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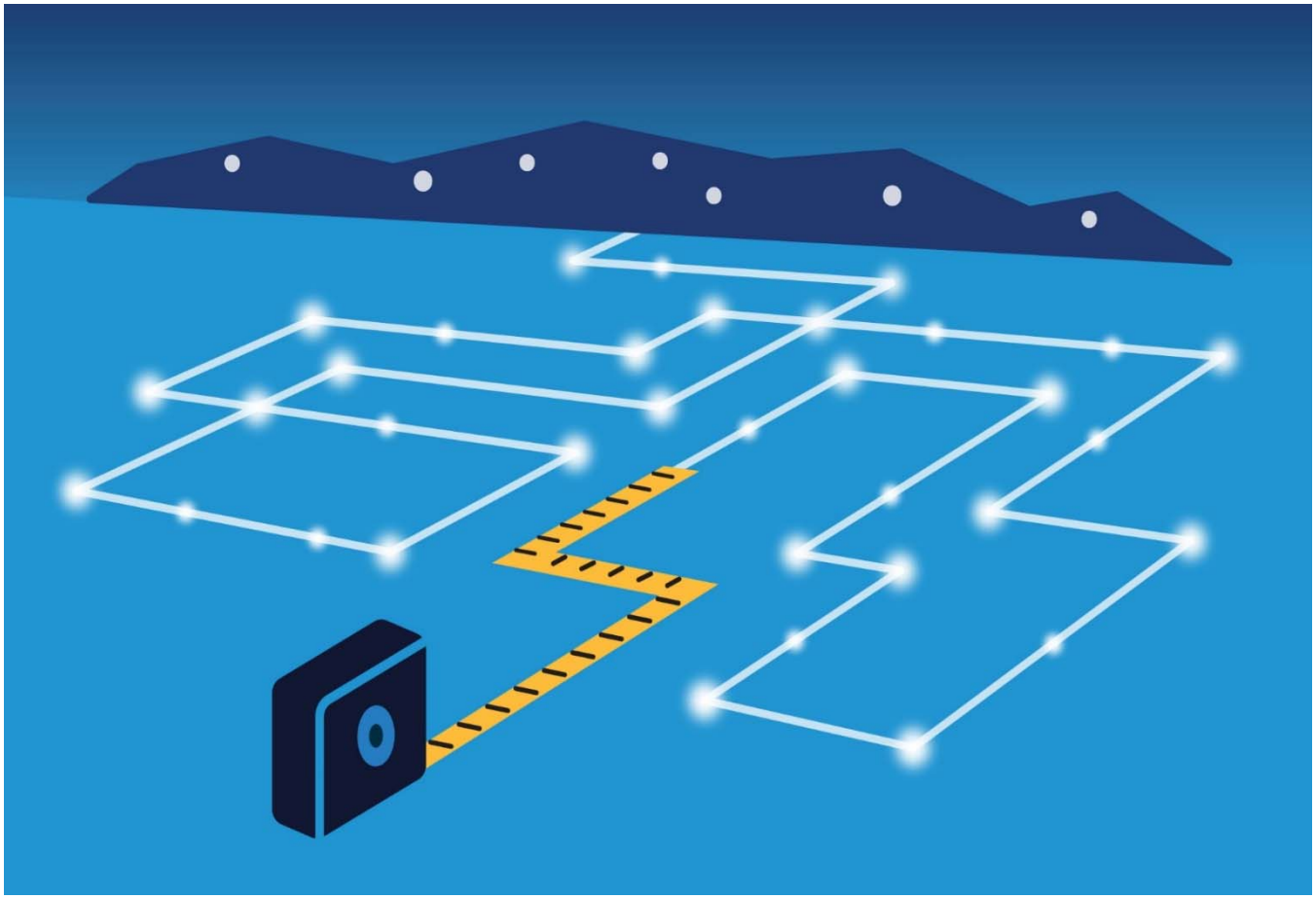

SCE & SoCalGas Energy Upgrade California—Multifamily Pilot Process Evaluation

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1. Executive Summary

This report presents results from a process evaluation of Southern California Edison (SCE) and Southern California Gas Company's (SoCalGas) Energy Upgrade California™ Multifamily Pilot (EUC MF) Program (the Pilot). The Pilot launched in September 2013 and was designed to offer incentives and technical assistance for comprehensive (whole-building) energy efficiency upgrades in the multifamily sector. Opinion Dynamics conducted a process evaluation of the Pilot to assess the effectiveness of its design and implementation strategy and to make recommendations for how it can improve moving forward. To inform this evaluation, we conducted in-depth interviews with the investor-owned utilities (IOUs), utility consultants (UCs), installation contractors, and participating property owners[1] and analyzed the program-tracking databases and project documentation.

For this process evaluation, we examined Pilot performance in terms of the program's design, participant and stakeholder experiences, and overall implementation outcomes. To contextualize process findings from the evaluation, we also present the program-tracking data's ex ante savings and report on our higher-level review of the Pilot's process for estimating these ex ante savings. As this study was not an impact evaluation we did not estimate ex post impacts; therefore, all impact estimates presented in the report are ex ante. The program's impact evaluation, which will develop the ex post savings estimates and complete a more granular review of the savings calculations, is a separate effort that was still underway at the time of this report.

Energy Upgrade California Pilots

In addition to the Pilot, the multifamily sector in SCE/SoCalGas territories can receive assistance for installing energy efficiency measures through several different programs. The Multifamily Energy Efficiency Rebate (MFEER) program, the Energy Savings Assistance Program (ESAP), the Middle-Income Direct Install (MIDI) program, and the SoCalGas Third Party Direct Install Program offer rebates or direct installation services for tenant units or common areas and have been available for more than a decade.[2] In contrast, the EUC design promotes comprehensive energy efficiency retrofits and emerged in California only over the past few years. The SCE/SoCalGas Pilot was one of six pilots[3] that provided whole-building solutions, including energy efficiency measures, such as building shell upgrades, high-efficiency HVAC units, domestic hot water heating, and central heating and cooling upgrades.

In contrast to existing prescriptive energy efficiency incentive programs for the multifamily sector (i.e., MFEER, MIDI, and ESAP), the EUC MF Pilot objectives were to reduce barriers to comprehensive whole-building upgrades. These pilots allowed customers the flexibility to select their own measures as long as the entire package of upgrades saved at least 10% of the property's existing baseline usage. The pilots offered free assessment incentives and a tiered incentive structure based on expected energy savings to offset the cost of completing the retrofit. The SCE/SoCalGas EUC MF Pilot offered several distinguishing features compared to some of the other five pilots:

- Provided building assessments to property owners free of charge, whereas some of the other pilots charged for assessments

[1] The Pilot worked with both property owners and property managers depending on who was the most appropriate contact. For brevity in this report, we refer to these entities as "property owners," but recognize that some of them were management.

[2] The Cadmus Group, 2013a.

[3] The six Program Administrators offering EUC multifamily program pilots are: SCE/SoCalGas, Pacific Gas and Electric (PG&E), San Diego Gas & Electric (SDG&E), the Southern California Regional Energy Network (SoCalREN), Marin Clean Energy (MCE), and the Bay Area Regional Energy Network (BayREN).

- Implemented a closed-rater model, requiring property owners to work directly with one of three program-approved UCs (all of whom were qualified Home Energy Rating System [HERS] raters) for property assessment, whereas SoCalREN, PG&E, and SDG&E attempted an open-rater model
- Provided installation incentives using a per-dwelling tiered approach ($700–$1,600) based on total building energy savings estimates (10% to 35% or more), which was slightly higher than most other pilots
- Provided a no-cost, sample-based combustion appliance safety (CAS) test-in approach as well as CAS test-out at a sample of units for QC and safety purposes, while requiring property owners to pay for test-out at 100% of units for safety purposes
- Calibrated building energy simulations to property's bill history, which the other five pilots did not.

Pilot Performance

SCE/SoCalGas administered the Pilot from September 2013 to March 2016. Three UCs who are qualified HERS[4] raters—Affordable Energy Association (AEA), Partner Energy, and TRC—implemented the Pilot by working directly with multifamily property owners. The goal of the Pilot was to recruit 20 participating properties and 1,700 units to achieve gross energy savings.[5] The Pilot exceeded its unit goal by upgrading 1,919 units, but fell slightly short of its property participation and energy saving goals (Table 1). Most properties entered the Pilot through preexisting relationships with the UCs. Despite not reaching its property participation and energy saving goals, the Pilot did gain enough participation multifamily properties to test and learn from introducing this program design to the market. Notably, the table shows results based on ex-ante gross savings. An impact evaluation of this program is not complete and therefore these results have not been verified yet.

Table 1. Pilot Goals and Results

	# of Properties	# of Units	Pilot Expenditures[A]	Ex Ante kWh Savings	Ex Ante kW Savings	Ex Ante Therm Savings
Pilot Goals	20	1,700	$2,550,000	1,416,100	1,360	116,025
Achieved	15	1,919	$2,371,572	849,724	258	95,177
Percent Achieved	75%	113%	93%	60%	19%	82%

[A] Pilot expenditures reported by IOUs include property incentives (assessments and rebate) and UC services (customer engagement, quality assurance, quality control, and verifications). Expenditures do not include IOUs' administrative costs.

Participating properties varied widely in terms of their structural and operational characteristics.

- **Mix of market-rate and affordable housing:** Eleven of the completed projects were affordable housing properties and four were market-rate properties. While the Pilot did not have formal goals surrounding market-rate property participation, the IOUs had hoped for 20% market rate participation based on the other EUC-MF Pilots' inability to enroll a large number of market rate properties.
- **Property size:** Properties ranged in size from 15 to 403 units (with an average of 128 units) and ranged in size from 6,400 to 406,875 square feet. The properties had between 1 and 22 buildings. Based on

[4] Home Energy Rating System Rater. See http://www.resnet.us/professional/rater/what-is-a-hers

[5] SCE (2013, p. 175). 2013–2014 Energy Efficiency Program Plans.

interviews with the participating property owners, the upgrade costs and current program design made it more suitable for larger properties with at least 30 units.

- **Building age:** The program did not target specific building vintages. The median age of the properties was about 30 years, although building vintages spanned the 1920s to the mid-2000s.
- **Property ownership:** Participation with more than one property was common, but property ownership varied across the market-rate and affordable housing properties. Corporate firms generally own the market-rate housing, whereas a mix of 501(c)(3) nonprofits and corporate property owners and developers own or manage the affordable housing properties. Most of the participating property owners own more than 30 properties in California (3 of 5 property owners interviewed), while the others owned three properties.
- **Project time:** For most projects, project implementation extended over at least 16 months, as determined by the date of the Basic Energy Assessment Report to the date of the Verification Report that summarized the measures installed, expected energy savings, and incentive amount. Note that, while property owners were participating in the Pilot, all of them were also making other upgrades as part of the comprehensive remodeling effort. Altogether, this indicates that projects can take about 1.5 years from start to finish and has implications for setting realistic program implementation cycles for whole-building design serving the multifamily sector.

Based on ex-ante savings, the Pilot properties are expected to achieve an average of 20.4% annual savings (range: 10.5% to 41.5%) relative to their baseline energy use (Table 2). In terms of costs, the program provided $1.79 million in free energy assessments and rebates for energy-saving measure installations. Property owners invested a total of $4.4 million in these projects. On average, the rebates for energy-saving measure installations covered about 41% of the property owners' investment, and the Pilot paid almost $120,000 in free assessments and incentives per property, translating to $144 per MMBtu saved (ex ante).

Table 2. Ex Ante Property Savings and Incentive Costs

Property Attributes				Ex Ante Annual Savings					Total Property Owner Incentives (Assessment + Rebate)	Incentive per MMBtu
ID	Type[A]	Size (ft²)	Units	kWh	kW	Therms	MMBtu	% Site Savings		
8842-011	M	406,875	403	9,319	0.00	22,438	2,276	18.5%	$301,980	$133
8842-002	M	296,872	336	130,622	2.08	15,696	2,015	18.5%	$250,570	$124
8842-003	M	293,200	356	94,394	1.13	16,168	1,939	15.1%	$277,093	$143
7426-006	A	74,238	76	135,610	69.52	12,044	1,667	26.2%	$109,810	$66
1383-002	A	78,644	90	141,878	64.00	9,584	1,442	34.4%	$151,412	$105
7426-004	A	128,670	168	109,763	54.41	4,063	781	17.2%	$157,720	$202
1383-005	M	158,816	121	106,969	24.85	519	417	11.2%	$105,357	$253
7426-005	A	52,536	54	17,905	12.96	2,617	323	16.9%	$59,940	$186
7426-003	A	65,243	115	50,988	23.66	1,379	312	10.5%	$105,770	$339
8842-004	A	10,875	26	4,571	0.04	2,890	305	38.7%	$53,800	$177
8842-008	A	37,092	41	6,962	0.34	2,040	228	12.9%	$41,016	$180
8842-006	A	6,400	15	2,009	0.21	2,169	224	41.5%	$35,526	$159
8842-007	A	15,803	44	12,064	1.18	1,806	222	22.2%	$56,316	$254

8842-005	A	21,648	44	391	0.03	1,172	119	11.4%	$44,036	$372
1383-003	A	17,500	30	26,279	3.19	592	149	11.1%	$41,243	$277
Total	**n/a**	**1,664,412**	**1,919**	**849,724**	**257.60**	**95,177**	**12,417**	**n/a**	**$1,791,589**	**n/a**
Average per unit	**n/a**	**n/a**	**n/a**	**443**	**0.13**	**50**	**6**	**n/a**	**$934**	**n/a**
Average per property	**n/a**	**110,961**	**128**	**56,648**	**17.17**	**6,345**	**828**	**20.4%**	**$119,439**	**$198[B]**

[A] A = Affordable housing property; M = Market-rate property.

