program? How so?

38. To what extent do design teams carry over their EE practices from reach code areas to their work in non-reach code areas?

39. [IF WORKED ON TCAC PROJECTS] To what extent do design teams carry over their EE practices from CTCAC affordable housing projects to other projects?

40. To what extent do design teams carry over their EE practices from other programs, such as LEED or GPR, to other projects that aren't going through those programs? **[PROBE FOR SPECIFIC PROGRAMS]**

Awareness and understanding of ZNE building practices

41. Are you familiar with the idea of Zero Net Energy building practices?
[IF YES]

a. To what extent was ZNE a goal for this project?

b. To what extent are the builders you work with familiar with ZNE practices?

Design Assistance

42. For projects that go through the utilities' CAHP/MFNH incentive programs, the utilities offer design assistance to the design team on those projects to help them attain higher energy efficiency levels. Have you received design assistance on any multifamily projects going through the utilities' CAHP/MFNH incentive program?

[IF YES]

a. We're curious about how the construction industry carries over its practices from one type of circumstance to another. Using a rating scale of 0 to 10 where 0 is 'no influence' and 10 is 'a great deal of influence," could you tell me, what is the influence of the CAHP/MFNH design assistance offerings on the efficiency level of non-program projects you worked on?

b. Why did you rate the CAHP/MFNH design assistance that way?

Trainings

43. Similarly, beyond the design assistance that the utilities' CAHP/MFNH program offer on specific program projects, some of the utility companies' CAHP/MFNH programs have offered trainings about energy-related topics, such as efficient construction practices, or the efficiency requirements in upcoming code cycles. Have you participated in any of those utility trainings?
[IF YES]

a. Using [the same/a] rating scale of 0 to 10 where 0 is 'no influence' and 10 is 'a great deal of influence," could you tell me, what is the influence of the utilities' trainings on the efficiency level of non-program projects you worked on?

b. Why did you rate the training that way?

44. Have you participated in any other trainings that helped you perform your design work on California multifamily projects?

a. **[IF YES]** Who sponsored the trainings?

45. [IF ATTENDED MULTIPLE TRAININGS] Thinking about all of these trainings related to energy-efficient construction for multifamily projects, which is the most important in terms of pushing energy efficiency construction practices beyond Title 24?

a. Why do you say that?

Conclusion

46. Those are all the questions I have. Do you have any final thoughts to add that would help us better understand the main factors that affect how efficiently the multifamily projects you work on are built?

Thank you so much for your time, etc.

F.2.3 Energy Consultant (HERS Rater, Title 24 Consultant, etc.) Interview Guide

Note that this guide was modified on a case-by-case basis for use with Title 24 consultants, GreenPoint Raters, and so forth, given that these roles were often similar or overlapping.

Introduction

[Note: introduction may differ from this wording as most HERS raters will have been already contacted about the nature of the interviews via email or phone prior to the actual interview date. Those initial contacts will provide much of the below context prior to the interview, and the entirety of the info below will not have to be repeated entirely at the start of every interview.]:

Hi, this is _____ from [COMPANY]. I am calling on behalf of the California Public Utilities Commission (CPUC). [As we have discussed previously] The CPUC has asked us to conduct interviews with energy consultants in order to better understand the multifamily new construction market, energy efficiency, and the California Investor Owned Utilities' (the 'utilities') multifamily new construction programs. We're looking at the effects of the California utilities multifamily new construction program and we're trying to focus on the 2010 through 2012 time period.

The interview will discuss the multifamily new construction market generally, but will focus on a particular multifamily new construction project that you worked on, built by [DEVELOPER] at [ADDRESS] called [PROJECT NAME] that was chosen to serve as a case study. This was a [TYPE OF PROJECT: PROVIDE DESCRIPTION – STORIES, DATE STARTED/COMPLETED, etc.]. We are particularly interested in learning more about your recollection of that project's energy efficiency.

Can you confirm that you were the [HERS Rater, GreenPoint Rater, Title 24 consultant, etc.] who worked on that multifamily project?

[IF YES, CONTINUE]

[IF NO, SET UP CALLBACK]

Great. We are offering $150 for you to talk to us about your experience on that project related to its energy efficiency, and we expect the interview will take between 30 minutes and an hour. All your responses will be held confidential - this is, we never link any information to a particular person or company. Is now a good time to talk?

[IF YES, CONTINUE]

[IF NO, RESCHEDULE, OR PROBE TO FIND CORRECT CONTACT AS NECESSARY]

[IF INTERVIEWEE ASKS ABOUT THE STUDY'S SPONSORSHIP, REFER TO Cathy Fogel of the CPUC, at (415) 703-1809]

HERS Rater Background

[MODIFY QUESTIONS AS APPLICABLE TO INDIVIDUAL RESPONDENT.]

1. In addition to working as a HERS rater, do you also work as a Title 24 energy efficiency consultant in California?
    a. [IF YES] Were you both the Title 24 consultant and HERS rater on the project at [ADDRESS]?
    b. [IF YES, BOTH TITLE 24 CONSULTANT AND HERS RATER] Is more of your business related to Title 24 consulting or HERS rating?
2. Are you certified as a Certified Energy Plans Examiner (CEPE)?
3. For the purpose of this interview, when I talk about multifamily projects, we're just interested in standard residences, not assisted living facilities, hotels, or dorms. As a [RESPONDENT ROLE], about how many multifamily new construction projects did you review in California from 2010 through 2012?
4. Could you estimate how many units were in all of those projects?
5. Roughly what percentage of those units were affordable housing units?
6. Do you do HERS/consulting work on low- and high-rise multifamily projects?

IOU Program Awareness and Participation

7. Do you have experience working with the utility companies' multifamily new construction program? [IF NEEDED: California Advanced Homes Program (CAHP) SPONSORED BY SCE, SDG&E AND SCG or California Multifamily New Homes Program (CMFNH) SPONSORED BY PG&E.; IF NEEDED: The program offers training and pays incentives for building more efficiently than Title 24 requires]
    a. [IF YES:] How many program projects did you work on from 2010 through 2012?
        i. How many total units did they have?
8. In a sentence or two, can you describe your understanding of the utility program's energy efficiency requirements?
9. Now I'm going to read you the names of some programs that encourage the installation of energy-efficient features in multifamily homes, and I'm going to ask you if you have ever worked with projects that have participated in them:

	Have any of your MF projects ever participated in [PROGRAM]
California Tax Credit Allocation Committee (CTCAC) affordable housing programs	

LEED for Homes	
GreenPoint Rated	
ENERGY STAR Certified Buildings	
Enterprise Green Communities	

Role in Case Study Project

10. What were your main responsibilities on the project at [ADDRESS]?
11. [IF NOT ANSWERED] Did you prepare the Title 24 paperwork for the project?
12. [IF NOT ANSWERED] Did you perform onsite inspections?
13. [IF NOT ANSWERED] Were you responsible for qualifying the project for any green building certifications?
    a. Which ones?
14. Did you see your role mainly as one of ensuring code compliance, or as an advisor to the builder, or something else [IF NEEDED: By advisor, we mean advising a project to help it qualify for a green building certification]?
    a. Was this project different in that regard from your other typical projects?
        i. [IF YES] How so?

Energy Efficiency Performance and Decision Making

15. As you may know, some municipalities in California enforce Reach Code energy efficiency standards that exceed Title 24, typically by 15%. Our understanding is that the project at [ADDRESS] [WAS/WAS NOT] subject to reach code requirements. How did the energy efficiency of the [NAME] project compare to what was required by code in that area when it was being built?
    a. [IF NEEDED: Was it right at code, a little more efficient, a lot more efficient?]
    b. [INCLUDE PROJECT DETAILS HERE; PROBE ON ANY EE FEATURES NOT MENTIONED BY INTERVIEWEE]
16. PLACEHOLDER FOR QUESTION(S) THAT DRAW ON OTHER INTERVIEWS, SUCH AS BUILDER AND CODE OFFICIAL INTERVIEWS]
17. Why do you think that the builder decided to build it that way?
    a. [Probe: Were there any particular programs or policies that drove them to do that?]
18. How much of a priority was energy efficiency for the builder on this project?

19. Did the builder and design team approach you with clear energy efficiency goals for the project already in place?
20. How did they develop their efficiency goals?
21. To what extent did the builder have clear preferences for the specific types of measures to install to meet their efficiency targets?
    a. What input did you have on the energy efficiency measures installed in this project?
        i. [PROBE:] Did you push for them to adopt certain practices, or did they know what they wanted to do already?
    b. At what stage was your input sought?
    c. Could they project have been more energy efficient if your input had been sought at an earlier stage? In what way?
    d. Were there any barriers that limited your ability to advise the project on improving its energy efficiency?
    e. Did the project change its approach to energy efficiency or the measures installed as a result of your input? In what way?
22. To what extent did the builder integrate energy efficiency considerations throughout the entire planning and design process?
23. How do you think the design team made decisions about whether to use budget on energy efficiency upgrades as opposed to spending that money on other, non-energy parts of the project?
    a. Who made those kinds of decisions?
24. During what stage of the project cycle do you think that key decisions about the project's energy efficiency started being made?
    a. [IF THEY SAY ANYTHING OTHER THAN AT THE VERY START OF THE PROJECT:] Could the building have been made more efficient if those decisions about energy efficiency had been made at a different stage in the project?
        i. At what stage and why?
25. During what other stages of the project cycle were key decisions about the project's efficiency made?
    a. [Probe:] At what stages?
    b. Who was making those decisions?
26. Was there anything specific about the energy-efficiency of the project that stood out to you?

27. During your review, did you find any serious issues related to energy efficiency that needed to be fixed?
    a. What kinds of issues did you find, and how were they resolved?
28. Did this project differentiate between common areas and individual units when making decisions about energy efficiency?
    a. IF YES:
        i. In what way?
        ii. Why did the project make such a differentiation?
        iii. Who made the decision to do so?
29. This was a [LOW/HIGH] rise, [MARKET-RATE/AFFORDABLE] project. How efficient was it compared to similar projects started in the area from around the same time period?
    a. [IF DIFFERENT] Why do you think this project differed from others?