[B] The average of all property's Incentives-per-MMBtu ($198) is slightly different than the Pilot-wide Incentives-per-MMBtu ($1,791,589 ÷ 12,417 MMBtu = $144).

Across all Pilot properties, property owners installed a mix of 23 types of measures. The most commonly installed measures per project were water-saving, water heating, lighting, and HVAC measures. Based on the relative savings for each of the measures installed at properties, we found that 12 of the measures were consistently important drivers of the expected savings per site (Table 3).

Table 3. Pilot Measure Mix and Major Contributors to Property Savings

Measure Description	% of Properties Installing (n=15)	Measure Was a Major Contributor to Property Savings[A]
Low-Flow Faucets	87%	–
Lighting	73%	–
Low-Flow Shower Heads, Aerators	67%	Yes
Domestic Hot Water Heaters	53%	Yes
HVAC	40%	Yes
Pipe Insulation	33%	Yes
Boilers	33%	Yes
Windows	33%	Yes
Insulation (Attic)	27%	–
Refrigerators	27%	–
Washing Machines	27%	Yes
Exterior Lighting	20%	–
Boiler Demand Control Pumps	13%	–
Variable Speed Pool Pumps	13%	Yes
Demand or Other Controls on Recirculation Pumps	13%	Yes
Domestic Hot Water Temperature Control	7%	–
Appliances	7%	–
Furnaces	7%	Yes
Wall Insulation	7%	Yes
Low-Flow Toilets	7%	–
Cool Roof	7%	–
Pool Heaters	7%	–

[A] Indicates whether the measure's combined gas and electric savings were relatively high compared to other measures installed at the property, as determined by the evaluation team by reviewing EnergyPro model files. Measures marked with "Yes" were one of the two top measures for at least one property.

This process evaluation did not attempt to rigorously measure free-ridership but did explore this topic lightly during participant interviews. Although most property owners already had plans to make energy efficiency upgrades as part of a larger retrofit, they would have completed different building upgrades had they not enrolled the property in the pilot. Property owners indicated that the program did generally not influence the project scope in terms of *which* products they would install. However, property owners tended to report that they would have installed *less-efficient* products without the program for most measures.

Although the Pilot fell short of its property-level enrollment and savings goals, aspects of the properties upgraded through the Pilot compare favorably to those completed through the SDG&E pilot (market rate participation and per-unit kWh, therms, and MMBtu savings) and the PG&E pilot (market rate participation and per-unit therms) (Table 4).

Table 4. Comparison of Ex Ante Savings and Incentive Costs by EUC MF Pilot

				Average Savings per Unit (Ex Ante)			Pilot Savings Totals			
Pilot	# of Properties	# of Units	% Market Rate	kWh	Therms	MMBtu	kWh	Therms	MMBtu	Total Incentives Paid
SCE/ SoCalGas	15	1,919	27%	443	50	6.47	849,724	95,177	12,417	$1,791,589
PG&E[A]	7	513	0%	1,303	48	9.26	668,536	24,687	4,750	$527,470
SDG&E[B]	6	574	DK[B]	858	26	5.54	492,290	14,981	3,178	$614,834

[A] Source: SBW/Opinion Dynamics (2014).

[B] Source: TRC (2013). Includes savings and incentives associated with several coordinated and overlapping programs: SDG&E's EUC-MF pilot, SDG&E's ESAP, and program incentives from the County of San Diego and City of San Diego. TRC (2013) reported that market rate properties were a "a minority" of SDG&E pilot properties.

However, a valid comparison of all the costs and savings for all of the pilots should be conducted based on ex post savings and final program costs that account for both incentives and administration. A comparison of the gross savings realization rates across the pilots will also help determine the effectiveness of SCE/SoCalGas's unique approach of using billing data to calibrate the ex ante modeled savings estimates.

- ***We recommend that the six EUC multifamily pilots collectively report on the following information in the future: conversion rates (full assessment to project), implementation cost (total, cost per project, cost per unit per project), and ex ante savings levels (ex ante savings per unit, ex ante savings per project, measure mix per project). We also recommend that the pilots report on savings accuracy as indicated by realization rates comparing ex ante savings to ex post savings per project.***

It will be important that the pilots report on these data both on average per project and the actual data per project, for which the analyst will need to know the measure mix, realization rate, and cost for each project. For example, if a pilot had three completed projects, it should provide the following information.

Table 5. Example Pilot Outcome Data Needed for Comparison

	Realization Rate	Ex Ante Savings	Measure Mix	Program Cost	# of Units Retrofitted	Gas/Electric/Combo	Conversion Rate
Project 1	XX%	kWh, kW, Therms	Windows, Insulation, etc.	$15K	200	Combo	n/a

Project 2	XX%	kWh, kW, Therms	Windows, Insulation, etc.	$13K	100	Electric	
Project 3	XX%	kWh, kW, Therms	Windows, Insulation, etc.	$17K	230	Combo	
Total	Xx%	n/a	n/a	$	n/a	n/a	70%

The realization rate would be calculated as the ratio of the final reported ex ante savings per project (as claimed through the program) relative to ex post savings per project (as verified in a billing analysis conducted after pilot completion).

We recommend calculating the conversion rates following methods we used in this analysis (see Section 4.1). The conversion rates are:

Conversion from Basic Assessment to recommendation for a Comprehensive Assessment

CR1 = (# Properties recommended for Comprehensive Assessment) / (# Properties completing Basic Assessment)

Conversion from Comprehensive Assessment to completed Pilot upgrades

CR2 = (# Properties completing program upgrades) / (# Properties recommended for Comprehensive Assessment)

Overall Conversion Rate

CR3 = (# Properties completing program upgrades) / (# Properties completing Basic Assessment)

Design Assessment and Recommendations

The Pilot design had a number of strengths and weaknesses bringing the whole-building concept to the multifamily market. Below we summarize the evaluation results across several key design components, including the incentive structure, the closed-rater model, and program requirements.

Incentive Structure: The Pilot provided Comprehensive Assessments at no cost to participants and provided a tiered incentive structure based on the expected project savings compared to baseline usage. As shown in Table 6, most participants completed projects in the lower tiers of the incentive structure.

Table 6. Achieved Pilot Incentive Levels by Property Type

Property Savings	Per-Unit Rebate	Market-Rate Housing (n=4)	Affordable Housing (n=11)	Total Number (n=15)
10%–14%	$700	25%	36%	33%
15%–19%	$800	75%	18%	33%
20%–24%	$1,000	0%	9%	7%
25%–29%	$1,200	0%	9%	7%
30%–35%	$1,400	0%	9%	7%
>35%	$1,600	0%	18%	13%
Total	**n/a**	**100%**	**100%**	**100%**

The main benefit of this approach is the flexibility granted to customers interested in an entire suite of energy-saving upgrades. One disadvantage of this approach—as echoed by all three UCs and several participating property owners—is its added complexity compared to other multifamily program options. Several property owners struggled with estimating their incentive payments based on Assessment Reports and complained that the savings and incentive calculation process lacked transparency. Further, less-experienced property owners and contractors had difficulty identifying the products that would qualify for incentives. Finally, some property owners had difficulty with what portion of their project would be covered through incentives given that energy upgrades were often part of a larger retrofit that may have included non-energy-related improvements.

- ***We recommend that the IOUs develop better communication tools regarding incentives and qualifying measures.***

Project Assessment Requirements: The Pilot had a two-phased approach to assessing properties, once via a Basic Energy Assessment and again as a Comprehensive Energy Assessment.[6] The two-phase approach was designed to provide early feedback about which properties were likely able to complete enough retrofits to meet the program's minimum 10% site savings threshold. Reflecting the Pilot's design to limit costs by providing Comprehensive Audits only to serious participants likely to achieve 10% site savings, about one-third of initial prospects that completed a Basic Assessment also completed retrofits through the Pilot (15 of 51, or 29%). About one-half of properties (45%) that UCs recommended for the more resource-intensive Comprehensive Assessments did end up completing Pilot upgrades (15 of 33).[7] UCs channeled properties that did not continue to the Comprehensive Assessment towards other programs if they could not save more than 10% for their property. Three of these properties completed upgrades through other multifamily programs.

The Basic Assessment requirement may not be needed for all properties, and UCs might be able to effectively complete this assessment via telephone for some properties. Eight of the 15 properties did not receive a Basic Assessment,[8] but all 15 properties received a Comprehensive Assessment. One concern that came out of the PG&E pilot was that providing free Comprehensive Assessments to market-rate property owners would "lead to many costly assessments on properties with no intention of completing retrofits" (SBW Consulting, 2014,

[6] For the sake of brevity, the Basic Energy Assessment and the Comprehensive Energy Assessment are referred to as the Basic Assessment and the Comprehensive Assessment, respectively, for the remainder of this report.

[7] The IOUs authorized Comprehensive Assessments at 21 of the 33 properties that UCs recommended. As noted in the body of this report, UCs estimated that Basic Assessments took 19 hours to complete (range: 13 to 25) and that Comprehensive Assessments took 127 hours to complete (range: 80 to 158).

[8] These properties did not have a Basic Assessment Report date in the program-tracking data.

p. 22). However, it appears that the SCE/SoCalGas Pilot's Basic Assessment was a good way to cost-effectively mitigate this concern while still offering free Comprehensive Assessments to truly viable program candidates.

- ***We recommend that the IOUs consider continuing to require an on-site Basic Assessment while still allowing the flexibility for a telephone assessment in cases where enough information can be captured via telephone.***

The Closed-Rater Model: The main benefit of a closed rater model is the ability to control installation quality thereby offering a more standardized customer experience. For this Pilot, the IOUs hired three UCs to serve in the rater role. As such, the UCs guided participants through a series of steps to screen, qualify, install, and verify whole-building retrofits. The IOUs selected the UCs based on their previous experience in the California multifamily market. Table 7 provides a more detailed overview of the UCs' qualifications and lists each UC's pilot activity.

Table 7. Utility Consultants' Qualifications and Property Enrollment during the Pilot

Utility Consultant	Unique Strengths	Pilot Property Enrollment
AEA	• Involved in the BayREN and MCE EUC multifamily programs • Brings in institutional knowledge of working with multifamily properties in northern California • Supports the New York State Energy Research & Development (NYSERDA) Multifamily Performance Program, the Con Edison Multifamily Energy Efficiency Program, and the California Housing Partnership Corporation (CHPC) Ratepayer Integrated Payment Program Predevelopment Pilot (RIOPP)	• 12 Basic Assessments, of which 8 properties completed upgrades (67%) • Completed upgrades at 50% of recruited market-rate properties (3 of 6)
Partner Energy	• Specializes in the affordable housing multifamily market • Works as rater in various EUC multifamily programs	• 31 Basic Assessments, of which 4 properties completed upgrades (13%) • Completed upgrades at no recruited market-rate properties (0 of 2)
TRC	• Has institutional knowledge of implementing the EUC-MF pilot in SDG&E territory • Has relationships with property owners who have a portfolio of buildings across IOU territories in California and therefore has an advantage to serve property owners with large portfolios of properties across the state • Involved in multifamily programs outside of California	• 8 Basic Assessments, of which 3 properties completed upgrades (38%) • Completed upgrades at 50% of recruited market-rate properties (1 of 2)

During the Pilot, there was a good degree of collaboration among all parties involved. Both the utilities and the UCs highlighted the collaborative effort and good communication in developing program processes. Property owners highlighted that the UCs were extremely helpful throughout the project and the contractors who interacted with the UCs echoed this sentiment.

Participants desire a single point of contact (SPOC) that is easy to reach throughout the participation process. IOUs initially envisioned a model in which an Account Manager at the IOU could serve as the SPOC, assisting customers with navigating through their multifamily program options and referring them to the most appropriate program. The Pilot also intended for extensive coordination among the Pilot and existing multifamily programs. Thus, our evaluation originally had intended to explore whether an IOU-based SPOC worked as intended during the Pilot. However, early in implementation, the UCs also functioned as SPOCs, and

seemed to handle the outreach and recruitment process well. Further, the UCs were also referring customers to other multifamily programs if the Pilot was not a good fit. As such, the UCs assumed the role of SPOC as they interacted with customers. The UC-based SPOC approach was well received by most property owners and contractors. Property owners who own multiple properties throughout California may also benefit from working with a SPOC who can help them navigate their options across service territories.

Open Contractor Model: Letting property owners choose their contractor worked well. Although few contractors held energy efficiency certifications beyond their general contracting licenses, property owners were, in most cases, satisfied with their contractors. Property owners typically hired contractors with whom they had an extensive prior working relationship. Moreover, the UCs reported few inspection failures related to installation issues. Property owner complaints about contractors were isolated and seemed to occur in cases where either the property owner or the contractor had less experience in whole-building energy efficiency upgrades. Consequently, these property owners reported either trimming their Pilot scope or not requesting rebates for measures because the contractor was unable to supply adequate documentation.