Reach Code

30. [IF FAMILIAR WITH REACH CODE AREAS:] From 2010 through 2012, did you work with any MF projects in jurisdictions where Reach Codes were in effect?
    a. How easy or challenging is it for builders to comply with the reach codes for multifamily projects?
    b. How so?
    c. Is there any difference between municipalities regarding how easy it is to comply with reach code?
        i. What and where are the differences?
    d. How about the enforcement of reach codes? Are there differences between jurisdictions in terms of enforcement of reach codes? Are there more hassles in some jurisdictions?

Program

31. [IF AWARE OF THE PROGRAM] Did the utility program affect the energy efficiency of this project? How so?
32. Why did this project not participate in the utilities' incentive program?
    a. Probe: too expensive? Too difficult?

Above-Code Practices and Decision Process – Other Projects (Spillover)

33. In general, to what extent have the utilities' MFNC programs influenced the way you review the energy efficiency of multifamily projects?
    a. IF HAVE INFLUENCED: In what way?

34. How does the energy efficiency of a typical, non-utility program project that you might work on compare to the statewide Title 24 standards?

35. Do you ever work on multifamily projects with builders who have never worked on projects going through the utilities' incentive programs?

    a. [IF YES] Do they think about the energy efficiency of their projects differently than builders who have gone through the utility program? How so?

    b. [IF THERE IS A DIFFERENCE:] To what extent is that difference attributable to the utility program as opposed to other programs, like LEED, or GreenPoint Rated, or the CTCAC affordable housing programs?

    c. Do you ever work on multifamily projects with builders who have never worked on projects going through the CTCAC affordable housing program?

    d. [IF YES] Do they think about the energy efficiency of their projects differently than builders who have gone through the CTCAC affordable housing program? How so?

36. To what extent do the builders who HAVE worked with the utilities' incentive programs carry over their EE practices to non-program projects?

37. To what extent do your builders carry over their EE practices from reach code areas to their work in non-reach code areas?

38. [IF WORKED ON TCAC PROJECTS:] To what extent do your builders carry over their EE practices from CTCAC affordable housing projects to other projects?

39. To what extent do your builders carry over their EE practices from other programs, such as LEED or GPR, to other projects that aren't going through those programs?

    a. [PROBE FOR SPECIFIC PROGRAMS]

Awareness and understanding of ZNE building practices

40. Are you familiar with the idea of Zero Net Energy building practices?

41. [IF YES] To what extent was ZNE a goal for this project?

42. To what extent are the builders you work with familiar with ZNE practices?

Design Assistance

43. For projects that go through the utilities' incentive programs, the utilities offer design assistance to the builder and design team on those projects to help them attain higher energy efficiency levels. Have you ever participated in any of that design assistance on any multifamily projects going through the utilities' incentive program?

44. To what extent does the construction industry carry over the practices they learned from those utility design assistance offerings into their other projects that do not go through the utilities' incentive programs. Using a rating scale of 0 to 10 where 0 is 'no influence' and 10 is 'a great

deal of influence," could you tell me, what is the influence of the utilities' design assistance offerings on the efficiency level of non-program projects you worked on?

a. Why did you rate the utility program that way?

Trainings

45. Similarly, beyond the design assistance that the utilities offer on specific program projects, some of the utility companies have offered trainings about energy-related topics, such as efficient construction practices, or the efficiency requirements in upcoming code cycles. Have you participated in any of those utility trainings?

    a. [IF YES to IOU TRAININGS:] Using the same rating scale of 0 to 10 where 0 is 'no influence' and 10 is 'a great deal of influence," could you tell me, what is the influence of the utilities' trainings on the efficiency level of non-program projects you worked on?

    b. Why did you rate the utility program that way?

46. Have you participated in any other trainings that helped you perform your HERS-related work in California multifamily projects?

    a. [IF YES] Who sponsored the trainings?

47. [IF ATTENDED MULTIPLE TRAININGS] Thinking about all of these trainings related to code or energy-efficient construction for multifamily projects, which is the most important in terms of pushing energy efficiency construction practices beyond Title 24?

    a. Why do you say that?

Conclusion

48. Those are all the questions I have. Do you have any final thoughts to add that would help us better understand the main factors that affect how efficiently the multifamily projects you work on are built?

Thank you so much for your time, etc.

F.2.4 Code Official Interview Guide

Introduction

[Note: We will be building on existing relationships with code officials and information from the builder interviews. As a result, we may know the code official to talk with. Accordingly, the introduction on the phone may differ from the wording below as code officials may have been already contacted about the nature of the interviews via email or phone prior to the actual interview date. Those initial contacts will provide much of the below context prior to the interview, and this will not have to be repeated entirely at the start of every call. We also plan to contact each code official via email before the interview in order to provide them with a few photos and a description of the project in order to jog their memory.]:

Hi, this is _____ from Cadmus Group. I am calling on behalf of the California Public Utilities Commission (CPUC). The CPUC has asked us to interview building code officials as a part of a study about energy efficiency in the multifamily new construction market.

I was hoping you could connect me with [NAME OF CODE OFFICIAL IDENTIFIED BY DEVELOPER/T24 PAPERWORK].

[IF COLD-CALLING A DEPARTMENT WHERE WE DO NOT KNOW THE CODE OFFICIAL:]

We would like to talk with the building inspector who would have been most responsible for overseeing a particular multifamily project, built by [DEVELOPER] at [ADDRESS].]

[IF NECESSARY:]

[Alternatively, we'd like to speak with the main building inspector in your office who works on multifamily projects, including low-rise and high-rise buildings. May I please have that person's name and job title?

[RECORD NAME AND JOB TITLE]

May I please speak to that person?]

[WHEN CORRECT PERSON IS ON-LINE, REPEAT INFO FROM ABOVE AS NEEDED, AND CONTINUE:]

Can you confirm that you are the code official in [JURISDICTION] who worked on the multifamily project at [ADDRESS] [or who works with multifamily new construction projects]?

[IF YES, CONTINUE]

[IF NO, PROBE TO FIND CORRECT CONTACT]

Great. We would like to get a better idea of how energy efficiency fits into multifamily new construction projects. The CPUC is also interested in learning about the potential effects of the utilities' multifamily new construction programs that encourage efficient building practices.

The interview will focus on a particular multifamily new construction project, built by [DEVELOPER] at [ADDRESS] called [PROJECT NAME] to serve as a case study. This was a

[TYPE OF PROJECT: PROVIDE DESCRIPTION – STORIES, DATE STARTED/COMPLETED, etc.]. We are particularly interested in learning more about your recollection of that project's energy efficiency.

We expect the interview will take around 30 minutes. All your responses will be held confidential - that is, we never link any information to a particular person or building department. Is now a good time to talk?

[IF YES, CONTINUE]

[IF NO, PROBE TO FIND CORRECT CONTACT]

[IF INTERVIEWEE ASKS ABOUT THE STUDY'S SPONSORSHIP, REFER TO Cathy Fogel of the CPUC, at (415) 703-1809]

Warm-Up Questions

1. [Obtain prior to interview, if possible:] What is your job title?
2. [IF NOT CLEAR ALREADY] What cities or towns are included in your jurisdiction?

Building Activity in the Area

3. For the purpose of this interview, when I talk about multifamily projects, we're just interested in standard residences, not assisted living facilities, hotels, or dorms. About how many multifamily new construction projects started construction in your jurisdiction from 2010 through 2012?
4. Could you estimate how many units were in all of those projects?
5. Roughly what percentage of those units were affordable housing units?

Role in Case Study Project

6. What was your role in reviewing the multifamily project at [ADDRESS]?
7. [IF NOT ANSWERED in Q3] Did you do the plan check for the project?
8. [IF NOT ANSWERED in Q3] Did you perform the onsite inspections?

Reach Code Awareness and Participation

[REACH CODE JURISDICTIONS ONLY – IF NON-REACH CODE JURISDICTION, SKIP TO Q12]

9. [REACH CODE AREA ONLY:] Subject to approval by the California Energy Commission (CEC), municipalities in California may enforce Reach Code energy efficiency standards that exceed Title 24, typically by 15%. Our understanding is that reach code went into effect in your jurisdiction in [YEAR]. Is that correct?

10. [REACH CODE AREA ONLY:] In a sentence or two, could you describe how reach code in your area differs from the standard Title 24 efficiency requirements for multifamily new construction?

11. [REACH CODE AREA ONLY:] Was the multifamily project at [ADDRESS] subject to Reach Code? [REMIND THEM OF THE DATE OF THE FIRST PERMIT APPLICATION IF NECESSARY.]

Awareness of IOU Programs

12. Are you aware of the utility companies' multifamily new construction program that offers training and pays incentives for building more efficiently than Title 24 requires? [IF NEEDED: California Advanced Homes Program (CAHP) SPONSORED BY SCE, SDG&E AND SCG or California Multifamily New Homes Program (CMFNH) SPONSORED BY PG&E.]

[IF NO, SKIP TO Q14.]

13. [ONLY IF THEY KNOW OF THE IOU PROGRAM:] In a sentence of two, can you describe your understanding of the utility program's energy efficiency requirements? [

Level of Performance Relative to Code

14. Now I'm going to read you the names of some other programs that encourage the installation of energy-efficient features in multifamily homes, and I'm going to ask you if the project at [ADDRESS] participated in any of them.

	Did the [NAME] project at [ADDRESS] participate in [PROGRAM]?
California Tax Credit Allocation Committee (CTCAC) affordable housing programs	
LEED for Homes	
GreenPoint Rated	
ENERGY STAR Certified Buildings	
Enterprise Green Communities	

15. Did it go through any other energy efficiency programs besides the ones we just mentioned?

16. How did the energy efficiency of the [NAME OF PROJECT] project compare to what was required by code in your area when it was being built?

    a. [IF NEEDED: Was it right at code, a little more efficient, a lot more efficient?]

17. Was there anything specific about the energy-efficiency of the project that stood out to you?

a. [INCLUDE PROJECT DETAILS HERE; PROBE ON ANY EE FEATURES NOT MENTIONED BY INTERVIEWEE]

18. PLACEHOLDER FOR QUESTION(S) THAT DRAW ON BUILDER INTERVIEWS]
19. Why do you think that the builder decided to build it that way?
20. [Probe: Were there programs or policies that drove them to do that?]
21. This was a [LOW/HIGH] rise, [MARKET-RATE/AFFORDABLE] project. How efficient was it compared to similar projects started in your jurisdiction from around the same time period?
    a. [IF DIFFERENT] Why do you think this project differed from others?