- ***To preserve the open contractor model, the program should continue inspecting contractor installations, but consider using specific forms to document any installation issues and providing protocols about how to direct contractors toward training resources as needed.***

Implementation Cycle Time: Broadly speaking, program manager feedback indicates that the originally-envisaged Pilot period (1 year, from 2013 to 2014) was too short. Beyond several project-specific delays due to CAS test results and managerial staff turnover at participating properties, whole-building multifamily property upgrades are inherently a longer-term process due to their complexity and level of coordination. The IOUs needed about 2 years for the Pilot and would likely need at least 2- to 3-year program cycles. Most property owners want a "phased implementation" plan over a longer period, suggesting a program that allows phased participation over 2–3 years could best accommodate market-rate properties.

- ***We recommend considering a rolling program design and its implications on a given implementation cycle time. It is worth considering whether the IOUs can support a longer-term, rolling unit participation model. This would be a drastic shift in program design and would require a longer-term commitment to the customer but may be worth considering.***

Serving Multifamily Market Needs Statewide: Structural barriers to high program uptake remain in the marketplace. These barriers arise because multifamily customers may prefer staggered in-unit rehabilitation projects on tenant turnover (according to property owners interviewed in this evaluation), because customers with gas measures may be turned away by the added liability and costs related to CAS testing required through the EUC Pilots (according to two of the three UCs, and some property owners interviewed in this evaluation, as well as findings from the PG&E EUC-MF pilot), and because customers still need to be educated on their portfolio of properties. Education will help them understand the energy usage at each property, determine the energy efficiency needs of each property, match the right program to the property needs at the right time, and monitor property performance over time.

- ***To serve the customer best, it may make sense to have one statewide multifamily program design and incentive structure. Such a program might still be able to offer several different sub-options.***

Marketing and Outreach: While marketing efforts are limited in this Pilot, the UCs leveraged existing relationships with property owners to attract customers. In addition, the IOUs had a number of interested customers at hand and referred them to the UCs. Therefore, this Pilot did not intend to test ways to best market and target customers in the program cycle. In other jurisdictions, some low-cost data analytic tools are used to target buildings with the greatest need for the upgrades.

- ***To target customers in the future, the IOUs should consider leveraging or building on analytic tools that track and benchmark energy and water use for multifamily properties.*** Benchmarking and comprehensive project planning is a long-term effort that can take several years before a property owner is ready to conduct a comprehensive upgrade. Given the implementation cycle allowed for the Pilot, it was limited in its ability to fully develop and execute a benchmarking strategy. Massachusetts successfully applied this approach recently.[9] Like the Massachusetts case study, the IOUs already have ways to target customers based on billing data analysis. The IOUs also are currently developing plans for benchmarking properties, and California multifamily property owners in California are encouraged to participate in benchmarking efforts.

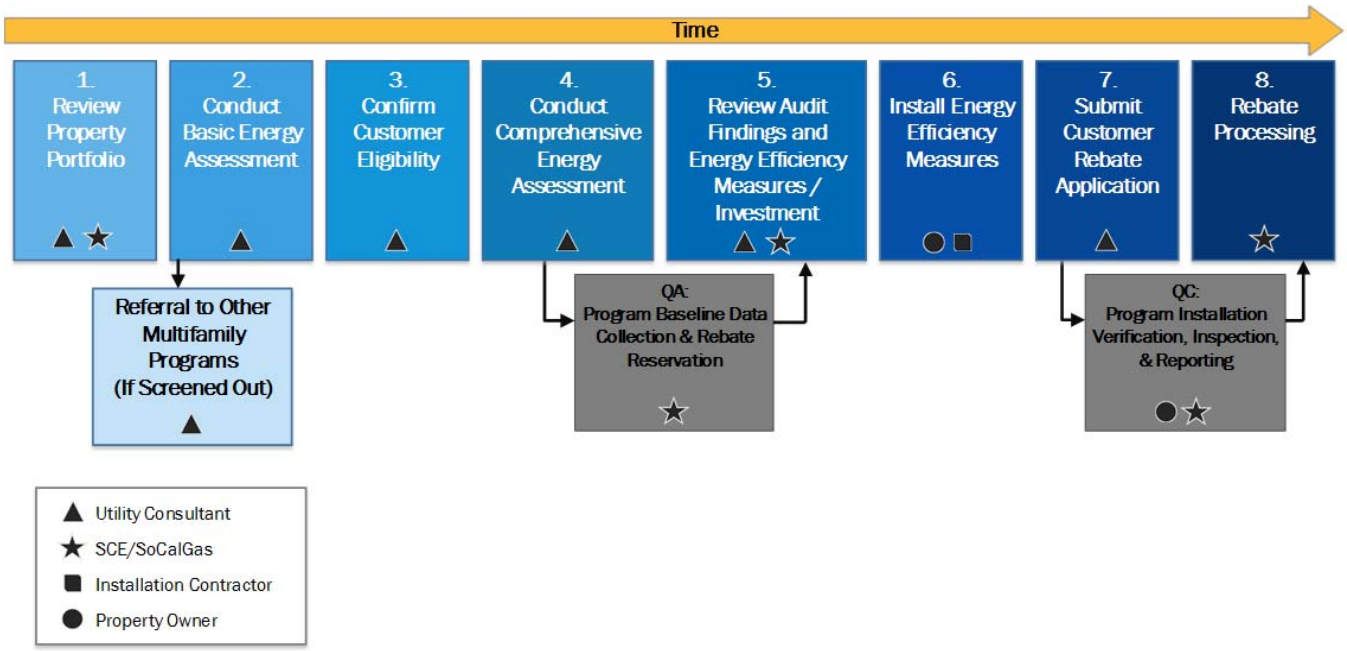
Implementation Assessment and Recommendations

Overall, the Pilot served as a useful test of how to implement a comprehensive whole-building multifamily program design. This evaluation, as well as the IOUs and UCs' own processes of learning by doing (part of all Pilot programs), have identified a number of strengths and weaknesses of the implementations approach that warrant consideration as the CPUC determines what would be needed to bring this design to scale.

The Pilot included eight main phases, starting with reviewing the property and ending with rebate processing, which we depict at a high level in Figure 1 on the next page. Program delivery included four main groups of stakeholders: SCE/SoCalGas, three UCs, property owners, and installation contractors. As shown in the figure, there are a number of steps, reports, and parties involved in implementing each project.

[9] Smith, Gray & Harrington (2014) describe a pilot that used existing utility data and information from prospective participants' program applications to benchmark over 10,000 buildings to develop a web-based data visualization tool that helped utilities identify highest saving properties and shape marketing and project conversion conversations around the specific property's energy use. The authors suggest that these tools are low-cost in comparison to potential studies (to determine market opportunity) and labor-intensive project qualification processes.

Figure 1. Pilot Project Implementation Diagram



QA/QC Processes: The Pilot included a variety of detailed QA/QC steps. First, the UCs conducted the final on-site inspection of all installed measures and created a Verification Report that specified the measures installed, building characteristics, and modeled energy-savings estimates. The IOUs then conducted an engineering desk review of this information and went back and forth with the UCs as needed to change or clarify data. IOUs report that, based on the documents received from UCs early in the Pilot, the IOUs felt it was necessary to review each subsequent document in detail.

Based on our review and IOU interviews discussed below, the Pilot's extensive QA/QC processes had mixed success. A main benefit of detailed QA/QC processes was that they served to explore the quality and feasibility of methods tested in the Pilot, thereby providing feedback that could inform the design of other pilots or a full-scale program. These QA/QC efforts led to improvements in the accuracy of modeled energy savings and strengthened the quality and accuracy of program reports (based on our review of program materials and the IOU program manager interviews). On the other hand, the amount of time that the IOUs' engineering review teams and the UCs spent to resolve QA/QC findings does suggest that this level of analytical and administrative time may not be scalable in a full program.

The evaluation team investigated the difference between the UCs' initial savings estimates and the final estimates after the IOU engineering desk review, using the project files. This investigation was limited due to a lack of documentation that explained all assumptions used in modeling files and tracked changes across project reports. Anecdotally from the IOU engineering staff, we gathered that most of the issues found during their engineering desk reviews involved proper modeling of baseline and upgraded equipment (e.g., measure capacity, efficiencies, or quantities), ensuring that model outputs matched report tables and text, and clarifying discrepancies within report tables and text. Fixing these issues apparently resulted in changes to the UCs' initial estimates within ±5%. While this may not seem like a large difference, given that incentive levels change based on the percent of savings expected, this engineering review is likely very important to uphold as this program goes to scale.

- *We recommend that the IOU engineering team document the common errors and issues that it had during the Pilot and translate them into a manual or checklist for the UCs to follow to help reduce the IOU review time. In this effort, it would be helpful to include a tabulation of the causes often driving the back-and-forth between SCE engineers and UCs. These common methodological discrepancies could then be addressed in future UC training efforts to serve as a part of feedback loop.*

The IOUs spend several hours per project verifying the UC estimates. This could be a reasonable amount of effort to support a scaled program, depending on the annual participation expectations. Given the difficulty in recruiting just 15 properties in two years that were market-ready for a whole-building retrofit in this Pilot, it is possible that annual participation could be similar if this program goes to scale in the marketplace. Further, impact evaluation results are still pending. Knowing how accurate the ex ante estimates are can help determine the value of the IOU engineering review step.

Further, the IOUs did not do any on-site verification or inspection of any of the projects and only verified the project information provided by the UCs via a desk review. It remains a question as to how reliable the UC information is because ex post impacts have not yet been calculated.

- *If the impact evaluation finds a large difference in ex ante and ex post savings, then the Pilot may need to begin some inspection of a sample of the projects conducted in the future to ensure that program recordkeeping is not a contributing factor.*

Energy Savings Assessment: The UCs estimated energy savings by modeling the measures and building characteristics in EnergyPro software. The Pilot added one more dimension to this stage by calibrating the models of baseline energy use to reflect the properties' billing, or usage history. This calibration step was a key difference in SCE/SoCalGas's approach compared to the other pilots. Calibrating EnergyPro models to building energy usage histories benefited the accuracy of savings modeling, but was a time-intensive process. Calibration is both an art and a science, and not all adjustments made during the calibration phase were documented. Based on our review, some building assumptions were not accurate. For example, a lighting or HVAC operation schedule did not match typical schedules of a multifamily property. According to follow-up information from IOU engineers, these deviations reflect adjustments that the UCs made to the models so that total energy use reflected the building's usage history. However, with the documentation available, we could not independently determine in all cases exactly what adjustments were made, or why – and whether these adjustments were in line with actual building operations.

- *Moving forward, we recommend better documentation and justification for the EnergyPro modeling adjustments that UCs make during the calibration phase.*

As part of this process evaluation we sought to determine whether energy savings from the Pilot's methods are not only verifiable, but also reasonable, accurate and valid. We could verify that much of the Pilot's ex ante savings were estimated using appropriate site-specific methods, including reasonable baseline energy use, accurate building characteristics and accurate quantities and product specifications for the measures driving most of each site's savings. However, documentation provided for the evaluation did not transparently describe all assumptions and sources and did not explain discrepancies to the extent that we could verify all savings in a cost-effective manner. These data gaps prevent us from making a conclusive determination about savings accuracy and validity of the method as implemented. Per the EnergyPro modeling reviews, our major process findings in this area are:

- All baseline models appear to have reasonably captured the most important components of building conditions, but gaps in calibration records prevented us from determining the reasonableness of all calibration decisions.

- Only “baseline” models were calibrated to actual building energy use.
- The Pilot could benefit from more consistency in how domestic hot water heater replacement measure efficiencies are modeled.
- The Pilot did not appear to require the UCs to name model files using any particular naming convention.
- In most cases, for the test-in/test-out conditions, general photographs of the equipment were included in the report.

Table 8, on the next page, summarizes the key issues and recommendations related to project documentation and ex ante savings estimates to consider if this Pilot transitions to a full program.

Table 8. Summary of Project Documentation Issues and Recommendations

Document Type	Issue[A]	Main Implication(s) of This Issue	Recommendation to Improve for Future
Assessment and Verification Reports	Reports are missing a complete list of EnergyPro assessment model inputs (6 properties, 7 measures)	Reviewers cannot fully verify all assessment model savings because available information does not allow reviewers to trace the reasoning for differences between assessment and verification models. This creates confusion and adds additional cost and time to technical reviews.	The IOU program managers should consider archiving assessment models (as run for the assessment report) before proceeding with verification model development so that assessment models can be compared to verification models.
	Sources behind EnergyPro modeling assumptions are not documented (8 properties, 8 measures)	Without source citations, reviewers cannot assess the appropriateness of the assumptions made to calculate savings. This calls into question the accuracy of the results and adds additional cost and time to technical reviews.	UCs should clearly justify all assumptions made when modeling the measure savings. If UCs draw a value or technique from modeling guidelines or another approved source, clearly state the source.
Building Energy Use Models	EnergyPro inputs are inconsistent with reported property description (2 properties, 2 measures)	In the cases we identified, no discrepancies were a major cause for concern about savings accuracy, but the level of review needed to make this determination is an unnecessary cost. These errors create confusion and add additional cost and time to technical reviews.	Ensure that UCs' Comprehensive Assessment Reports and Post-Upgrade Verification Reports accurately describe the inputs to the final models and detail known discrepancies between models and actual conditions (e.g., to achieve calibration).
	Incorrect or unreasonable model schedules and set-points (8 properties, 8 measures)	Many of the modeled heating/cooling schedules appeared unreasonable; it appears that the UCs used these schedules to achieve calibration. In other cases, no justification is provided for the modified schedules. This calls into question the accuracy of the models and the calibration activities, and may lead to inaccurate savings. It also adds time and cost to technical reviews.	UCs should base schedules on modeling guidelines and should provide written justification where schedules do not follow guidelines. Schedules and set-points should be reasonable wherever possible (i.e., what would be expected for the building type). If calibration can be achieved only by using unreasonable inputs, this either suggests a larger problem with the EnergyPro model or signals that some attributes of the actual building haven't been captured in the model.
Overall Documentation	Inadequate documentation of adjustments made for calibration (15 properties, 15 measures)	Reviewers cannot clearly see what changes the UCs made to assumptions in creating the calibrated model and cannot assess the reasonableness of the changes. This adds time and cost to technical reviews.	UCs should detail modifications made for calibration (e.g., "The heating set-point was changed from 70°F to 72°F to match existing conditions," instead of "The heating set-point was adjusted"). This level of documentation will save time in future technical reviews and ensure that input changes are reasonable.
	No documentation explains differences between assessment and verification conditions (10 properties, 18 measures)	Reviewers cannot fully trace savings calculations. Reviewers cannot see what changed from the original assessment estimate or why the UC made changes. For example, *does the quantity of a measure in the verification model differ from the quantity in the assessment model because the property owner installed a different quantity of equipment than planned? Did the efficiency change because the proposed efficiency was unavailable from the manufacturer?* This type of information is essential for a reviewer to identify areas for improvement for future assessment estimates. Providing this information also saves time and cost in technical reviews.	Ensure that UCs clearly and completely explain any differences in savings between the Comprehensive Assessment Report and the Verification Report.

[A] Issues identified out of 15 properties and 30 measures reviewed (2 per property).

Energy Efficiency Measure Installation: Customers selected the UC-recommended measures and selected their own contractor. Only one of five interviewed property owners reported issues with measure installation quality or their contractors; this individual reported that their contractor installed products that did not meet the minimum performance requirements set out by the program. Indirectly connected to measure installation, some property owners (two of five) reported issues related to translating Comprehensive Energy Assessment recommendations into practice. Smaller properties and contractors less experienced with whole-building upgrades tended to lack clarity about which products they should install. Some property owners also struggled with how their choices would impact the potential savings and incentive levels. Other property owners were confused about whether structural building costs to accommodate energy efficiency measures would be eligible for incentives. Both issues can be particularly confusing in whole-building design programs when several structural, cosmetic, and non-energy-related renovations are happening concurrently with energy efficiency upgrades.

- *To smooth out measure selection and installation, we recommend that the IOUs or the UCs provide additional guidance and communication during these steps, such as restructuring reports to provide more actionable information or by formalizing the technical assistance to property owners that helps them understand what measures to select, how incentive levels will be impacted based on different scenarios and clear communication regarding what is covered by the program in light of other non-energy-related costs.*

Required Forms and Reports: IOUs developed Pilot forms, databases, and report templates at the start of the Pilot. As with program pilots in general, this Pilot experienced a learning curve in designing and using these forms and reports to best effect. For example, the UCs and IOUs spent substantial time drafting, reviewing, and revising Assessment Reports and post-installation Verification Reports. As a result, the UCs felt that the report review cycle was too lengthy to keep up with project planning. The IOUs chose to conduct this extensive review both out of concerns about quality seen in early reports as well as out of interest in completing the reviews as a useful learning exercise. It is important to consider, however, that property owners change project plans frequently, and the reporting requirements and review points need to be quick and nimble enough to accommodate frequent project plan changes between the assessment and final project stages. While the IOUs note that they spent a large amount of time reviewing UC documents where paperwork did not meet the IOUs' quality and reporting requirements, if the Pilot progresses to full scale, we assume that review timelines could be streamlined given increased confidence in UC quality and experience.

Beyond the learning curves a Pilot typically faces, we also observed that reporting requirements tested in the Pilot did place a relatively higher burden on the UCs and IOU program staff than the UCs recall experiencing in other multifamily programs. Further, while some property owners appreciated the detailed reports, others thought that they were too technical and not actionable enough. In short, the Pilots' reports apparently provided information that was either too detailed or not timely enough for some property owners, yet not detailed enough to provide sufficient documentation of engineering model development and calibration steps. To fill in the gaps, property owners generally kept in contact with their UC to discuss Assessment Report findings and project implications, and the IOU had several rounds of discussions with the UCs when reviewing reports. In the scheme of overall Pilot implementation, these outcomes resulted in delays to project schedules and increased time costs.

The Pilot program experience suggests that IOUs can improve the reporting process by developing several smaller, more specialized reports that each target a specific program stakeholder's informational needs.

- *Specifically, we recommend:*

- ***A Customer-Focused Assessment Report:*** Customers need more information to understand the energy efficiency opportunities at their property and how to conduct the project within Pilot guidelines. They also need to know which measures they can choose, what costs will be covered by incentives, and what the property owner's total investment costs will be. To implement this, the Pilot could:

- **Restructuring customer-focused reports so that they provide more support for those property owners still developing their upgrade scope.** Primarily, the Pilot should focus on making reports to property owners more actionable. For example, to reduce the time property owners spend searching for appropriate products, reports could include a list of products that meet program performance requirements or specify the required efficiency levels and features for specific measures. To make the report more digestible for property owners with limited technical background, the Pilot could also simplify the report and provide a table summarizing all upgrade recommendations, estimated costs, and site savings.

- **Providing more transparency about which measures are eligible for rebates.** Because the Pilot offers rebates based on energy savings, not project costs, customer-focused reports should clearly state that ancillary upgrades made to accommodate the retrofit are not eligible for rebates. For example, documentation should clearly state that the Pilot will not reimburse costs of structural changes needed to accommodate Pilot upgrades.

- ***A Verification-Focused Technical Report:*** A spreadsheet format of just the technical aspects of the building and assessment that is entirely used to facilitate verification and QA/QC. This spreadsheet could build on the post-project verification workbooks already used to record which measures were installed per unit. In this report, the Pilot should consider:

  - **Requiring the UCs to justify why they recommended specific measures for a property.** In conducting our engineering review, we found that the UCs did not fully justify why proposed equipment was selected for the properties. We recommend that UCs describe their decision-making process in the Assessment Report so that external reviewers can understand which factors went into equipment selection (cost, available incentives, customer preference, space, or other limitations, etc.). For a full-scale program, these justifications could also help in determining instances of free-ridership.

- ***An Energy-Savings Report:*** A narrative report recording major assumptions and judgment calls that UCs used to calculate energy savings, including everything that the IOU would need to review the quality and completeness of EnergyPro savings models.

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2. Introduction

This report presents results from a process evaluation of Southern California Edison (SCE) and Southern California Gas Company's (SoCalGas) Energy Upgrade California™ Multifamily Pilot (EUC MF) Program (the Pilot). For the process evaluation, we examined pilot performance in terms of the program's design and implementation. To put these program design findings in context, we present the program-tracking data's ex ante savings and report on a higher-level review that we completed of the Pilot's model-based process for developing these ex ante savings. However, this report is not an impact evaluation and therefore did not estimate ex post impacts; all impact estimates presented in the report are ex ante. The program's impact evaluation is a separate effort that was still underway at the time of this report.

The Pilot launched in September 2013 and was one of six EUC pilots[10] that were designed to test an incentive and technical assistance approach to promoting comprehensive (whole-building) energy efficiency upgrades in the existing multifamily sector. Primary targeted measures included building shell upgrades, high-efficiency HVAC units, central heating and cooling systems, central domestic hot water heating, and other deep energy reduction opportunities.

The multifamily market has significant potential to deepen energy savings and support statewide energy efficiency goals. This section provides high-level context about the multifamily market in California based on recent literature available.

- **Market size:** As of 2009, at least 960,000 households in SCE's service territory lived in multifamily buildings with two or more units, which represents one-third (31%) of all households and approximately 1.88 million people.[11] The annual energy consumption from tenant units alone was 4,093 GWh in 2009.[12]

- **Buildings and Equipment:** The U.S. Census Bureau estimated that in SCE territory almost half (46%) of all multifamily buildings have fewer than 10 units, one-third (34%) have between 10 and 49 units, and one-fifth (20%) of all multifamily housing have 50 or more units. According to these U.S. Census data, many multifamily buildings in SCE's territory are older; almost two-thirds (65%) were built before 1980 (i.e., about 35 years old at the time of the Pilot). Estimates suggest that 75% of households (in PG&E and SCE service territory) have some CFLs and approximately 70% of units have air conditioning, with about half (50%) having units that are eight years old or older.[13]

- **Structure of Operating Companies:** Multifamily buildings have a diverse array of owners that range from housing management corporations, real estate investment trusts, and for-profit individuals to public housing agencies and nonprofit organizations.[14] The multifamily market is concentrated and large companies dominate the market. National estimates from 2002 suggest that 5% of operators

[10] The six Program Administrators offering EUC multifamily program pilots are: SCE/SoCalGas, Pacific Gas and Electric (PG&E), San Diego Gas & Electric (SDG&E), the Southern California Regional Energy Network (SoCalREN), Marin Clean Energy (MCE), and the Bay Area Regional Energy Network (BayREN).

[11] The Cadmus Group, 2013a. These data are based on the 2009 California Residential Appliance Saturation Study (RASS) prepared by KEMA in 2010 for the California Energy Commission, CEC-200-2010-004. The estimated size of the multifamily sector is likely a conservative estimate, as U.S. Census Bureau's American Community Survey Public Use Microdata for 2009 suggested a significantly larger market of 1,739,228 households living in multifamily housing.

[12] The Cadmus Group, 2013a. Multiplies RASS data estimates for per household consumption with the number of households in multifamily building.

[13] The Cadmus Group, 2013a.

[14] EPC, 2013.

manage 75% of rental properties.[15] A more recent survey from the Cadmus Group[16] yielded similar results.

- **Decision Making:** Rental operators' decision-making processes differ in company size, as smaller operators in buildings with fewer than 70 units are unlikely to have on-site personnel. Building owners of larger properties tend to hire property managers and have multiple layers of decision-making.[17] The majority of property owners (69%) state that they are sole decision makers, while property managers typically consult with other decision makers to determine upgrades (62%).[17] This highlights the importance of involving owners in marketing and outreach. Furthermore, priorities differ between property owners in the affordable housing and market-rate sectors. Owners of affordable housing are primarily concerned about safety and protecting infrastructure investments, whereas the concerns of owners of market-rate structures typically relate to profitability. [17]

Multiple documents, including the Pilot's Program Implementation Plan, the Statewide IOU EUC Multifamily Public Workshop in March 2014, and several recent program evaluation reports discuss potential barriers to completing upgrades through multifamily programs. The following barriers emerged most commonly:

- **Economics of split incentives** as property owners carry the costs of energy efficiency upgrades without directly benefitting from reduced energy costs
- **Upfront capital costs and access to capital**, especially where property owners carry the cost of initial assessments
- **Insufficient return on investment** due to split incentives and impact on rental income: Market-rate property owners are generally concerned with the bottom line (profitability) and consider a 5-year payback period as feasible[18]
- **Lack of knowledge about energy efficiency**
- **Customer inconvenience** of dealing with multiple contractors and site visits or any added workload beyond business as usual
- **Challenges in accessing decision makers**
- **Tenant time burden and tenant inconvenience**
- **Upgrade timing:** Market-rate property owners often plan to complete holistic upgrades as part of a larger retrofit to the property, such as the time when a new roof or cosmetic upgrade is installed. Among affordable-housing properties, the low-income housing tax credit program cycles also influence when property owners are able to participate in upgrade programs. Further, all property owners typically need some time to gather internal approvals and funding for projects of this size and therefore the lead time from program awareness to participation in the program could span multiple years.

Like all the EUC multifamily pilot programs, the SCE/SoCalGas[19] program's incentive structure included both assessment and retrofit incentives designed to achieve deeper retrofits than existing prescriptive rebate

[15] Oh et al., 2002.

[16] The Cadmus Group, 2013b.

[17] The Cadmus Group, 2013a.

[18] SBW/Opinion Dynamics, 2014.

[19] Throughout the report, we refer to SCE/SoCalGas as "the investor-owned utilities" or "the IOUs," except where needed to distinguish the SCE/SoCalGas Pilot from pilots run by other program administrators.

programs available to California multifamily properties. All EUC multifamily pilot programs incorporated assessment incentives; in the SCE/SoCalGas Pilot, assessments were offered completely free of charge. Further, like four of the other five EUC multifamily pilot programs, the SCE/SoCalGas Pilot offered tiered incentives. Participants received an incentive payment per retrofitted unit based on the expected site energy savings (%) from the project. Energy savings were modeled through whole-building energy usage simulations in EnergyPro software. In comparison to the other pilots, a unique feature of SCE/SoCalGas was that these models were calibrated to each property's energy bill history.