Plan Check and Title 24 Consultants

[REFER BACK TO THE FIRST INTRO QUESTIONS TO REMIND YOURSELF IF THEY DID THE PLAN CHECK.]

22. When you [or your office] did the plan check, did you find any serious errors related to energy efficiency that needed to be corrected? [Probe if not answered: What kind?]
23. Some builders employ Title 24 consultants who are certified Certified Energy Plans Examiners or CEPEs. Can you typically tell when Title 24 documents were prepared by certified CEPEs as opposed to people who are not certified? [Probe: Is there any difference in the amount of errors you find in the paperwork?]

Onsite Inspections

[REFER BACK TO THE FIRST INTRO QUESTIONS TO REMIND YOURSELF IF THEY DID THE ONSITE INSPECTIONS.]

24. How many site visits did you [or your department] make?
25. How long did each of these take?
26. When you [or your colleagues] were onsite, how much of your [/their] time was devoted to checking for compliance with energy efficiency requirements?
27. Was checking the energy efficiency of this project a low, medium, or high priority in your inspections, relative to the other things you [your colleagues] had to look for? Why?
28. During the inspections, did you find any serious issues related to energy efficiency that needed to be fixed?
29. Did anything about the project's energy efficiency stand out to you when you were onsite?
30. Generally speaking, is there a difference between code officials in reach code and non-reach code areas in regards to the relative priority of energy efficiency
31. In general, what factors determine the amount of time you spend checking for the energy-efficiency aspects of code compliance? [PROBE: To what extent have the IOU MFNC

programs influenced the amount of time you spend checking for the energy-efficiency aspects of code compliance? IF HAVE INFLUENCED: In what way? IF NOT: Why have the IOU MFNC programs not influenced the amount of time you spend checking for the energy-efficiency aspects of code compliance? Does the amount of time you spend checking for the energy-efficiency aspects of code compliance vary by type of project? In what way? Why?]

Trainings

32. Some of the utility companies have offered trainings about energy-related topics, such as efficient construction practices, or the efficiency requirements in upcoming code cycles. Has anyone in your department participated in any of those utility company trainings?
33. [IF YES to IOU trainings] After participating in the utilities' trainings, did you make any changes to the way you check multifamily projects for compliance with the energy-efficiency requirements of Title 24? [PROBE IF THEY DON'T GIVE ANY EXPLANATION: Why do you say that?]
34. Has anyone in your department participated in any other code-related trainings?
    a. [IF YES] Who sponsored the trainings?
35. [IF ATTENDED MULTIPLE TRAININGS] Thinking about all of the code-related trainings, which is the most important in terms of understanding the energy-efficiency requirements of Title 24?
    a. Why do you say that?

Spillover – IOU Programs

36. We've talked about the utility companies' program that offers training and incentives to builders for high efficiency new construction. Using a scale of 0 to 10, where 0 is 'no influence' and 10 is 'a great deal of influence,' could you estimate the influence of this program on the efficiency level on non-program projects in your jurisdiction?
37. Why did you rate the utility program in this way?
38. [IF RATING OF 6 OR HIGHER: How does the program influence the energy efficiency of non-program projects?]
39. Does the utilities' new construction program help developers prepare for meeting the efficiency requirements of new code cycles?
    a. [IF YES] How so?
    b. Does the CTCAC affordable housing program help developers prepare for meeting the efficiency requirements of new code cycles?
    c. [IF YES] How so?

Spillover - Other programs

40. [SKIP IF REACH CODE JURISDICTION] To what extent do builders carry over their EE practices from their work in reach code areas to their work in your jurisdiction?
41. To what extent do builders carry over their EE practices from CTCAC projects to their other projects?
42. To what extent do they carry over their EE practices from other 'green' programs, such as LEED or GPR, to their other projects? [PROBE FOR SPECIFIC PROGRAMS]
43. [ASK OF REACH CODE JURISDICTION]: Do you know if any other localities are thinking about adopting reach codes?
    a. [IF YES] Have any contacted you, asking for advice and your experiences?
    b. [IF YES] what kind of advice have you provided?
44. [ASK OF REACH CODE JURISDICTION] Could your locality have adopted reach codes without the IOU programs? [PROBE IF NO EXPLANATION GIVEN: How so?]

Conclusion

45. Those are all the questions I have. Do you have any final thoughts to add that would help us better understand how energy efficiency is incorporated into your code compliance review process for multifamily projects?

Thank you so much for your time, etc.

F.2.5 Investor/Lender Interview Guide

Introduction

[Note: introduction may differ from this wording as most investors will have been already contacted about the nature of the interviews via email or phone prior to the actual interview date.]:

Hi, this is _____ from NMR Group. I am calling on behalf of the California Public Utilities Commission (CPUC). [As we have discussed previously] The CPUC has asked us to conduct interviews with investors and lenders about the multifamily new construction industry in California in order to better understand the multifamily new construction market, energy efficiency, and the California Investor Owned Utilities' (the 'utilities') multifamily new construction programs. We chose specific projects started from 2010 through 2012 in order to help us better understand the market.

The interviews will discuss the multifamily new construction market generally, but we are going to focus on a project at [ADDRESS], which we understand your organization was involved with. We're particularly interested in learning about how decisions were made about the project's energy efficiency, and how investors think about energy efficiency in multifamily new construction projects. Can you confirm that you would be the best person to speak with at your organization about making investment or lending decisions in the [NAME OF PROJECT] project?

[IF YES, CONTINUE]

[IF NO, SET UP CALLBACK]

Great. We are offering $150 for you to talk to us about your experience on that project related to energy efficiency decisions, and we expect the interview will take between 30 minutes and an hour. All your responses will be held confidential - that is, we never link any information to a particular person or company. Is now a good time to talk?

[IF YES, CONTINUE]

[IF NO, PROBE TO FIND CORRECT CONTACT]

[QUESTIONS ABOUT STUDY'S SPONSORSHIP, REFER TO Cathy Fogel of the CPUC, at (415) 703-1809]

Respondent Background

1. What is your job title and role at your company?
2. For the purpose of this interview, when I talk about multifamily projects, we're just interested in standard residences, not assisted living facilities, hotels, or dorms. About how many multifamily new construction projects in California did your company invest in from 2010 through 2012? [IF RESPONDENT REPORTS ZERO PROJECTS, RECONFIRM THAT

THEY INVESTED IN THE CASE STUDY PROJECT. IF THEY DID NOT INVEST IN THE CASE STUDY PROJECT, THANK AND TERMINATE]

a. Could you estimate how many units were in all of those projects?

b. Roughly what percentage of those units were affordable housing units?

3. What percentage of the California projects you invested in in that time frame were low-rise and what percentage of the projects were high-rise?

IOU Program Awareness

4. We're interested in learning about any potential impacts of the utility companies' multifamily new construction programs. This includes the California Advanced Homes Program (CAHP) SPONSORED BY SCE, SDG&E AND SCG, and the California Multifamily New Homes Program (CMFNH), SPONSORED BY PG&E. These programs offer training and pay incentives to developers for building more efficiently than code requires. Are you aware of these multifamily new construction programs run by the utility companies that promote energy efficient construction?

IF YES:

a. In a sentence or two, can you describe your understanding of the utility program's energy efficiency requirements?

b. This project did not participate in that program. Do you know ahead of time if one of your multifamily investment projects is going to participate in the utilities' incentive program?

IF YES:

i. How do you find out about its participation?

5. Now I'm going to read you the names of some other programs that encourage the installation of energy-efficient features in multifamily homes, and I'm going to ask you first if you have ever heard of them, and then second if you have ever invested in projects that participated in them:

	Have you ever heard of the [NAME] program?	Have you ever invested in projects that participated in [PROGRAM]?
California Tax Credit Allocation Committee (CTCAC) affordable housing programs		
LEED for Homes		
GreenPoint Rated		

ENERGY STAR Certified Buildings		
Enterprise Green Communities		

[IF PARTICIPATED IN NON-IOU PROGRAMS AND NOT MENTIONED ALREADY]

6. My understanding is that your project at [ADDRESS] went through the [NAME OF PROGRAMS] program. Was that something you were aware of?

Role in Case Study Project

7. What were your main responsibilities related to the project at [ADDRESS]?
8. Who approached you regarding lending to or investing in this project? The builder? Somebody else?
   How far along in the design process was the design team when they approached your firm?

Energy Efficiency Performance and Decision Making

9. As far as you know, how did the energy efficiency of the [NAME OF PROJECT] project compare to what was required by code in that area when it was being built?
   a. Much more efficient than code?
   b. Moderately more efficient than code?
   c. Just meeting code?
10. How efficient do you think this project was compared to other similar projects you invested in from around the same time period?
11. Subject to approval by the California Energy Commission, municipalities can chose to enforce energy efficiency requirements on new construction that go above the statewide code, typically by 15%. These elevated energy efficiency requirements are often called Reach Code.

IF REACH CODE AREA:

   a. Our understanding is that the [NAME] project at WAS subject to reach code requirements. Did the project's representatives discuss this with you? [PROBE IF NOT ANSWERED: Were you aware that the building was subject to these Reach Code requirements?]

IF NON-REACH CODE AREA:

   a. Our understanding is that the [NAME] project was NOT subject to reach code requirements. Are you aware of these Reach Codes that are in effect in some parts of California?

b. [ALL RESPONDENTS, IF AWARE OF REACH CODES] How do reach codes affect your decision to invest in a multifamily project, if at all?

12. PLACEHOLDER FOR QUESTION(S) THAT DRAW ON BUILDER AND OTHER INTERVIEWS]

13. Did you or your organization and the project representatives ever discuss the energy efficiency of the project?

IF YES:

a. At what point in the project cycle did you discuss the energy efficiency of the project with the project's representatives?

b. What did you talk about when discussing the energy efficiency performance of the project?
[PROBE: Levels of performance relative to code? Green certifications? Particular pieces of mechanical equipment or construction techniques? Return on investment?]

c. [IF PROJECT WAS BUILT TO ABOVE CODE STANDARDS] To what extent did the project representatives need to try to make a case to you for the value of building the project to above-code standards?

14. Why do you think the design team decided to build it to the efficiency level they did? [PROBE FOR POLICIES, MOTIVATIONS, etc.]

15. How much of a priority was energy efficiency for the builder on this project?

16. Did the builder approach you with clear energy efficiency goals for the project already in place?

17. What input did your firm have, if any, on the energy efficiency of this project?

a. Is that typical for multifamily projects?

b. [IF THEY SAY THEY HAD SOME INFLUENCE ON THE EE:] At what stages in the project cycle did you influence the project's energy efficiency?

18. To what extent were your efficiency goals on the project in line with the developer's?

a. How did any differences get resolved?

19. In your other multifamily projects, are your efficiency goals ever different from the developer's?

IF YES:

a. If so, how do those differences typically get resolved?

20. Were there any discussions between your firm and the design team about whether to build the units to a different energy efficiency standard than the common areas?
IF YES

a. Who discussed this idea?

b. What was their rationale for their approach?

21. Does your organization require multifamily new construction projects to meet any particular levels of energy efficiency performance in order to lend to/invest in them?

IF YES:

a. What are those requirements/preferences?

b. Why did your firm you choose those particular requirements? Who made that decision?

c. How and when do you communicate those preferences/requirements to developers?

d. Would you ever ask developers to build more efficiently than code requires? Why?

e. Do you have different standards for different types of multifamily new construction projects?

IF YES:

i. How do they differ? [PROBE for high-rise vs. low-rise]

ii. Did you require the developer on the [NAME] project to follow those guidelines?

IF NO:

iii. To what extent does energy efficiency factor into your decisions about investing in a project? How so?

iv. Why does your firm take that approach?

v. Who makes those decisions? A particular person, or is there a policy in place?

vi. Would you ever ask developers to build more efficiently than code requires? Why or why not?

22. On this project, did your firm express preferences for how the design team allocated their budget for energy efficiency upgrades as opposed to spending that money on other, non-energy parts of the project? How so?

a. IF NEEDED/EXAMPLE: Did you have guidance on how they were supposed to prioritize spending money on EE instead of granite countertops, for example; what factors determined that priority?

b. Is that typical for multifamily projects you invest in?

23. We discussed the utility companies' new construction program that pays incentives for building more efficiently than code requires. This project did not participate in that program.

Why do you think that the development team did not participate in the utilities' incentive program for this project?

ii. Probe: too expensive? Too difficult?

24. What are the ownership plans for the project when it is complete? Do you or the developer intend to own and manage the project, sell individual units, sell the project when it is complete, or something else?
    a. Do your energy efficiency goals or requirements differ depending on whether you or the developer will own and manage or sell a project? How so?

[IF A NEW SOLAR HOMES PROJECT:]

25. This project installed solar PV panels through the utility companies' solar incentive program. How much of a priority for your organization was the installation of solar panels on this project?
    a. Is that typical of your other multifamily projects?
26. For multifamily projects that you invest in, what is the relative importance of a project having solar panels as opposed to being built efficiently? Is either of those a higher priority than the other? How so?
27. This project went through the utility companies' solar incentive program, but not the utilities' program that incentivizes efficient construction. Why do you think that is?

Target Markets

28. What consumer segment(s) did you have in mind for this project?
29. Compared to other factors, how important did you expect energy efficiency to be to your target market for this [NAME] project?
30. Are there specific consumer segments that seek out energy efficiency construction in market rate projects?
    a. Which ones are those? [PROBE: Higher end/luxury? Green?]
    b. Why are they more inclined to seek out energy efficient construction?
31. Are there green programs or certificates that have more cachet and are asked about by homeowners or renters?
    a. Which ones?
32. Are you any more likely to invest in a multifamily project that intends to attain a green certification than one that doesn't? How so?
33. To what extent would you ever encourage a developer to attain green certifications or achieve certain levels of energy efficiency in order to appeal to a specific target market?

34. Compared to standard efficiency buildings, how much of a premium, if any, do you expect developers to charge on the sale prices or rents for multifamily projects that are more efficient than required to be by code?

35. Did any of the programs or policies that we have discussed have an impact on your awareness of or support for energy efficiency in the multifamily new construction projects you support?

    a. Which programs?

    b. How so?

Spillover

36. To what extent have your preferences regarding the energy efficiency performance of your multifamily investment projects been shaped by your experiences with design teams on previous projects?

    a. Who, or what programs or policies do you think were responsible for changing your views on energy efficiency for multifamily investment projects?

Awareness and understanding of ZNE building practices

37. Are you familiar with the idea of Zero Net Energy building practices?

IF NEEDED: ZNE buildings use no more energy over the course of the year than they produce. These buildings achieve ZNE first through high levels of energy efficiency, and then through the addition of clean, on-site renewable power generation, typically solar panels.

IF FAMILIAR

    a. To what extent did ZNE play a role in your efficiency goals for this project?

    b. To what extent does ZNE ever play a role in California multifamily projects you are investing in or lending to?

    c. What is the consumer demand for ZNE in California multifamily projects?

    d. Does this vary by market segment?

Contact information – decision makers and influencers

38. [ASK IF INTERVIEWEE MENTIONED OTHER INDIVIDUALS WHO WERE CRITICAL TO THE ENERGY EFFICIENCY DECISIONS] Earlier you mentioned several individuals who were key decision makers or influencers of the energy efficiency of this project.

Could you provide the contact information for these individuals**? [RECORD NAME, PHONE NUMBER, EMAIL ADRESS]**

We would like to speak with the key people involved in affecting the project's energy efficiency

    a. Architects,

    b. HERS raters,

c. Title 24 Consultants

d. etc.

Conclusion

39. Those are all the questions I have. Do you have any final thoughts to add that would help us better understand the main factors that affect how you think about energy efficiency as it relates to you decisions to invest in multifamily projects?

Thank you so much for your time, etc.

F.3 On-Site Data Collection Form

Note that this form was used as the basis for data collection, and only relevant information was collected for each project, based on whether they were low-rise, high-rise, and so forth.

Non-Residential Wizard

Job Number:	

(Enter your job number as it will appear on the report)

Envelope Designer

Name:	
Company:	
Address:	
City:	
State:	
Zip:	
Telephone:	
Fax:	
E-Mail:	

Project

Name:	
Address:	
City:	
State:	
Zip Code:	

Building Data

Building Type:	a) Existing
CIRCLE ONE	b) New
	c) Addition
	d) Exist+Addition/Alteration
Front Orientation:	a) North
CIRCLE ONE	b) Northeast
	c) East
	d) Southeast
	d) South
	e) Southwest
	f) West
	g) Northwest
	h) Skylight
Number of Zones or Stories:	

Construction Details		
Roof Construction:		(i.e. R-30 Roof Attic)
Skylight Fenestration:		(i.e. Double Non Metal Clear)
Wall Construction:		(i.e. R-13 Wall)
Window Fenestration:		(i.e. Double Metal Clear)
Door Construction:		(i.e. Wood Door)
Raised Floor Construction:		(i.e. R-19 Floor Crawlspace)
Slab on Grade Construction:		(i.e. Slab on Grade)

Select which Features of the Building to include in your Scope of Compliance	
Envelope - Perform Calculations on the Building Shell	a) Yes b) No
Lighting - Performa Calculations on the Indoor Lighting System	a) Yes b) No
DHW - Perform Calculations on the Domestic Hot Water System	a) Yes b) No
Mechanical - Perform Calculations on the HVAC Systems	a) Yes b) No

Lighting Designer	
Name:	
Company:	
Address:	
City:	
State:	
Zip:	
Telephone:	
Fax:	
E-Mail:	

Mechanical Designer	
Name:	
Company:	
Address:	
City:	
State:	
Zip:	
Telephone:	
Fax:	
E-Mail:	