The SCE/SoCalGas Pilot tested several additional program delivery processes. First, the Pilot was expected to test a single point of contact (SPOC) approach, wherein a single entity would guide property owners through various energy efficiency programs and provide broad education on energy efficiency benefits. While the IOUs initially planned to be the SPOC for customers, the IOUs ultimately found it easier for the Utility Consultants (UCs) to serve as the SPOC since they UCs were given most of the customer-facing roles for the Pilot. Second, the Pilot also tested a consultant- (rater)-driven program delivery. This consultant-driven model differed from other EUC multifamily programs in California in that three utility consultants (UCs) served as the program implementers, without oversight of a centralized external program implementer. The three UCs were Affordable Energy Association (AEA), Partner Energy, and TRC. Finally, the Pilot offered combustion appliance safety (CAS) test-in at no cost for a sample of units, but required property owners to cover 100% of test-out costs after the program tested a sample of units.

The Pilot's goals were to install retrofits in 1,700 multifamily dwelling units. As of the Pilot's conclusion in March 2016, the Pilot had completed upgrades in 1,919 dwelling units at 15 market-rate and affordable housing properties. Most of these properties entered the Pilot through preexisting relationships with the UCs. Participating properties completed Basic Assessment Reports between November 2013 and May 2014 and completed Comprehensive Assessment Reports between May 2014 and August 2015.[20] The UCs submitted final Verification Reports to the IOUs between May 2015 and December 2016, and the IOUs completed final QA/QC and delivered incentive payments to property owners[21] between May 2015 and March 2016.

As part of the initial research tasks for this process evaluation, we documented the Pilot's design and implementation strategy to fully understand the Pilot and the context in which it operated. We also summarized the multifamily market conditions and market barriers, compared the Pilot to other similar programs, and provided the team's early assessment of the Pilot's strengths and weaknesses. Results of that initial effort were presented in a stand-alone memorandum (October 2014), and we have incorporated main findings from the effort into this final report.

The remainder of this document is a final report that contains our full evaluation results and feedback on the overall Pilot based on in-depth interviews with program stakeholders, our review of secondary materials and program-tracking data, and our engineering review of the Pilot's approach to estimating ex ante energy savings with EnergyPro. The remainder of this section provides additional details about the Pilot's processes and key stakeholders and details the research questions that we developed to guide a study of how well those processes performed during the Pilot. Thereafter, we have organized the report as follows.

- We present our data collection and analysis methods in Section 3, organized by data source.
- We summarize program participation and ex ante energy and demand savings in Section 4.

[20] For the sake of brevity, the Basic Energy Assessment and the Comprehensive Energy Assessment are referred to as the Basic Assessment and the Comprehensive Assessment, respectively, for the remainder of this report.

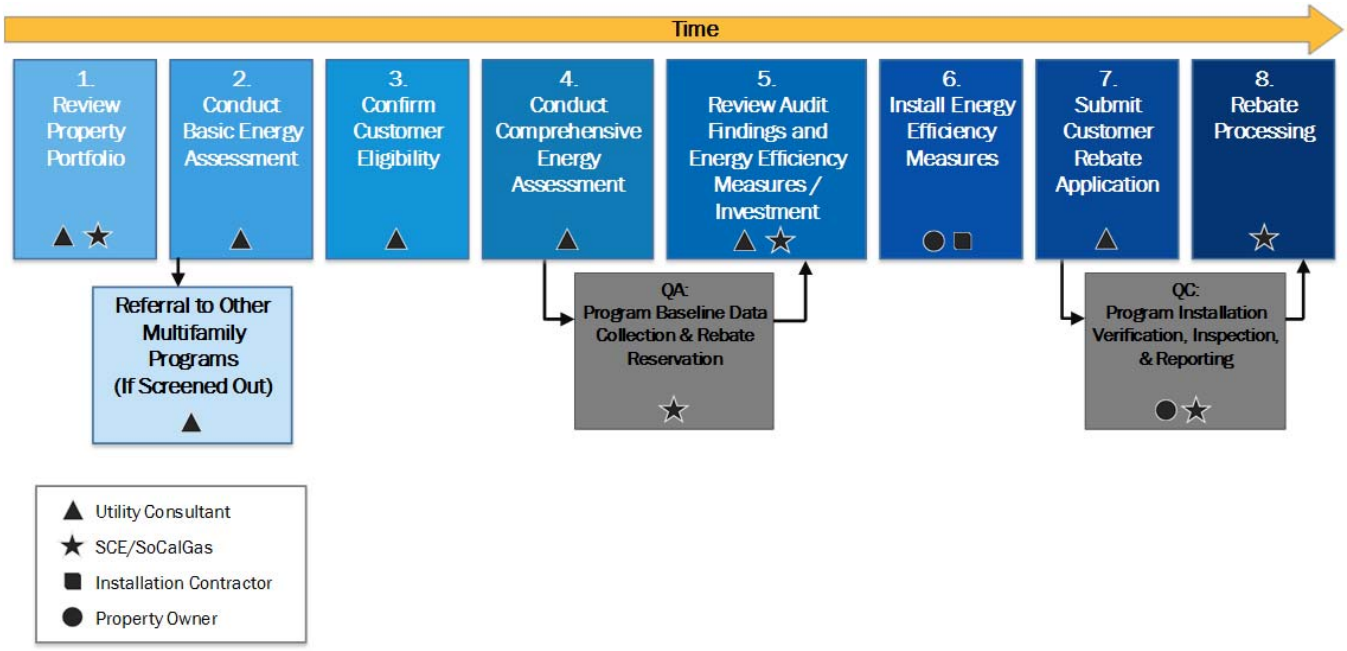
[21] The UCs worked with either property owners or managers to facilitate projects. For simplicity in this report, we refer to them collectively as "property owners" while recognizing that some were managers of the properties.

- We then present our main process findings in Section 5, organized by program design elements.
- We compare the SCE/SoCalGas Pilot to other EUC multifamily pilots in Section 6,
- We provide additional details in a set of appendices following the report.

2.1 Pilot Description

The Pilot included eight main phases, depicted at a high level in Figure 2. Program delivery included four main groups of stakeholders: the two IOUs sponsoring the program (SCE and SoCalGas), the three implementing UCs (AEA, Partner Energy, and TRC), the property owners participating in the program, and several independent installation contractors.

Figure 2. Pilot Project Implementation Diagram



The IOUs chose a closed-rater model for the Pilot, based on benefits expected from past experiences in the multifamily market. The UC's assumed the rater role for the Pilot, they had staff on-hand with the qualifications to conduct the assessments. The main benefit of a closed-rater model is the ability to control installation quality thereby offering a more standardized customer experience:

- **Ability to select qualified raters and monitor project quality**: With a limited number of consultants implementing a closed-rater program, the model allows project sponsors to better control the quality of energy efficiency upgrade installations, and to more easily monitor consultants' work. For example, open-rater models have experienced numerous customer complaints about contractors' work quality.

On the other hand, the closed-rater model has some notable drawbacks, including the following:

- **Limited market transformation:** A key intent of many EUC multifamily programs is the professional development of raters and other stakeholders so that energy efficiency upgrades can be sustained

without program incentives. As the Pilot does not train new players in the market, we expect its reach to be limited with respect to market transformation.

- **Reduced number of stakeholders for program outreach and recruitment:** Energy raters commonly have existing relationships with property owners and can thus actively promote program participation. A smaller group of stakeholders share recruitment and outreach tasks in the "closed" rater model. While this may reduce the quantity of project leads, better-controlled messaging and more-targeted marketing can also yield benefits.

SCE/SoCalGas chose the closed-rater model for the above reasons, but emphasized the value of UCs providing insights to the multifamily and low-income market space to guide the development of best practices in the Pilot. For this Pilot, the IOUs hired three UCs to serve in the rater role. As such, the UCs guided participants through a series of steps to screen, qualify, install, and verify whole-building retrofits.

The IOUs chose the UCs based on their previous experience in the California multifamily market. Table 9 provides a more detailed overview of the UCs' qualifications.

Table 9. Utility Consultants' Qualifications

Utility Consultant	Unique Strengths
AEA	• Involved in the BayREN and MCE EUC multifamily programs • Brings in institutional knowledge of working with multifamily properties in northern California • Supports the New York State Energy Research & Development (NYSERDA) Multifamily Performance Program, the ConEdison Multifamily Energy Efficiency Program, and the California Housing Partnership Corporation (CHPC) Ratepayer Integrated Payment Program Predevelopment Pilot (RIOPP)
Partner Energy	• Specializes in the affordable housing multifamily market • Works as rater in various EUC multifamily programs
TRC	• Has institutional knowledge of implementing the EUC-MF pilot in SDG&E territory • Has relationships with property owners who have a portfolio of buildings across IOU territories in California and therefore has an advantage to serve property owners with large portfolios of properties across the state • Involved in multifamily programs outside of California

To recruit customers to the Pilot, the UCs and IOUs leveraged existing relationships with property owners who were in the early stages of planning a building retrofit. Once interest in the Pilot was established, the UCs typically had a telephone conversation with the prospective customer to schedule a Basic Assessment, to gather preliminary building data, and to confirm the desired scope. Some UCs gathered basic building data over the phone.

For each site, the UCs next conducted the Basic Assessment to examine property potential in more detail. Following the visit, the UCs provided a short assessment report to the property owner and the IOUs. Before giving a green light to conduct the Comprehensive Assessment, the IOU program managers typically sought additional information about each property from their internal account representatives. Projects that were deemed unlikely to reach the 10% savings threshold were directed to other IOU programs as needed.

For sites expected to achieve the energy savings target, the UCs or their subcontractors then conducted a Comprehensive Assessment, which included an ASHRAE Level II audit to assess building conditions, Combustion Appliance Safety (CAS) test-ins, and a building energy simulation to project total savings from the planned retrofits' measure mix. The output of the Comprehensive Assessment is a detailed report. The Comprehensive Assessment Report includes a "to-do list" of recommended energy-saving retrofits, energy

model assumptions, a narrative of existing conditions, a narrative on recommended measures, a cost-benefit analysis, a summary analysis covering simulation models used, a utility and end-use breakdown analysis, and a summary of sources of information. This report was provided to the IOU program managers and engineering staff for review.

Once the IOUs approved the energy savings estimates and reserved the stipulated incentives, property owners hired an independent contractor of their choice to install the measures outlined in the scope of work.

After contractors installed all measures, the UC would return to the property to verify the installation of measures according to Pilot guidelines (e.g., quantity installed, efficiency of installed measures, and confirmation of proper installation) and to conduct a CAS test on a sample of remodeled units for QC and safety purposes. The property owner also hired a contractor to test CAS in all remodeled units for safety purposes.

The UCs provided the IOUs with a Verification Report summarizing the post-installation site visits and providing final site savings estimates based on building energy use models (EnergyPro). The IOU engineering staff reviewed the Verification Reports and in most cases worked with the UCs to ensure that energy models accurately captured retrofit conditions and that Verification Reports were clear and consistent with energy usage models.

To close out the project, the UCs provided the IOUs with a variety of documentation. Documentation included the customer's incentive application form,[22] a completed project workbook (including project closeout worksheet, measure location worksheet, and project permit list), the project Verification Report, energy savings models (EnergyPro files and any applicable side calculations or default table), and health and safety test results (Building Performance Institute [BPI]-certified CAS/CAZ test results, remediation of combustion safety issues). The IOUs reviewed all documents and, after final review and revisions with the UC, would approve all final site savings and disburse payments to the property owners.

2.2 Research Objectives

Our research objectives were to assess the effectiveness of this Pilot's overall design and individual implementation strategies and to develop recommendations for how the design and implementation strategy could be improved moving forward. To answer these questions, we collected Pilot feedback from key stakeholders (the IOU staff, the UCs, contractors, and property owners) and closely reviewed program documentation and reports. To explore the relative merits of the designs used in this Pilot, we compared Pilot findings to those of other recent EUC-MF pilot evaluations (PG&E, SDG&E). Table 10 maps our primary research objectives to evaluation tasks.

[22] The application included signed terms and conditions, manufacturer's specification sheets for installed measures, and copies of itemized contractor/product invoices.

Table 10. Research Questions and Evaluation Activities

Research Questions	Evaluation Activities						
	Program Records/ Material Review	Program Manager Interviews	UC Interviews	Property Owner Interviews	IOU Program Manager Interviews	Contractor Interviews	Engineering Review
Document the fuel-switching rules as they pertain to the multifamily sector in SCE/SoCalGas territory	x	x					
Can this program be implemented as designed?	x	x	x	x	x		
Is this SPOC program design working? Why or why not? What alternatives should the program team consider?		x			x		
How do property owners experience the program? Are they satisfied? What program benefits do they identify?				x			
Is the program QA/QC system working as designed? What is the difference between reported program results and inspection results?	x	x	x				
Is the energy savings estimate reasonable and valid?							x
Are the energy savings accurate?							x
Can the energy savings be verified?							x
Where are the energy savings coming from?							x
What savings can be directly attributed to the EUC MF Pilot?							x
Is the EUC MF Pilot valuable?	x						
How do the program implementation approaches compare among the three UCs?	x		x				
What is the project conversion rate based on a review of Basic Assessment, Comprehensive Assessment, applications, and projects completed?	x		x				
Is this Pilot achieving measure diversity and integrated demand-side management (IDSM) savings?	x						
What are the qualifications of the UCs?	x	x					
Are the UCs certified individuals? If so, what kind of certifications have they obtained?			x				
What kind of certifications have the contractors obtained?						x	
How do the program design and results compare with other IOUs?	x						
What improvements are needed for 2015 and beyond?	x	x	x	x	x	x	x

3. Evaluation Methods

We evaluated the Pilot using a combination of primary and secondary data collection methods. As shown in Table 11, we reviewed the program implementation guidelines; reviewed program-tracking data; examined EnergyPro model files, assumptions, and outputs; and interviewed program managers, the UCs, installation contractors, and property owners. Combined, findings from these methods serve as the basis for the process and engineering assessments. Table 11 summarizes each of these activities.

Table 11. Summary of Pilot Evaluation Activities

Activity	Details
Program Materials Review	Reviewed the Pilot's database and program implementation plan. Analyzed and reported on using summary statistics.
IOU Program Manager Interviews	Interviewed SCE and SoCalGas program managers at Pilot conclusion to gain feedback on Pilot processes, challenges, and successes. Held follow-up meetings with the IOU engineers and program managers to explore early findings.
UC Interviews	Interviewed the three UCs to collect information about their role in program marketing and implementation and to gain their perspectives on potential barriers to participation.
Participating Property Owner Interviews	Interviewed participating property owners to collect information about property characteristics and experiences with the Pilot and to gain perspective on what worked and did not work well during Pilot processes.
Partial-Participant Property Owner Interviews	Interviewed property owners who dropped out of the program before upgrade completion to collect information about their experiences and to determine barriers to participation.
Installation Contractor Interviews	Interviewed contractors that installed Pilot upgrades to collect information about company certifications, qualifications, and contractors' experiences with the Pilot.
Savings Estimation Approach Review	Reviewed the EnergyPro models used to calculate savings and incentives for each property. Compared file contents (.bld files and ECON-2 reports) to Assessment Reports, Verification Reports, and program-tracking data to evaluate reasonableness of assumptions and the overall EnergyPro approach.

3.1 Program Materials Review

Our program materials review was a detailed study of program planning and implementation documents and a detailed analysis of program-tracking databases. Table 12 lists the data sources and then describes what information they provided. Throughout these activities, we noted observations about data completeness and quality.

During these analyses, we reviewed basic property characteristics and types of measures installed at each property and assessed and verified project savings estimates and other information. We developed basic summary statistics to report on program conversion rates, common measure types, property characteristics, and other metrics.

Table 12. Information Obtained from Program Materials Review

Program Materials	Information Obtained
Program-Tracking Data	• Project characteristics • Site characteristics • Property owner information • Project conversion rate information • Planned and verified energy efficiency measures
Program Manual	• Document program processes and requirements (including QA/QC requirements)
Assessment Reports, Verification Reports and EnergyPro models	• Document UC certifications • Identify initial inspection failures (to help assess if QA/QC system is working as designed) • Identify differences between the UCs • Identify key model inputs • Identify modeling strategies
Project-Specific Records	• Obtain further information from conversation

3.2 IOU Program Stakeholder Interviews

Table 13 summarizes the in-depth interviews we conducted with 20 individuals representing five main types of program stakeholders. We conducted all interviews over the phone in a semi-structured format, using interview guides to ensure that we addressed critical research questions, but also allowing for the natural flow of conversation. We interviewed stakeholders between January 2016 and May 2016. We have attached all interview guides in Appendix F.

Table 13. Program Stakeholder Interview Response Rates

Stakeholder Group	n=	Contact Response Rate	% Properties Represented
IOU Program Managers	2	100%	n/a
UCs	3	100%	100% (15/15)
Property Owners (Participants)	5	63%	67% (10/15)
Property Owners (Partial Participants)	2[A]	25%[B]	8% (2/25[C])
Contractors	10	76%	73% (11/15)
Total	**20**		

[A] Both partial participants (n=2) completed a Pilot upgrade at another property in their portfolio.
[B] Response rate is out of 8 property owners who had at least one partially completed property.
[C] Contact information was available for 17 of these 25 partial projects. 35% of the partial projects (n=6) completed the Basic Assessment and the Comprehensive Assessment and 65% (n=11) completed only the Basic Assessment.

3.2.1 Program Manager Interviews

The evaluation team conducted in-depth interviews with both of the IOUs' Pilot program managers, near the completion of the Pilot (January and February 2016), to gain their feedback on Pilot processes and challenges to implementation. Interviews focused on topics related to customer outreach efforts, management of program phases, challenges to using the SPOC approach and why it was not used to the extent originally planned, the program's approach to verifying energy savings, and additional strengths and weaknesses of the program design.

3.2.2 Utility Consultant Interviews

After Pilot completion, the evaluation team interviewed representatives from each of the three UCs: AEA, Partner Energy, and TRC (March 2016). These interviews built on earlier discussions with each consultant (August 2014) that had focused on program design and implementation. The purpose of the post-program interviews was to gather the UCs' experiences with the program as implemented, to learn the UCs' perspectives about whether the program could be implemented as designed, and to identify improvements needed to scale up the program. Detailed discussions included verifying key program recruitment procedures, gathering data about participation results, learning how the UCs referred participants to other multifamily programs (e.g., the Multifamily Energy Efficiency Rebate [MFEER] program, the Energy Savings Assistance Program [ESAP], and the Middle-Income Direct Install [MIDI]), and learning more about the UCs' QA/QC procedures and the program's energy savings verification process.

3.2.3 Participating Property Owner Interviews

In April and May 2016, the evaluation team conducted in-depth interviews with five of the eight property owners who represented 10 projects in this Pilot (Table 14).

Table 14. Property Owner Interview Dispositions

	Property Owners	Market-Rate Properties	Affordable Housing Properties	Total Properties
Total	8	4	11	15
Completed	*5*	*2*	*8*	*10*
Never Available	*1*	*2*	*0*	*2*
No Response	*2*	*0*	*3*	*3*
Response Rate	62.5%	50%	72.7%	66.7%

The purpose of these interviews was to learn about property owners' decision-making processes related to energy efficiency upgrades, learn about their experiences with the program, and get their perspectives on how the program could be improved. The overarching research questions that we addressed through these interviews were:

- How did property owners experience the program? Were they satisfied? What program benefits did they identify?
- What improvements are needed for 2016 and beyond?
- Can this program be implemented as designed?
- Is the SPOC design working?

Interviews also collected information about company and property characteristics; the company's decision-making process with respect to the projects completed through the Pilot; the property owner's recollections about the SPOC approach; and broader discussions about program experiences, satisfaction with the program, and recommended improvements from their perspective as property owner.

3.2.4 Partial-Participant Property Owner Interviews

Between May and June 2016, the evaluation team attempted to conduct in-depth interviews with a sample of property owners who received a Basic Assessment from their UC, but who did not complete Pilot upgrades at their property (Table 15). The purpose of the interviews was to learn about partial-participant property owners' decision making related to energy efficiency upgrades, explore barriers to participation, and collect ideas about how the program could be improved moving forward. Property owners were contacted by email and telephone.

Contact information was available for seven of 13 property owners who dropped out of the program after their Basic Assessment or Comprehensive Assessment. In one case, the person serving as property owner at the time of the Pilot was no longer working with the company. We ultimately interviewed two property owners of market-rate properties, both of whom canceled a project after the Comprehensive Assessment.

Table 15. Partial-Participant Property Owner Interview Dispositions

	Property Owners	Market-Rate Properties	Affordable Housing Properties	Total Properties
Total	14	7	18	25
Completed	*2*	*2*	*0*	2
Never Available	*1*	*0*	*1*	1
No Response	*4*	*4*	*10*	14
No Contact Information	*7*	*1*	*7*	8
Response Rate	15.3%	28.6%	0.0%	8.0%

Given that we interviewed a small number of partial-participant property owners, property owners' feedback appears only occasionally throughout the report where relevant. We provide a cohesive summary of these two interviews in Appendix C.

3.2.5 Installation Contractor Interviews

In May 2016, the evaluation team completed telephone interviews with contractors who completed retrofits at the participating properties. Interviews focused on learning about the types of contractors that property owners selected, determining which licenses and certifications the contractor companies held, and collecting contractors' feedback on program processes.

We first attempted to identify contractors through invoices supplied with program materials; however, invoices did not provide sufficient information for us to identify specific contacts likely to be knowledgeable about the Pilot. Thus, we asked the UCs and property owners to provide us with a list of contractors involved at each property, including contact information. This resulted in a sample frame of 14 entities that completed upgrades at 14 of the 15 participating properties. Four of these entities installed upgrades at multiple properties (2–5 properties each).

We interviewed 13 of the 14 contractors installing energy efficiency upgrades through the Pilot (93%). We excluded two respondents from further analysis because they were not able to provide answers from the perspective of an installation contractor. One of the excluded respondents was a property owner who completed the lighting and appliance upgrades at his own property by himself. The other respondent reported that his firm was part of the property ownership and had subcontracted all installation work to other companies. After removing these contacts, we based our analysis on the sample of 10 in-scope responses

(71% of contractors in the sample frame). These 10 contractors completed upgrades at 12 participating properties, of which 9 were affordable housing (75% of represented properties). Three of the responding contractors completed upgrades at multiple properties during the Pilot (2–5 properties each).

3.3 Savings Estimation Approach Review

Pilot UCs estimated ex ante property-level energy and demand savings using calibrated EnergyPro building energy use simulations. Compared to other approaches (deemed savings, EnergyPro without calibration), the Pilot's approach was designed to offer a more holistic and accurate savings estimate. On the other hand, the Pilot's approach is costlier and more time intensive than either deemed calculations or non-calibrated models and offers less transparency to non-technical stakeholders. To study the validity, completeness, and appropriateness of the program's approach to estimating savings, we reviewed program models and documentation for the 15 completed projects and determined which measures drive the Pilot's ex ante savings. We reviewed documents to better understand the strengths and weaknesses of the program's approach to savings estimation and to identify ways to increase the cost-effectiveness of the approach.

The IOUs provided documentation for each of the 15 completed projects. Documentation included the pre-installation Assessment Report; the post-installation Verification Report; and supporting documentation, such as invoices, cutsheets, and correspondence emails. The IOUs also provided savings calculations in the form of EnergyPro model files and deemed calculator Excel files. For most sites, we received a sufficient package of materials to support a complete review. For projects with partial documentation (e.g., missing assessment models), we attempted to fill in gaps using supporting documents.

We conducted a desk review of available materials. This included reviewing all available documentation, but focusing on assessment and verification models and reports. We checked these reports for accuracy and completeness relative to each other and to the provided savings calculations. We noted any discrepancies, errors, or missing information. We also examined the general structure and inputs to the savings calculators and EnergyPro models. To determine whether the models accurately represented the buildings at each site, we checked:

- Modeled property characteristics (total square footage and number of buildings and floors) relative to property characteristics as documented in reports
- The building's baseline and proposed energy use intensity (EUI, measured in kBtu/ft^2-yr) relative to the EUI typical of a multifamily property.
- Operation schedules and temperature set-point schedules relative to documented lighting, occupancy, HVAC, and other conditions that influence these schedules. This data was obtained from EnergyPro models, Assessment Reports, and Verification Reports.
- Model zoning, or how the UC modeled a building's energy usage zones by floor and residential unit

Because it is typical that several key measures will drive savings in a multifamily program, modeling assumptions about those key measures are likely to drive the majority of possible issues related to savings estimates' accuracy and uncertainty. Thus, for each project, we also selected the top two energy-saving measures for a more-detailed review (See Appendix E for detail). We selected "top" measures in terms of all installed measures' total savings (kWh plus therms) relative to total ex ante project savings. For each property's top two measures, we reviewed:

- How accurately the measure was input into each model (e.g., measure quantities, efficiency ratings, and other assumptions that drive savings), noting any missing information
- How well the measure was incorporated into models of the baseline building energy use model (pre-upgrade conditions), proposed upgrade model (assessment), and installed conditions (verification) and any supplemental deemed savings calculators
- The sources cited for each input assumption, including algorithms (e.g., IOU work papers) and professional judgments that may have been made during model adjustment (e.g., to conform to model calibration); we did not attempt to comment on deemed savings values as this was outside the scope of our evaluation
- Any errors or inconsistencies in model and calculator inputs (e.g., showerhead or lighting fixture savings calculators), as well as in the savings methodology used; we also noted and attempted to quantify measure-level differences between the assessment and verification versions of the models/calculators

We used the site- and measure-level evaluations to identify strengths and weaknesses of the program's current approaches to savings estimation. Our examination of the quality, completeness, and level of documentation provided in the final work products provided to the evaluation team for review also serves as a review of the QA/QC methods and reproducibility of the savings estimation approach.

4. Pilot Participation and Energy Savings

This section introduces results related to the Pilot's participation and ex ante savings estimates. Section 4.1 details the conversion rate, that is, the proportion of recruited properties that conducted a project in the Pilot. Section 4.2 summarizes the structural and ownership characteristics of properties receiving the full Pilot upgrade. Section 4.3 summarizes ex ante savings estimates reported in the program-tracking databases.