Zone 1 Envelope

Enter information that will describe the Exterior Building Components

Building Dimensions

Front Length:		feet
Side Length:		feet
Wall Height:		feet

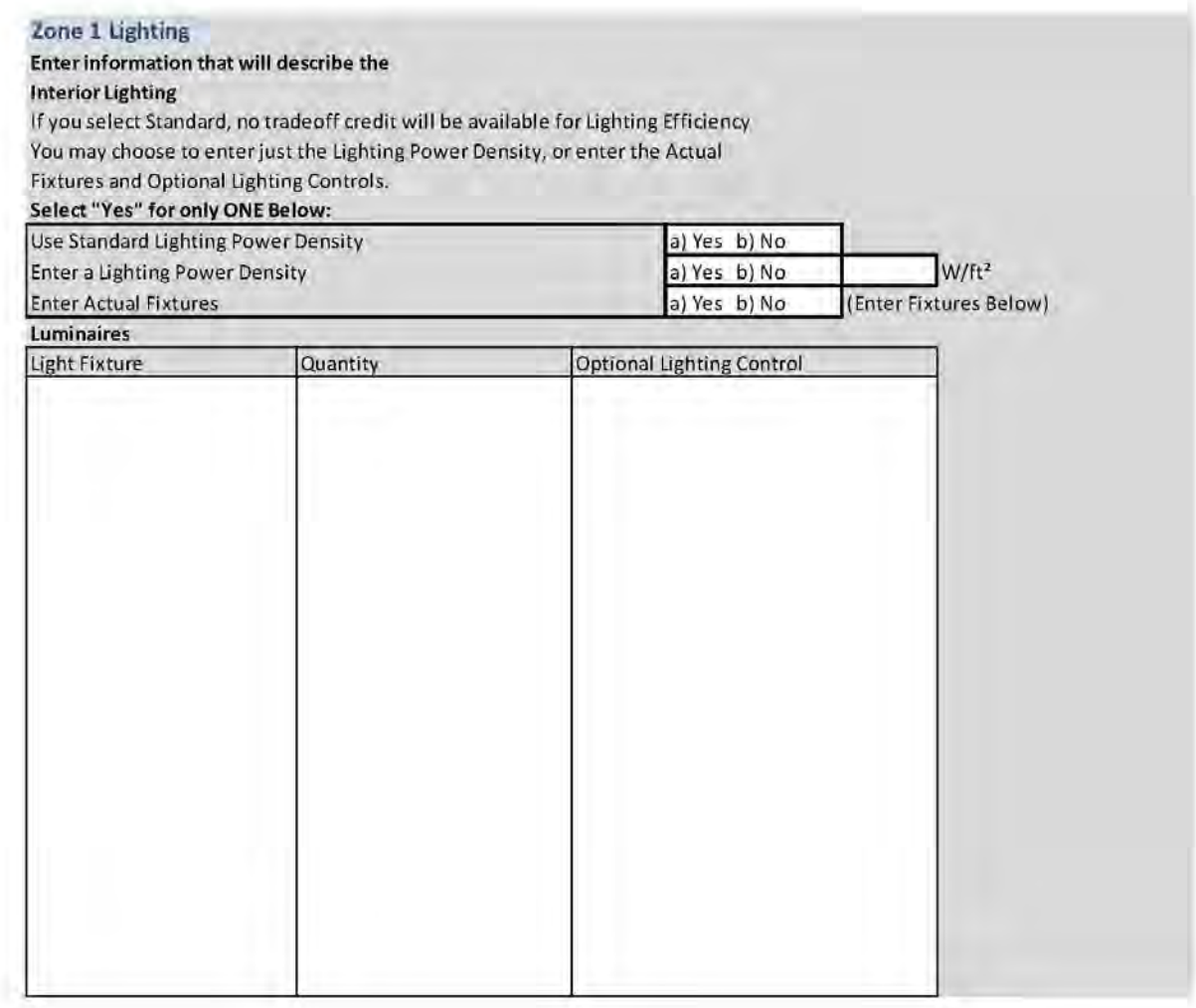
Misc

Floor Area:		ft^2
Type:	a) Existing	
CIRCLE ONE	b) New	
	c) Altered	
	d) Removed	
Year Built:		
Roof Slope		/12
Floor No.		

Occupancy:		(i.e. Comp Bldg Office)
Slab On Grade:		ft^2
Raised Floor:		ft^2
Perimeter:		feet

	Gross Opaque		Glazing		Solid Door	
Front Wall:		ft^2		ft^2		ft^2
Left Wall:		ft^2		ft^2		ft^2
Rear Wall:		ft^2		ft^2		ft^2
Right Wall:		ft^2		ft^2		ft^2
Roof:		ft^2		ft^2		

Left/Right as viewed from the outside looking at the front of the building.



Zone 1 Lighting

Enter information that will describe the
Interior Lighting

If you select Standard, no tradeoff credit will be available for Lighting Efficiency
You may choose to enter just the Lighting Power Density, or enter the Actual
Fixtures and Optional Lighting Controls.

Select "Yes" for only ONE Below:

Use Standard Lighting Power Density	a) Yes b) No		
Enter a Lighting Power Density	a) Yes b) No		W/ft²
Enter Actual Fixtures	a) Yes b) No	(Enter Fixtures Below)	

Luminaires

Light Fixture	Quantity	Optional Lighting Control

System 1 Mechanical

Select an HVAC System sized to adequately meet the Loads.

HVAC Characteristics

HVAC:		(i.e. Carrier 38HDF018)
Number of Systems:		
Heating Distribution:	a) Ducted	
CIRCLE ONE	b) Ductless/with Fan	
	c) Ductless/No Fan	
	d) Radiant Floor	
	e) Baseboard	
Cooling Distribution:	a) Ducted	
CIRCLE ONE	b) Ductless	
Duct Location:	a) Conditioned	
CIRCLE ONE	b) Outdoors	
	c) Crawlspace	
	d) Garage	
	e) Basement	
	f) Attic/Ceiling Ins/Unvented	
	g) Attic/Ceiling Ins/Vented	
	h) Attic/Ceiling+Roof Ins	
	i) Attic/Roof Ins	
	j) Attic (Buried)	
	k) Attic (Deep Buried)	
Duct Insulation:		R-value

Zone 2 Envelope (IF APPLICABLE)

Enter information that will describe the Exterior Building Components

Building Dimensions

Front Length:		feet
Side Length:		feet
Wall Height:		feet

Misc

Floor Area:		ft²
Type:	a) Existing	
CIRCLE ONE	b) New	
	c) Altered	
	d) Removed	
Year Built:		
Roof Slope		/12
Floor No.		

Occupancy:		(i.e. Comp Bldg Office)
Slab On Grade:		ft²
Raised Floor:		ft²
Perimeter:		feet

	Gross Opaque		Glazing		Solid Door	
Front Wall:		ft²		ft²		ft²
Left Wall:		ft²		ft²		ft²
Rear Wall:		ft²		ft²		ft²
Right Wall:		ft²		ft²		ft²
Roof:		ft²		ft²		

Left/Right as viewed from the outside looking at the front of the building.

Zone 2 Lighting (IF APPLICABLE)

Enter information that will describe the
Interior Lighting

If you select Standard, no tradeoff credit will be available for Lighting Efficiency
You may choose to enter just the Lighting Power Density, or enter the Actual
Fixtures and Optional Lighting Controls.

Select "Yes" for only ONE Below:

Use Standard Lighting Power Density	a) Yes b) No		
Enter a Lighting Power Density	a) Yes b) No		W/ft^2
Enter Actual Fixtures	a) Yes b) No	(Enter Fixtures Below)	

Luminaires

Light Fixture	Quantity	Optional Lighting Control

System 2 Mechanical (IF APPLICABLE)

Select an HVAC System sized to adequately meet the Loads.

HVAC Characteristics

HVAC:		(i.e. Carrier 38HDF018)
Number of Systems:		
Heating Distribution:	a) Ducted	
CIRCLE ONE	b) Ductless/with Fan	
	c) Ductless/No Fan	
	d) Radiant Floor	
	e) Baseboard	
Cooling Distribution:	a) Ducted	
CIRCLE ONE	b) Ductless	
Duct Location:	a) Conditioned	
CIRCLE ONE	b) Outdoors	
	c) Crawlspace	
	d) Garage	
	e) Basement	
	f) Attic/Ceiling Ins/Unvented	
	g) Attic/Ceiling Ins/Vented	
	h) Attic/Ceiling+Roof Ins	
	i) Attic/Roof Ins	
	j) Attic (Buried)	
	k) Attic (Deep Buried)	
Duct Insulation:		R-value

Zone 3 Envelope (IF APPLICABLE)

Enter information that will describe the Exterior Building Components

Building Dimensions

Front Length:		feet
Side Length:		feet
Wall Height:		feet

Misc

Floor Area:		ft^2
Type:	a) Existing	
CIRCLE ONE	b) New	
	c) Altered	
	d) Removed	
Year Built:		
Roof Slope		/12
Floor No.		

Occupancy:		(i.e. Comp Bldg Office)
Slab On Grade:		ft^2
Raised Floor:		ft^2
Perimeter:		feet

	Gross Opaque		Glazing		Solid Door	
Front Wall:		ft^2		ft^2		ft^2
Left Wall:		ft^2		ft^2		ft^2
Rear Wall:		ft^2		ft^2		ft^2
Right Wall:		ft^2		ft^2		ft^2
Roof:		ft^2		ft^2		

Left/Right as viewed from the outside looking at the front of the building.

Zone 3 Lighting (IF APPLICABLE)

Enter information that will describe the
Interior Lighting
If you select Standard, no tradeoff credit will be available for Lighting Efficiency
You may choose to enter just the Lighting Power Density, or enter the Actual
Fixtures and Optional Lighting Controls.
Select "Yes" for only ONE Below:

Use Standard Lighting Power Density	a) Yes b) No		
Enter a Lighting Power Density	a) Yes b) No		W/ft²
Enter Actual Fixtures	a) Yes b) No	(Enter Fixtures Below)	

Luminaires

Light Fixture	Quantity	Optional Lighting Control

System 3 Mechanical (IF APPLICABLE)

Select an HVAC System sized to adequately meet the Loads.

HVAC Characteristics

HVAC:		(i.e. Carrier 38HDF018)
Number of Systems:		
Heating Distribution:	a) Ducted	
CIRCLE ONE	b) Ductless/with Fan	
	c) Ductless/No Fan	
	d) Radiant Floor	
	e) Baseboard	
Cooling Distribution:	a) Ducted	
CIRCLE ONE	b) Ductless	
Duct Location:	a) Conditioned	
CIRCLE ONE	b) Outdoors	
	c) Crawlspace	
	d) Garage	
	e) Basement	
	f) Attic/Ceiling Ins/Unvented	
	g) Attic/Ceiling Ins/Vented	
	h) Attic/Ceiling+Roof Ins	
	i) Attic/Roof Ins	
	j) Attic (Buried)	
	k) Attic (Deep Buried)	
Duct Insulation:		R-value

Project Design Data

General	
Building Name:	
Building Type:	a) Existing
CIRCLE ONE	b) New
	c) Addition
	d) Exist+Addition/Alteration
Job No:	
Front Orientation:	a) North
CIRCLE ONE	b) Northeast
	c) East
	d) Southeast
	e) South
	f) Southwest
	g) West
	h) Northwest
	i) Skylight
Rotation:	
Number of Dwelling Units:	

Location	
Country:	
State:	
City:	
Zone:	

Project Title

Project	
Name:	
Address:	
City:	
State:	
Zip Code:	
Remarks:	

Designers

Designer	
Name:	
Company:	
Address:	
City:	
State:	
Zip:	
Telephone:	
Fax:	
E-Mail:	

Designers

Lighting Designer

Name:	
Company:	
Address:	
City:	
State:	
Zip:	
Telephone:	
Fax:	
E-Mail:	

Mechanical Designer

Name:	
Company:	
Address:	
City:	
State:	
Zip:	
Telephone:	
Fax:	
E-Mail:	

Utility

Utility Rate Schedules

Electricity:	
Fossil Fuel:	

Principal Heating Source	a) Natural Gas
	b) Propane
	c) Electric (Natural Gas Available)
	d) Electric (No Natural Gas Available)

Utility

DOE-2 Reports	
Loads	
Verification:	a) LV-A
	b) LV-B
	c) LV-C
	d) LV-D
	e) LV-E
	f) LV-F
	g) LV-G
	h) LV-H
	i) LV-I
	j) LV-J
	k) LV-K
	l) LV-L
	m) LV-M
Summary:	a) LS-A
	b) LS-B
	c) LS-C
	d) LS-D
	e) LS-E
	f) LS-F
	g) LS-G
	h) LS-H
	i) LS-I
	j) LS-J
	k) LS-K
	l) LS-L
	m) All-Summary

Utility

Systems	
Verification:	a) SV-A
	b) SV-B
Summary:	a) SS-A
	b) SS-B
	c) SS-C
	d) SS-D
	e) SS-E
	f) SS-F
	g) SS-G
	h) SS-H
	i) SS-I
	j) SS-J
	k) SS-K
	l) SS-L
	m) SS-M
	n) SS-N
	o) SS-O
	p) SS-P
	q) SS-Q
	r) All-Summary

Utility

Plant	
Verification:	a) PV-A
	b) PV-B
	c) PV-C
	d) PV-E
	e) PV-G
	f) All-Verification
Summary:	a) PS-A
	b) PS-B
	c) PS-C
	d) PS-D
	e) PS-E
	f) PS-F
	g) PS-G
	h) PS-H
	i) PS-I
	j) BEPS
	k) BEPU
	l) All-Summary
Economics	
Verification:	a) EV-A
Summary:	a) ES-A
	b) ES-B
	c) ES-C
	d) ES-D
	e) ES-E
	f) ES-F
	g) All-Summary

Utility

Economics	
Verification:	a) EV-A
Summary:	a) ES-A
	b) ES-B
	c) ES-C
	d) ES-D
	e) ES-E
	f) ES-F
	g) All-Summary

Outdoor

Outdoor Lighting Zone:	

Standard Outdoor Lighting	CIRCLE selection (standard or override)
Use Standard:	
Use Override:	

If using standard, leave override blank

Proposed Outdoor Lighting	CIRCLE selection (standard or override)
Use Standard:	
Use Installed:	
Use Override:	

If using standard or installed, leave override blank

Operating Schedule:	

HERS

Date of Rating:		
Rater ID:		
Inside Refrigerator:		kWh/yr
Garage Refrigerator:		kWh/yr
Dishwasher:		Energy Factor
Range:	a) Gas No Pilot	
	b) Gas w/Pilot	
	c) Electric	
Washer Location:	a) None	
	b) In Conditioned Space	
	c) In Unconditioned Space	
Dryer Location:	a) None	
	b) In Conditioned Space	
	c) In Unconditioned Space	
Dryer Type:	a) Gas	
	b) Electric	
Spa:	a) None	
	b) Gas Heated	
	c) Solar/Gas-Heated	
	d) Electric Heated	
	e) Solar/Electric-Heated	
Well Pump:	a) Yes	
	b) No	
Sewer Grinder Pump:	a) Yes	
	b) No	

HERS – Indoor Lighting

Quantity	Type: High Efficiency, Screw in CFL, Incadescent	Location: Small Closet, Bedroom/Walk-in Closet, Hall/Entry/Stairs/Other, Living, Utility/Laundry, Kitchen/Dining/Nook

HERS – Outdoor Lighting

Control: On/Off Switch, Sensor	**Quantity**	**Type:** High Efficiency, Screw in CFL, Incadescent	**Location:** Garage, Front Entry, Outdoor

Exterior Uses

Electricity Uses		
Description	**Watts**	**Schedule**

Exterior Uses

Fossil Fuel Uses

Description	Btu/hr	Schedule

Pools

General

Pool Type:	a) None	
	b) Gas Heated with Cover	
	c) Gas Heated with No Cover	
	d) Solar or Nonheated	
	e) Electric Heated with Cover	
	f) Electric Heated without Cover	
Pool Volume:		gallons
Filter Type:	a) Sand	
	b) DE	
	c) Cartridge	
Suction Pipe Diameter		inches
Return Pipe Diameter		inches

Filter Pump

Type:	a) Single Speed	
	b) Two Speed	
	c) Variable Speed	
Rated Power:		hp
Number of Pumps:		
Motor Watts Verified in Field:	a) Yes	
	b) No	
High Speed Hours Per Day:		

Cleaner Booster Pump

Rated Power:		hp
Number of Pumps:		
Hours Per Day:		
Motor Watts Verified in Field:	a) Yes	
	b) No	

Heating Hot Water

Name:		(i.e. Campus Plant)			
Hot Water Boiler					
Type:	a) Existing				
	b) New				
	c) Altered				
	d) Removed				
Boiler:	→ → → → → → →	→	Name:		(i.e. Standard Gas 50 gal or Less)
Multiplier:			Type (CIRCLE ONE):	a) Gas Fired b) Electric Res c) Heat Pump d) Indirect Gas	
Loop Setpoint Temperature:		°F	Volume:		gallons
Hot Water Pump			Input:		Btu/hr
			Energy Factor:		
Flow Rate per Pump:		gpm	Recovery Efficiency:		
Pump Multiplier:			Standby Loss:		
Design Power:		hp	Pilot Loss:		Btu/hr
Head:		feet	External Insulation:		R-value
Flow Control:	a) One-Speed				
	b) 3-Way Valves, One Speed				
	c) 2-Way Valves, Variable Speed				
Head:					
Hydronic Pumping					
Pipe Length:		feet			
Pipe Diameter:		inches			
Insulation Thickness:		inches			

Chilled Water

Chilled Water		
Number of Chiller Types:		
Chilled Water Supply:		°F

Hydronic

Ground Coupled System	a) Yes	
CIRCLE ONE	b) No	

Economizer/Condenser (Water)		
Flow Rate per Pump:		gpm
Pump Multiplier:		
Design Power:		hp
Head:		feet
Flow Control:	a) One-Speed/3 Way Valves b) One-Speed/2 Way Valves c) Variable Speed	
Min Power Ratio		
Percentage Propylene Glycol in Loop:		%

Cooling Tower			(Name: i.e. 100 Ton Tower)				
Cooling Tower:	→ → → → →	→	General		→	Fan	
Tower Multiplier:			Name:			Design Power:	hp
			Type: CIRCLE ONE	a) Open Circuit b) Closed Circuit		Drive Efficiency:	%
			Capacity Control: CIRCLE ONE	a) Variable Speed Fan b) Two-Speed Fan c) One-Speed Fan d) Fluid Bypass			
Cooling Tower Pump							
Flow Rate per Pump:		gpm	Output:		tons		
Pump Multiplier:			Condenser Water Reset:				
Design Power:		hp	Approach Temperature:		°F		
Head:		feet	Setpoint Temperature:		°F		
			Min. Water Temperature:		°F		

Domestic Hot Water

DHW Boiler

Type:	a) Existing				
CIRCLE ONE	b) New				
	c) Altered				
	d) Removed				
Boiler:	→ → → → → → → →	→	Name:		(i.e. Rheem 41-R40)
Multiplier:			Type:	a) Gas Fired	
			CIRCLE ONE	b) Electric Res	
Multi-Family Central System	a) Yes			c) Heat Pump	
	b) No			d) Indirect Gas	
If not Multi-Family, skip to Residential section below.			Volume:		gallons
			Input:		Btu/hr
			Energy Factor:		
			Recovery Efficiency:		
			Standby Loss:		
			Pilot Loss:		Btu/hr
			External Insulation:		R-value

Pump

Control:	a) None	
CIRCLE ONE	b) Timer	
	c) Demand	
	d) Temperature	
	e) Timer+Temp	
Pump Multiplier:		
Design Power:		hp

Piping

Length Outside		feet
Length Underground		feet
Length in Plenum		feet
Additional 1/2" Insulation		

Domestic Hot Water

Residential		
Distribution:	a) No Pipe Insulation	
CIRCLE ONE	b) Kitchen Pipe Ins	
	c) All Pipes Ins	
	d) Below Grade No Ins	
	e) Below Grade Ins	
	f) Parallel Piping	
	g) Point of Use	
	h) Recirc/No Control	
	i) Recirc/Timer	
	j) Recirc/Temp	
	k) Recirc/Time+Temp	
	l) Recirc/Switch	
	m) Recirc/Motion Sensor	
	n) Temp Buffering Tank	

Combined Hydronic Piping		
Pipe Length:		feet
Pipe Diameter:		inches
Insulation Thickness:		inches

Monitored System	a) Yes
CIRCLE ONE	b) No

Renewables

Solar Space Heating		
Net Solar Fraction:		%

Solar Domestic Hot Water		
Net Solar Fraction:		%

Electricity Production		
DC Rating:		kW
TDV:		kBtu/ft²-yr

Month	Production (kWh)	Demand (kW)	Cost
Jan			
Feb			
Mar			
Apr			
May			
Jun			
Jul			
Aug			
Sep			
Oct			
Nov			
Dec			
Total:	0	0	$0.00

Exceptional

Name:	
Description:	

Electricity

Month	Energy	Demand	Cost
Jan			
Feb			
Mar			
Apr			
May			
Jun			
Jul			
Aug			
Sep			
Oct			
Nov			
Dec			

Gas

Month	Energy	Cost
Jan		
Feb		
Mar		
Apr		
May		
Jun		
Jul		
Aug		
Sep		
Oct		
Nov		
Dec		

System - General

System Details			Heating					
Name:						Preheat Coils	Select "YES" only once	
System Type: **CIRCLE ONE**	a) Existing b) New c) Altered d) Removed					None	a) Yes b) No	
System:		→→→→	Name:			Electric	a) Yes b) No	Setpoint:
Multiplier:			System Type:	a) Split DX		Hot Water	a) Yes b) No	
Use Supply Air Temperature Specified in Central System for Load Calculations	a) Yes b) No			b) Packaged DX c) Hydronic Heat Pump d) Packaged VAV e) Packaged MZ		Reheat Coils	Select "YES" only once	
Constant Volume Required for Process	a) Yes b) No			f) Built-Up SZ g) Built-Up VAV		None	a) Yes b) No	
Exempted Fan Power:		inches		h) Built-Up MZ i) Dual Duct j) 4 Pipe Fan Coil		Electric	a) Yes b) No	Delta T:
				k) Room PTAC l) Packaged VVT		Hot Water	a) Yes b) No	
Space > 8,000 sqft and Ceiling Height > 15' and LPD >=0.5 w/sqft (Section 143)	a) Yes b) No			m) Four Pipe Induc n) Evap Cooler o) Variable Ref Flow p) Single Package Vertical Unit		Baseboard Heat	Select "YES" only once	
Outside Air From:						None	a) Yes b) No	
						Electric	a) Yes b) No	
						Hot Water	a) Yes b) No	

Heating (contd.)