4.1 Conversion Rates

We calculated project conversion rates to determine the proportion of recruited properties that ultimately completed upgrades through the Pilot. We estimated the conversion rate using summary statistics based on the IOUs' ex ante program-tracking data, which provided three worksheets: a list of properties that received only a Basic Assessment, a list of properties that received a Comprehensive Assessment but did not complete upgrades, and properties that received full Pilot upgrades. We combined these three worksheets into a single database, removed duplicate data (2 properties), and calculated the number of properties that completed each of several program steps: received a Basic Assessment, was recommended for a Comprehensive Assessment by the UC, completed the Comprehensive Assessment, completed the Pilot application, and completed the measure installations. Two conversion rates are important to understand when considering whether to scale up the program: the percentage of properties that completed a Basic Assessment and which were recommended by UCs for a Comprehensive Assessment, and the percentage of properties completing a Comprehensive Assessment and completed upgrades through the Pilot.

Conversion from Basic Assessment to recommendation for a Comprehensive Assessment: The UCs completed Basic Assessments at 51 properties, of which they recommended nearly two-thirds (n=33, or 65%) for the more expensive Comprehensive Assessment (Table 16, intermediate rate from "Stage 1 to Stage 2"). Basic Assessment reports were missing for six properties, but our review of available documentation confirmed that the UCs followed Pilot guidelines and did not recommend properties not expected to achieve the per-property 10% minimum energy savings requirement.[23] Assessments were supposed to channel participants to other programs if they did not seem likely to save more than 10% for their property. Of the 18 properties that were recruited but did not complete Pilot upgrades, program-tracking data report that three (16%) were serviced under other IOU programs (MFEER and ESAP).

Conversion from Comprehensive Assessment to completed Pilot upgrades: According to the IOUs, IOUs authorized Comprehensive Assessments at 21 of the 33 properties that UCs recommended (63%). Nearly all the properties approved for the Comprehensive Assessment completed one (20 of 21). On net, about half of the 33 projects that UCs recommended for the Comprehensive Assessment completed one (n=20, 61%). Seventy-five percent of properties (15 of 20) that completed a Comprehensive Assessment completed the Pilot upgrades. All told, just under one-half of properties (45%) that UCs recommended for the more resource-intensive Comprehensive Assessments ended up completing Pilot upgrades (Table 16, intermediate rate from "Stage 2 to Stage 3"). This combined reflects the combined results of not all properties completing the recommended Comprehensive Assessment and the not all properties completing upgrades after finishing the Comprehensive Assessment. Tracking data recorded that the most common reason for canceling after the

[23] In most of these reviewed reports, UCs clearly stated that the property was not recommended specifically because suitable measures were not expected to achieve 10% energy savings. One report used more nuanced language, noting that, "…[the] items that either need to be or are good candidates [to be] replaced based off of the savings to investment ration (sic) may not be enough to meet the 10% minimum savings threshold for the property of the Comprehensive Assessment. Based on the identified measures, it is not recommended that the Subject Property proceed with the Comprehensive Assessment since the property is in overall good condition and most of the existing equipment has not reached the end of its useful life."

Comprehensive Assessment was that the property could not complete the project by 2015 (3 of 6). Additionally, one property did not meet the 10% site savings requirement, one property had a termite infestation, and one property's participation was delayed while undergoing a property acquisition.

Overall Pilot conversion rate: Table 16 shows that, overall, 29% of properties that completed an initial assessment (15 of 51) completed upgrades through the program. As the Pilot was designed to screen out properties not likely to pursue or achieve the minimum site savings, the Pilot's cumulative conversion rate is moderately strong.

Table 16. Pilot Conversion Rates

Stage	Number of Projects Completing Stage	Conversion Rates		
		From Previous Stage	Intermediate Rates	Cumulative Pilot Total
0. Marketing and Outreach	Unknown	n/a	Stage 1 to Stage 2: 65% Stage 2 to Stage 5: 45%	29%
1. Basic Assessment	51	Unknown		
2. Recommended by UC for Comprehensive Assessment	33	65%		
3. Approved for and Completed Comprehensive Assessment	20	61%		
4. Completed Application	15	75%		
5. Completed Pilot	15	100%		

Note: For 6 of the 48 properties that received a Basic Assessment, tracking data did not note whether the UC recommended a Comprehensive Assessment. For conversion rate calculations, we assumed that those six properties were not recommended for a Comprehensive Assessment because they are not included in the list of projects canceled after the Comprehensive Assessment.

4.2 Property Characteristics

Eleven of the 15 completed projects were at affordable housing properties and four were at market-rate properties. Eight of the 15 properties did not require a Basic Assessment,[24] but all 15 properties received the Comprehensive Assessment. Each participating property's participation process lasted approximately 7–28 months (based on the date of the Basic Assessment Report and the date of the final rebate payment). For all but three properties, measure installations extended over a total of 16 months, from submission of the Comprehensive Assessment Report to the submission of the post-installation property upgrade Verification Report.

Participating properties varied widely in terms of their building and operational characteristics. This section summarizes participating properties' ownership and property characteristics.

- **Status of energy efficiency prior to upgrade:** Prior to receiving upgrades through the Pilot, none of the properties had received significant energy efficiency upgrades within the last five years, and only two properties received lighting upgrades during that time. No participating property owners specifically mentioned completing IDSM projects at the same time as this Pilot.
- **Mix of market-rate and affordable housing:** Eleven of the completed projects were affordable housing properties and four were market-rate properties.

[24] These eight properties did not have a Basic Assessment Report date in the program-tracking data. From in-depth interviews with UCs, the evaluation team learned that some properties did not need this assessment.

- **Property size:** Properties ranged in size from 15 to 403 units (mean 128) and covered between 6,400 and 406,875 square feet. The properties had between 1 and 22 buildings. From the perspective of property owners, the program's costs make it more suitable for larger properties with at least 30 units.

- **Heating and water heating fuel type:** All participating properties have gas water heaters, and most properties (11 of 15) used gas for space heating. Nine properties had central water heating, six had individual water heating.

- **Building age:** The median age of the properties was about 30 years, although building vintages spanned the 1920s to the mid-2000s.

- **Property ownership:** Participation with more than one property was common, but property ownership varied across the market-rate and affordable housing properties.

  - Of the eight participating property owners, four completed projects at one property, three completed projects at two properties, and one in the affordable housing segment participated with five properties. Three of the participating property owners also completed basic energy assessments at properties that did not ultimately complete upgrades through the program. All told, these trends indicate that there is potential for the program to leverage existing participants for future projects.

  - A mix of companies owned the Pilot participant properties. Corporate firms generally own the market-rate housing, whereas a mix of 501(c)(3) nonprofits and corporate property owners and developers own or manage the affordable housing properties. Two property owners have both affordable housing and market-rate properties. Most of the participating property owners own more than 30 properties in California (3 of 5 property owners interviewed). The owners with fewer properties both own three properties.

  - All told, these property ownership statistics indicate that there is potential for the program to leverage existing participants for future property upgrades. As with the national market, the multifamily market appears to be concentrated, with large companies dominating the market. National estimates from 2002 suggest that 5% of operators manage 75% of rental properties.[25] A more recent survey from the Cadmus Group[26] yielded similar results.

- **Billing arrangements:** Billing arrangements were consistent across participating properties. Tenants generally paid their own electric bill (9 of 10 properties owned by the property owners we interviewed), but did not pay their own gas bill, as gas is commonly master-metered (9 of 10 properties owned by the property owners we interviewed). Some property owners indicated that low-income tenants received bill subsidies to help households cover energy costs. In these cases, the property management collected the subsidies from the appropriate authority and charged the tenant only for the difference.

- **Tenant turnover:** All units in participating properties were renter-occupied, meaning that there was only one property owner. All units in participating properties were renter-occupied, meaning that there was only one property owner. Based on property owner's recollections (n=3), tenant turnover in participating properties may range from 3% to 50% of units turning over once during the year. Although the rates should not be treated as definitive values, the low end of the range does suggest that a

[25] Oh et al., 2002.

[26] The Cadmus Group, 2013b.

property owner interested in completing upgrades at turnover could have difficulty doing so within the traditional one-year program cycle.

- **Project time:** For most projects, project implementation extended over at least 16 months, as determined by the date of the Basic Energy Assessment Report to the date of the Verification Report that summarized the measures installed, expected energy savings, and incentive amount. This indicates that projects can take about 1.5 years from start to finish and has implications for setting realistic program implementation cycles for whole-building design serving the multifamily sector.

4.3 Energy and Demand Savings

The Pilot exceeded its goal for the total number of upgraded units, but fell short of its target number of upgraded properties and its target electric savings, demand savings, and gas savings. Savings reported so far are the ex-ante results as an impact evaluation for ex-post results is pending. By the Pilot's conclusion in March 2016, 15 properties received upgrades from the Pilot, which are projected (via EnergyPro models) to achieve ex ante total savings of 849,724 kWh, 258 kW, and 95,177 therms (Table 17). The 15 fully completed[27] retrofits covered 1,919 tenant units, which is 113% of the planned number of tenant units (Table 17).

Table 17. Pilot Goals and Achievements

	# of Properties	# of Units	Pilot Expenditures[A]	Ex Ante kWh Savings	Ex Ante kW Savings	Ex Ante Therm Savings
Pilot Goals	20	1,700	$2,550,000	1,416,100	1,360	116,025
Achieved	15	1,919	$2,371,572	849,724	258	95,177
Percent Achieved	75%	113%	93%	60%	19%	82%

[A] Pilot expenditures reported by IOUs include property incentives (assessments and rebate) and UC services (customer engagement, quality assurance, quality control, and verifications). Expenditures do not include IOUs' administrative costs.

Table 18 presents detailed property-level energy and demand savings estimates. All estimates are ex ante projections based on EnergyPro models. As shown in the table, properties are expected to achieve an average of 20.4% annual savings relative to their baseline energy use (range: 10.5% to 41.5%) and an average site savings of 56,648 kWh, 17.17 kW, and 6,345 therms. Individual properties substantially varied from one another in terms of total installed savings (range: 119 MMBtu to 2,276 MMBtu per property). This range in per-property savings reflects the wide range of property sizes (range: 15 tenant units to 403 tenant units), as well as varying upgrade scopes. The five properties with the highest energy savings accounted for 75% of total combined electric and gas savings.

In terms of costs, the program provided $1.79 million in free energy assessments and rebates for energy-saving measure installations. Property owners invested a total of $4.4 million in these projects. By property, rebates for energy-saving measure installations allowed property owners to recover an average of 41% of their investment in the upgrades (ranging from 6% to 100%, not including the free energy assessment cost). The Pilot paid an average of almost $120,000 in free assessments and incentives per property. Averaged across the Pilot's total enrollment and savings, the IOUs' total direct costs of incentives plus free assessments

[27] We defined a "fully completed" project as one that completed energy efficiency upgrades.

amounted to $934 per unit and $144 per MMBtu. These costs exclude time and materials expended by the IOU staff and the UCs and are not intended to represent a total resource cost.

Table 18. Ex Ante Property Savings and Incentives

Property Characteristics					Annual Ex Ante Savings								
Project ID	Type[A]	Size (ft²)	Max # Floors	Units	kWh	kW	Therms	MMBtu	% Site Savings[B]	% of Program's Btu Savings	Ratio of Ex Ante Expected Btu Savings to Planned Btu Savings[C]	Property Incentives (Assessment + Rebate)	Property Incentives (Assessment + Rebate) per MMBtu
8842-011	M	406,875	3	403	9,319	0.00	22,438	2,276	18.5%*	18%	0.65	$301,980	$133
8842-002	M	296,872	2	336	130,622	2.08	15,696	2,015	18.5%***	16%	1.05	$250,570	$124
8842-003	M	293,200	2	356	94,394	1.13	16,168	1,939	15.1%*	16%	0.81	$277,093	$143
7426-006	A	74,238	2	76	135,610	69.52	12,044	1,667	26.2%*	13%	2.42	$109,810	$66
1383-002	A	78,644	2	90	141,878	64.00	9,584	1,442	34.4%**	12%	0.99	$151,412	$105
7426-004	A	128,670	2	168	109,763	54.41	4,063	781	17.2%***	6%	1.00	$157,720	$202
1383-005	M	158,816	2	121	106,969	24.85	519	417	11.2%**	3%	0.97	$105,357	$253
7426-005	A	52,536	2	54	17,905	12.96	2,617	323	16.9%*	3%	0.22	$59,940	$186
7426-003	A	65,243	2	115	50,988	23.66	1,379	312	10.5%*	3%	0.78	$105,770	$339
8842-004	A	10,875	2	26	4,571	0.04	2,890	305	38.7%*	2%	0.95	$53,800	$177
8842-008	A	37,092	2	41	6,962	0.34	2,040	228	12.9%**	2%	1.01	$41,016	$180
8842-006	A	6,400	2	15	2,009	0.21	2,169	224	41.5%***	2%	1.44	$35,526	$159
8842-007	A	15,803	5	44	12,064	1.18	1,806	222	22.2%***	2%	0.96	$56,316	$254
8842-005	A	17,500	5	44	391	0.03	1,172	119	11.4%**	1%	0.89	$44,036	$372
1383-003	A	21,648	2	30	26,279	3.19	592	149	11.1%***	1%	1.06	$41,243	$277
Total	**n/a**	**1,664,412**	**n/a**	**1,919**	**849,724**	**257.60**	**95,177**	**12,417**	**n/a**	**n/a**	**n/a**	**$1,791,589**	**n/a**
Average[D]	**n/a**	**110,961**	**2**	**128**	**56,648**	**17.17**	**6,345**	**828**	**20.4%**	**n/a**	**1.01**	**$119,439**	**$198[E]**

[A] A = Affordable housing property; M = Market-rate property.