Heating Coil

Heating Type:	a) None
	b) Gas Furnace
	c) Electric Res
	d) Heat Pump
	e) Hot Water
	f) Gas Heat Pump
Furnace Type:	a) Central
	b) Fan Wall
	c) Gravity Wall
	d) Floor
	e) Room
Coil Control:	a) Constant Temp
	b) Warmest Zone
	c) Coldest Zone
	d) OA Reset

Total Output:		Btu/hr
Electrical Power:		kW
Supply Temp:		°F
Efficiency:		AFUE

System - General

Cooling

Cooling Coil

Coil Control:	a) Constant Temp b) Warmest Zone c) Coldest Zone d) OA Reset	
Output:		Btu/hr
Sensible:		Btu/hr
Supply Temp:		°F
Efficiency:		
Fan Heat Included in Output:	a) Yes b) No	

Performance at ARI Conditions

Energy Efficiency Ratio:		EER
Comp/Cond Power:		kW

Room A/C & Heat Pump Side Louvers	a) Yes b) No	

Condenser

Condenser Type:	a) Air Cooled b) Water Cooled c) Evap Pre-Cooled d) Ice Storage A/C e) Res Absorption
Ice Storage/AC:	a) B600 LRL1CXX
	b) B600 LTI59LT
	c) B600 LTL1CFT
	d) B600 LTL1CLT
	e) B600 LRJ5ALR
	f) B600 LRL1CXX-R
	g) B600 GTG1CXX-R
	h) IB30A 060-1218-4
	i) IB30A 060-1218-6
	j) IB30A 060-1319-6
Evap PC Eff:	

Evap Pump Monitor

Design Power:		hp

Controls

Fan Operation	a) Continuous b) Intermittent
Cycle System on at Night to Meet Loads	a) Yes b) No
DDC Controls to Zone Level	a) Yes b) No
Fault Detection & Diagnostic Controls	a) Yes b) No
Maximum Humidity:	%

System - General

VRF Heat Recovery	
Mode:	a) None
	b) Supply DHW Load
	c) Supply HW Load
	d) Supply DHW Load - then HW Load
	e) Supply HW Load - then DHW Load
Number of Heat Exchangers:	
Model:	a) PWFY-P36NMU-E-AU
	b) PWFY-P72NMU-E-AU

Booster Unit Mode:	a) None
	b) Supply DHW Load
	c) Supply HW Load
	d) Supply DHW Load - then HW Load
	e) Supply HW Load - then DHW Load
Number of Booster Units:	

Outdoor Air

Air Economizer Characteristics

Economizer Type:	a) No Economizer	
	b) Fixed Temp (Non-Integ)	
	c) Fixed Temp (Integrated)	
	d) Fixed Enth (Non-Integ)	
	e) Fixed Enth (Integrated)	
	f) Diff Temp (Non-Integ)	
	g) Diff Temp (Integrated)	
	h) Diff Enth (Non-Integ)	
	i) Diff Enth (Integrated)	
	j) 100% Outside Air	
Limit Temperature:		°F
Waterside Economizer:		

Exhaust Air Heat Recovery

Energy Recovered:		
Heat Recovery Effectiveness:		
Minimum Delta T required for Heat Recovery:		°F
Electrical Energy Use:		kW
Pump/Motor runs only when Heat Recovery is Active		
Fan Savings when Heat Recovery is in Bypass Mode:		%
Exhaust Air Stream Evaporative Cooling Effectiveness:		

System - General

Fans

Supply Fan

Induction Ratio:		
Fan Control:	a) Constant Volume	
	b) Two Speed	
	c) FC w/Vanes	
	d) FC w/Dampers	
	e) AF w/Vanes	
	f) AF w/Dampers	
	g) Variable Speed	
	h) Vane Axial	
Fan Type:	a) Draw-Through	
	b) Blow-Through	
	c) Outside Airflow	
Airflow:		cfm
Design Power:		hp
Drive Efficiency:		%

Return Fan

Airflow:		cfm
Design Power:		hp
Drive Efficiency:		%

Evaporative Cooling

Evaporative Cooling Characteristics

Type:	a) None	
	b) Indirect	
	c) Indirect/Direct	
	Direct	
Air Flow:		cfm
Direct Effectiveness:		
Indirect Effectiveness:		
Integrated Operation:	a) Yes	
	b) No	
Return Air Heat Recovery:	a) Yes	
	b) No	

Supplemental Fan

Design Power		hp
Drive Efficiency		%

Pump

Design Power		hp

System - General

Curves

Use Custom Heating Curve Coefficients	a) Yes b) No

Performance at 70F Indoor Drybulb

Out. DB	Capacity	Input kW
47		
60		
35		
25		
17		

Use Custom Cooling Curve Coefficients	a) Yes b) No

Performance at 67F Indoor Wetbulb

Out. DB	Capacity	Input kW
95		
115		
85		
80		
75		

System - Distribution

Distribution Type:	a) Existing
	b) New
	c) Altered
	d) Removed
Heating Distribution:	a) Ducted
	b) Ductless, with Fan
	c) Ductless, no Fan
	d) Radiant Floor
	e) Baseboard
Cooling Distribution:	a) Ducted
	b) Ductless
Duct Location:	a) Conditioned
	b) Outdoors
	c) Crawlspace
	d) Garage
	e) Basement
	f) Attic (Ceiling Ins, Unvented)
	g) Attic (Ceiling Ins, Vented)
	h) Attic (Ceiling+Roof Ins)
	i) Attic (Roof Ins)
	j) Attic (Buried)
	k) Attic (Deep Buried)

System - Distribution

Duct Insulation:		R-value		
< 12 feet Duct in Unconditioned	a) Yes b) No			
Duct Leakage not Verified	a) Yes b) No			
Sealed Ducts with Leakage Verified	a) Yes b) No			
Low Leakage AHU or Leakage Verified	a) Yes b) No	If yes, give percent		%
Ducts in Conditioned Space with Leakage	a) Yes b) No			
Measured Duct Surface	a) Yes b) No			
CFM25		cfm		

Nonresidential

>25% of Ducts in Unconditioned	a) Yes b) No		
Heating Duct Losses:		%	
Cooling Duct Losses:		%	

System - Residential

Residential Features

Thermostat:	a) Setback
	b) No Setback
	c) Living
	d) Sleeping
Hydronic Space Heating:	a) None
	b) DHW Boiler Provides Heat
	c) Heating Boiler Provides Hea
House Wrap Credit:	a) Yes
	b) No

Lowrise Residential Mechanical Ventilation

Supply	
Exhaust	
Power	

System – HERS Credit

HVAC Measures	
Verified Refrigerant Charge or Charge Indicator Display	a) Yes b) No
Verified Air Conditioner EER	a) Yes b) No
Verified Cooling Coil Airflow	a) Yes b) No
Verified Fan Energy	a) Yes b) No
Verified Cooling Size	a) Yes b) No

Building Envelope	
Quality Insulation Installation	a) Yes b) No
Building Leakage Testing:	a) No Testing b) Specific Leakage Area c) Airflow
Building Leakage Type:	a) Existing b) New c) Altered d) Removed

	Specific Leakage Area		CFM50	
Existing Tested Value		ft²/10,000ft²		cfm
New Tested Value		ft²/10,000ft²		cfm

System – MECH-2

MECH-2 Features	
Time Control:	a) Programmable Switch
	b) Occupancy Sensor
	c) Manual Timer
Outdoor Damper:	a) Auto
	b) Gravity
DP Sensor Location:	
Supply Pressure Reset:	a) Yes
	b) No
Natural Ventilation:	a) Yes
	b) No
Pipe Insulation:	

Zone Room - General

Zone Details

Name:		(i.e. Room 1117)
Zone Type:	a) Unconditioned	
	b) Conditioned	
	c) Return Air Plenum	
Occupancy:		(i.e. classroom, auditorium)
90.1 Ltg Occupancy:		(i.e. dining area, restrooms)
Floor Number:		
Rotation:		
Vertical Multiplier:		
Horizontal Multiplier:		

	North, East, South		West	
Display Perimeter:		feet		feet

Zone Room - Lighting

Standard Lighting	Choose ONE	Title-24	ASHRAE 90.1	
a) Yes b) No	Use Standard LPD	0.7 W/ft²	1.5 W/ft²	
a) Yes b) No	Use Calculated LPD	0.2 W/ft²		
a) Yes b) No	User Input LPD (Area Category)		W/ft²	(If "yes," enter amount for W/ft²)

Proposed Lighting	Choose ONE	Title-24	ASHRAE 90.1	
a) Yes b) No	Use Standard LPD (No Plans)	0.7 W/ft²	1.5 W/ft²	
a) Yes b) No	Use Installed LPD	0 W/ft²		
a) Yes b) No	User Input LPD		W/ft²	(If "yes," enter amount for W/ft²)

Lighting Type:	a) Incandescent	
	b) Recessed Fluorescent	
	c) Suspended Fluorescent	
	d) Rec Fluor Return Vent	
	e) Rec Fluor Ret/Sup Vent	
Lighting Heat To Zone:		%

Zone Room - Mechanical

Zone Level Mechanical System Data		
Zonal System:	→→→→→→→→→→→→→→→→→→→→→→→→→→→→	
Zonal Multiplier:		
Demand Control Ventilation:	a) Yes b) No	
Pipe Length:		feet
Supply AC per Hour:		
Supply Air Flowrate:		cfm

Ventilation	Select "yes," for standard OR occupancy, not both	
Use Standard (Area Basis)	a) Yes b) No	0.15 cfm/ft²
Use Occupancy	a) Yes b) No	0.15 cfm/ft²
Use Air Change		AC/hr

General	(i.e. 20% VAV Box/No Reheat)	
Name:		
Type:	a) VAV Box	
	b) VAV/Series Fan	
	c) VAV/Parallel Fan	
	d) Variable Ref. Flow	
	e) VAV Diffuser	
Thermostat Type:	a) Proportional	
	b) Reverse Action	
	c) Two Position	
Minimum Airflow Ratio:		
Zone is Heated:	a) Yes b) No	
Heating Output:		Btu/hr
Cooling Output:		Btu/hr
Sensible Output:		Btu/hr

Fan		
Fan Cycles with Load:	a) Yes	
	b) No	
ECM Motor:	a) Yes	
	b) No	
Flow Rate:		cfm
Design Power:		hp
Drive Efficiency:		%

Outside Air	
Outside Air:	a) No Economizer
	b) Temperature
	c) Enthalpy
	d) Energy Recovery

Energy Recovery Ventilator		
Power:		watts
Sensible Effectiveness:		
Latent Effectiveness:		
Minimum DeltaT:		°F
Preheat Setpoint:		°F

Zone Room - Schedules

Load Profiles	
Lighting:	
Process Lighting:	
Infiltration:	
Occupant:	
Receptacle:	
Process:	
DHW:	

HVAC Operation	
Fan:	
Heating:	
Cooling:	

Room - General

Name:		(i.e. Room 1000-1, 1001-2, and 1008)
Area:		ft²
Ceiling Height:		feet
Type:	a) Existing	
	b) New	
	c) Altered	
	d) Removed	
Year Built:		
Winter Indoor Temp:		°F
Summer Indoor Temp:		°F

Room - Infiltration

Infiltration Rate:		Air Changes/hr

Room - Occupant

Nonresidential		
Occupant Density:		ft²/occ
Occupant Sensible:		Btu/hr-occ
Occupant Latent:		Btu/hr-occ
Ventilation:		cfm/occ

Residential		
Number of Kitchens:		
Number of Bedrooms:		

Room – Domestic Hot Water

DHW Internal Gains		
Load:		Btu/hr-occ
Sensible Heat Gain:		
Latent Heat Gain:		

Room – Exhaust Fan

Exhaust Fan Description		
Airflow:		cfm
Design Power:		hp
Drive Efficiency:		%
Fan Multiplier:		

Room – Receptacle Process

Receptacle		
Sensible Heat:		W/ft²
Latent Heat:		W/ft²

Process Equipment		
Sensible Heat:		W/ft²
Latent Heat:		W/ft²

Process Lighting		
Process LPD:		W/ft²

Room - Lighting

Task Data		
Task Height:		feet
Mounting Height:		feet

Room Dimensions		
Length:		feet
Width:		feet
Perimeter:		feet

Daylighting		
Sidelit Area:		ft²
Skylit Area:		ft²

Slab-On-Grade - General

Name:		(i.e. Slab-on-Grade)
Area:		ft²
Surface Type:	a) Existing	
	b) New	
	c) Altered	
	d) Removed	
Assembly:		(i.e. Slab-on-Grade)
Ext. Perimeter:		feet

Slab-On-Grade –Thermal Mass

Thermal Mass Attributes		
Thickness		inches
Exposed	a) Yes	
	b) No	

Roof - General

Name:		
Area:		ft²
Surface Type:	a) Existing	
	b) New	
	c) Altered	
	d) Removed	
Assembly:		(i.e. R-30 Metal Deck Roof)
Orientation:	a) North	
	b) Northeast	
	c) East	
	d) Southeast	
	e) South	
	f) Southwest	
	g) West	
	h) Northwest	
	i) Skylight	
Tilt:		degrees

Roof – Thermal Mass

Thermal Mass Attributes		
Mass Type:	a) Non	
	b) Adobe	
	c) Concrete (Heavyweight)	
	d) Concrete (Lightweight)	
	e) Masonry (Partial Grout)	
	f) Masonry (Solid Grout)	
	g) Wood (Solid, Logs)	
	h) Wood Cavity Wall	
Thickness:		inches
Exposed:	a) Yes	
	b) No	

Wall- General

Name:		
Area:		ft²
Surface Type:	a) Existing	
	b) New	
	c) Altered	
	d) Removed	
Assembly:		(i.e. R-13 Wall)
Orientation:	a) North	
	b) Northeast	
	c) East	
	d) Southeast	
	e) South	
	f) Southwest	
	g) West	
	h) Northwest	
	i) Skylight	
Tilt:		

Wall- Thermal Mass

Thermal Mass Attributes		
Mass Type:	a) None	
	b) Adobe	
	c) Concrete (Heavyweight)	
	d) Concrete (Lightweight)	
	e) Masonry (Partial Grout)	
	f) Masonry (Solid Grout)	
	g) Wood (Solid, Logs)	
	h) Wood Cavity Wall	
Thickness:		inches
Exposed:	a) Yes	
	b) No	

Window- General

Name:		
Area:		ft²
Surface Type:	a) Existing	
	b) New	
	c) Altered	
	d) Removed	
Fenestration:	→→→→→→→→→→→→→→	→→→→

Name:		(i.e. PPG Solexia)
Product Type:	a) Manufactured	
	b) Site-Built	
	c) Field Fabricated	
Visible Transmitance:		

U-Factor	Choose ONE		
Default	a) Yes b) No		Btu/hr-ft²-
Center of Glass	a) Yes b) No		Btu/hr-ft²-
NFRC Labeled	a) Yes b) No		Btu/hr-ft²-

SHGC	Choose ONE	
Default	a) Yes b) No	
Center of Glass	a) Yes b) No	
NFRC Labeled	a) Yes b) No	

Fenestration Properties	
Fenestration Type:	a) Window
	b) Greenhouse/Garden
	c) Glass Block
	d) Door
	e) Skylight w/Curb
	f) Skylight w/o Curb
Number of Panes:	
Frame Type:	a) Metal
	b) Metal-Thermal Break
	c) Non-Metal
Tinted:	a) Yes b) No
Operable:	a) Yes b) No

Window- Exterior Shading

Shading Device:	a) Bug Screen (Default Exterior Shade, Same as None)
	b) Woven Sunscreen (SC < 0.35)
	c) Louvered Sunscreen
	d) Low Sun Angle Sunscreen
	e) Roll-down Awning
	f) Roll-down Blinds or Slats

Overhangs and Sidefins

Window Width:		feet
Window Height:		feet
Overhang:		→→→→→→→→→→→→
Sidefin:		
	↓↓↓↓↓↓↓↓↓	
Name:		(i.e. 2' Left Fin/0.1' Away)
Left Fin Depth:		feet
Distance from Window:		feet
Right Fin Depth:		feet
Distance from Window:		feet

Name:		(i.e. 3' Overhang/0
Horizontal Projection:		feet
Distance Above Window:		feet
Left Extension Past Window:		feet
Right Extension Past Window:		feet

List the amount of floor space utilized by the following activities in the audit area

Total Floor Area _____ SF

Space Utilization

Code	Area Category	Estimated %	Cooled %	Heated %	Code	Area Category	Estimated %	Cooled %	Heated %
1	Auditorium				12	Exercise center, gymnasium			
2	Auto Repair				13	Exhibit, museum			
3	Beauty Salon				14	Financial transactions			
4	Civic Meeting Place				15	General commercial and industrial work - Low bay			
5	Classrooms, lecture, training, vocational room				16	General commercial and industrial work - High bay			
6	Commercial and industrial storage (conditioned & unconditioned)				17	General commercial and industrial work - Precision			
7	Commercial and industrial storage (refrigerated)				18	Grocery sales			
8	Convention, conference, multipurpose and meeting centers				19	Hotel function area			
9	Corridors, restrooms, stairs, and support areas				20	Housing, Public and Commons Areas - Multi-family, Dormitory			
10	Dining				21	Housing, Public and Commons Areas - Senior Housing			
11	Electrical, mechanical, telephone rooms				22	Kitchen, food preparation			

Code	Area Category	Estimated %	Cooled %	Heated %	Code	Area Category	Estimated %	Cooled %	Heated %
24	Laundry				35	Parking garage - Parking Area			
25	Library - Reading areas				36	Parking garage - Ramps and Entries			
26	Library - Stacks				37	Religious worship			
27	Lobbies - Hotel lobby				38	Retail merchandise sales, wholesale showrooms			
28	Lobbies - Main entry lobby				39	Tenant lease space			
29	Locker/dressing room				40	Theaters - Motion picture			
30	Lounge/recreation				41	Theaters - Performance			
31	Malls and atria				42	Transportation Function			
32	Medical and clinical care				43	Waiting area			
33	Offices - > 250 square feet				44	All other, Specify			

	Cool Roof Checklist:	Answer	Verification Method (plans, section details, photos, Manufacturer data, etc.)	Notes
1	Is the roofing project part of a new construction or an existing building alteration?	New		
2	Is the cool roof a manufactured membrane/film or a field applied liquid coating?	onsite application	Product Submittal/Manufacturer data	
3	What is the roof's construction material? Wood/ Metal decking/ Concrete?	Wood	Plans/Section details	
4	Is the roof CRRC-rated?	Yes	Product Submittal/Manufacturer data	
5	What is the roof manufacturer's name (trade name) and product number?	GAFGLAS Energy Cap BUR Mineral Surfaced Cap Sheet	Product Submittal/Manufacturer data	
6	Is the roof covered partially or fully with PV panels and/or HVAC units?		Plans, photos, field verification	Heat pump condensing units, no PV
7	If manufacturer data is handy:			
	a) What is the 3-year aged thermal reflectance of the roof?	0.63	CRRC Rating	
	b) What is the roof thermal emittance?	0.90	Product Submittal/Manufacturer data	
	c) What is the roof SRI?	100	Product Submittal/Manufacturer data	
8	Roofing Type?	Lightweight (<5lb/sf)	Technical Specification	
9	Slope of the roof for 90% of the space?	<=2:12 (low slope)	Plans, photos, field verification	

Appendix G Recommendations and IOU Responses

Table G- 1: Recommendations and IOU Responses

Recommendations	IOU Response
Design assistance: Speed up recommendations	
Design assistance: Focus on upgrades other than higher mechanical system efficiencies	
Design assistance: Provide data on maintenance costs	
Design assistance: Provide more advanced support for experienced teams, in addition to basic support for new participants	
Increase outreach beyond repeat participants to non-participating developers in order to expand the market of developers working on above-code projects	
Consider partnership with LEED or other green certification programs, such as GreenPoint Rated	
Reconsider the timing and amount of IOU program incentives so as to increase participation	
Demonstrate feasibility of energy efficiency via benchmarking of energy performance and maintenance costs; offer publicity and marketing support to developers who participate	
Increase marketing and advertising	
Continue coordinating with CTCAC	
Coordinate with the Codes and Standards Program to improve enforcement of and compliance with base and reach codes	