[B] Relative to savings threshold in Comprehensive Assessment Report, ex ante site savings met or exceeded (***), fell within 2 percentage points of (**), or fell more than 2 percentage points below (*) the target.

[C] This is the ratio between ex ante verified Btu approved by the IOU at incentive payment and the ex ante Btu expected at the time of the Comprehensive Assessment Report. The ratio indicates the extent to which the property's final upgrade scope expanded or shrank after the Comprehensive Assessment phase.

[D] Average of property-level data.

[E] Incentives-per-MMBtu is slightly different when taken as the average of per-property Incentives-per-MMBtu ($198) versus when taken as an average across Pilot total Incentives and MMBtu ($1,791,589 ÷ 12,417 MMBtu = $144).

Table 19 compares property-level savings at market-rate and affordable housing properties. As planned, the Pilot completed upgrades at a mix of affordable housing (73%, or 11 of 15) and market-rate properties (4 of 15, or 27%). Table 19 shows that market-rate housing properties made up only 36% of Pilot participation at the whole property level, but contributed 63% of participation on a tenant unit basis because participating market-rate properties tended to be larger than affordable housing properties. On the other hand, upgrades at affordable housing projects achieved higher per-unit savings than upgrades at market-rate properties did. Therefore, despite contributing 63% of the Pilot's total unit upgrades, market-rate properties contributed only half (54%) of the total savings achieved through the Pilot.

Table 19. Average Project Characteristics among Affordable and Market-Rate Properties

Property Type	% Pilot Properties	% Pilot Savings	% Pilot Units	Mean Number of Tenant Units per Property (Range)	Ex Ante Mean Savings per Unit (Range)			
					kWh	kW	Therms	MMBtu
Affordable (n=11)	73%	46%	37%	64 (15–168)	584.3 (8.9–1,576)	0.23 (<0.01–0.91)	67.5 (12.0–158.5)	8.7 (2.7–21.9)
Market Rate (n=4)	36%	54%	63%	304 (121–403)	390.3 (23–884)	0.05 (<0.01–0.21)	38.0 (4.3–55.7)	5.1 (3.4–6.0)

Table 20 shows the number of projects that achieved each rebate threshold, based on ex ante savings. Sixty-seven percent of properties (10 of 15) achieved less than 20% ex ante site savings. Based on ex ante savings, five projects met or exceeded the savings threshold set out in the Comprehensive Assessment Report, four achieved savings within two percent of their site savings target (in absolute terms), and the remaining six projects missed their site target by more than 2% (absolute terms). Program staff attributed lower-than-expected ex ante savings to property owners' decisions to trim down their project scopes after the Comprehensive Assessment Report.

Table 20. Participant Incentive and Savings Tier Results

Property Savings	Per Unit Rebate	Market-Rate Housing (n=4)	Affordable Housing (n=11)	Total Number (n=15)
10%–14%	$700	25%	36%	33%
15%–19%	$800	75%	18%	33%
20%–24%	$1,000	0%	9%	7%
25%–29%	$1,200	0%	9%	7%
30%–35%	$1,400	0%	9%	7%
>35%	$1,600	0%	18%	13%
Total	**n/a**	**100%**	**100%**	**100%**

4.3.1 Reductions in Project Scope between Recommended and Actual Projects

The UCs provided Comprehensive Assessment Reports to property owners to convey recommended measures and expected savings. A comparison between the recommended and actual project scopes in the program-tracking data showed that most property owners (11 of 15 properties) did not install all measures

recommended to them.[28] Nonetheless, 11 of the 15 participating properties still met or fell just shy of their savings forecasts (Table 18).[29]

It may not be reasonable for a property owner to install all recommended upgrades, particularly in context of a property owner's ability to balance Pilot recommendations and requirements in the context of their ongoing whole-building retrofit. We spoke with three of the five property owners who trimmed project scopes and found a variety of explanations. All three property owners did install at least some of the recommended measures. However, each had his own reason for not installing all measures. One installed other measures that did not end up meeting program requirements, one who did install all recommended measures could not provide required documentation to claim savings, and one believed that they had already installed some of the recommended measures before getting involved with the Pilot.

In other instances, property owners decided to forego some of the recommended upgrades because they were either too time intensive to complete within the Pilot cycle (1 of 5), because the upgrades would not have met the property owner's financial criteria given the program requirements and product costs (2 of 5), and/or because upgrades were not technically feasible given property limitations (1 of 5). As one property owner put it:

> "The lighting replacement is not very time consuming, but the design and selection we thought would be more time consuming than the amount of time we were afforded. So … [w]e did the lighting but not through the program. … We determined the lighting portion of the program did not make financial sense."

Another commented that:

> "I was going back and forth fighting with the contractor and it didn't seem worth it. But more importantly …we don't necessarily own the refrigerators at the property. So, it was going to become a property management nightmare to try to buy the fridges or make some sort of agreement with the tenants who already have the fridge as personal property and then we would give them a fridge that would be our property. It was way too much work for way too little benefit."

4.3.2 Project Measure Mix and IDSM Savings

Across all Pilot properties, participants installed a mix of 23 types of measures in eight primary types of energy efficiency upgrades (Table 21). Of the eight measure groups offered through the program, each property installed between three and five types of end uses, including a mix of lighting, water conservation, HVAC, insulation, appliances, and other measures (Table 21). All but one property installed low-flow measures, including faucets, shower heads, and toilets (14 of 15). Most properties also installed efficient lighting for interior and/or exterior spaces (12 of 15); domestic hot water heater upgrades; upgrades to high-efficiency condensing units; or temperature controls (10 of 15), insulation (8 of 15), and efficient appliances (7 of 15). In our program materials review, we did not find evidence of demand response or renewables happening at

[28] Another indicator of a trimmed-down project may be the proportion of expected budget actually spent. A comparison of the property owners' projected and final investment amounts showed that nine properties (60%) completed the upgrades with lower project costs than expected. On average, property owners who either came close to meeting or exceeded their site savings target spent the project investment amount. In comparison, property owners who fell short of their site savings target spent only 69% of their project investment amount on average.

[29] In terms of the ratio between a property's ex ante Btu savings and the Btu savings projected in the Comprehensive Assessment Report.

the same time as the Pilot property upgrades. Therefore, we did not find any evidence of this pilot successfully incorporating IDSM projects (e.g., demand response, advanced metering, distributed generation, or energy storage projects).

Based on relative savings for each of the measures installed at properties (as identified in EnergyPro review), we found that 12 types of measures were consistently important drivers for total site savings. These are: washing machines, boilers, domestic hot water upgrades, condensers, packaged terminal air conditioner replacements, furnaces, pipe insulation, window replacements, wall insulation, low-flow shower heads, variable speed pool pumps, and demand or other controls on recirculation pumps (Table 21). Of these 12 key measures, only two (condenser, efficient windows) are not offered through existing multifamily programs like EUC-MF, MIDI, ESAP, and MFEER.

Table 21. Energy Efficiency Measures Installed

End Use Category	End Use Measures Installed	Properties Installing Measure		Stand-Alone Rebates Also Offered for Measure in MIDI, ESAP, or MFEER[A]
		%	n=	
Appliances	Refrigerators	27%	4	Yes (ESAP)
	Washing machines	27%	4	Yes (MFEER)
	Dishwashers	7%	1	–
Boilers	**Boilers**	33%	5	Yes (MFEER)
	Boiler demand control pumps	13%	2	Yes (MFEER)
Domestic Hot Water	**Domestic hot water** 5 in buildings with individual/common water heating (33% of all properties); 3 in buildings with central water heating (20% of all properties)	53%	8	Yes (MFEER)
	Domestic hot water temperature controls 1 in building with central water heating (7% of all properties)	7%	1	–
HVAC	**Packaged terminal air conditioner replacements**	40%	6	Yes (MFEER)
	Furnaces	7%	1	Yes (MFEER)
Insulation	**Pipe insulation**	33%	5	–
	Attic insulation	27%	4	Yes (MIDI, MFEER)
	Wall insulation	7%	1	Yes (MFEER)
Lighting	Lighting	73%	11	Yes (MFEER, ESAP)
	Exterior lighting	20%	3	Yes (ESAP)
Low-Flow	Low-flow faucets	87%	13	Yes (MIDI)
	Low-flow shower heads, aerators	67%	10	Yes (MIDI)
	Low-flow toilets	7%	1	–
Other	**Window replacements**	33%	5	–
	Variable speed pool pumps	13%	2	–
	Demand or other controls on recirculation pumps	13%	2	Yes (ESAP)
	Cool roof	7%	1	–

	Pool heaters	7%	1	–

Bolded measures drove ex ante modeled property savings for at least one property (Source: Evaluation Team review of project EnergyPro files).

4.3.3 Influence of Pilot on Project Measure Mix

Although most property owners already had plans to make energy efficiency upgrades as part of a larger retrofit, they would have completed different building upgrades had they not enrolled the property in the pilot. Property owners indicated that the program did generally not influence the project scope in terms of *which* products they would install. However, property owners tended to report that they would have installed *less-efficient* products without the program for most measures. Only one of five interviewed property owners appeared to be a complete free-rider; this person indicated that he would have done the exact same project without the program.

We asked the property owners about the program influence on each of the energy efficiency measures they had installed at their properties. Specifically, we first asked if and how the program influenced the scope of that particular upgrade, and then probed if the energy efficiency levels of the chosen product would have been different without the program requirements. Of those who installed the measures, all reported the program influenced the energy efficiency of domestic hot water measures (3/3), while a majority of property owners who installed lighting (2/3) and HVAC (2/3) indicated that they installed higher-efficiency measures through the program than they otherwise would have. Half of property owners installing energy efficiency of low-flow appliances (2/4), insulation (1/2), boiler upgrades (1/2) and appliances (1/2) noted that the program influenced efficiency of the measures.

5. Evaluation Findings by Program Design Element

This section reports evaluation findings by the Pilot's main design elements. In each subsection, we combine findings about the design element from in-depth interviews with the IOU program managers, the UCs, and participating property owners, as well as from our own review of program materials and databases. These combined analyses are designed to show a multidimensional review of how and how well the Pilot's main processes were implemented. At the end of each subsection, we provide a summary finding that comments on the overall viability of the element and what changes the IOUs would need to make, if any, to improve the process moving forward.

5.1 Program Administration

As planned, two IOUs (SCE and SoCalGas) administered the program with implementation support from three preapproved UCs. With two IOU program administrators, the program could incentivize both gas and electric savings, and with three UCs, the program implemented a closed-rater model (discussed in Section 5.3 below). Overall, the UCs found the IOUs' program staff to be helpful and accommodating where it was possible.

The Pilot was originally designed so that all property upgrades would be completed in a short period of time (by 2014). This approach was supposed to allow "rapid" feedback, but, as noted above, IOUs extended the implementation period to 2015. In total, implementation spanned about 2.5 years, from the first Basic Assessments in the fall of 2013 to the last property owner incentive payments in the spring of 2016. Several property-specific hurdles lengthened implementation timelines in some instances (e.g., time to address CAS test failures, managerial staff turnover at participating properties). Moreover, the program's approach to estimating and reporting on savings—calibrated EnergyPro models summarized in technical reports—necessitated a more detailed and time-intensive level of QA/QC review than either the IOU program managers or the UCs anticipated at the outset of the Pilot.

Interestingly, while the UCs and the IOUs spent substantial time drafting, reviewing, and revising various Assessment Reports and Verification Reports, none of these documents provided information that met all potential recipients' needs. For many property owners, Assessment Reports were too detailed and not timely enough to make actionable property upgrade decisions. As a result, some UCs kept in touch with property owners to discuss report findings before the IOU had approved final reports, while other property owners had difficulty translating upgrade recommendations into scopes of work for installation contractors. For the IOU program managers and engineering review teams, on the other hand, the reports appear not to have been detailed enough to provide sufficient documentation of engineering model development and calibration steps. Without sufficient technical detail, review and revision timelines were extended unnecessarily, including several rounds of discussions with the UCs when reviewing reports. In the scheme of overall program implementation, both outcomes resulted in delays to project schedules and increased time costs. As a critical function of Pilot programs is to take the time to test approaches, refine them, and learn how to best implement them, many of these time line issues may not carry forward to a full-scale version of the program. For example, reporting time lines were extended in part because the IOUs devoted time to learn about the UCs' methods and find ways to improve reporting quality. These Pilot time line extensions will likely pay off in the long run because they generated valuable feedback to improve a full-scale program so that it runs more efficiently.

In the bigger picture, IOU program manager feedback also indicates that the envisioned Pilot period was perhaps too short. Comprehensive multifamily property upgrades are inherently long-term processes due to their complexity and level of coordination. Most participating property owners would appreciate a "phased implementation" plan over a longer period and suggest that a full-scale version of the program allow phased participation over two to three years to accommodate market-rate properties.

5.2 Incentive Structure

The Pilot provided Comprehensive Assessments at no cost to participants and provided a tiered incentive structure based on savings as a percentage of the whole property's energy use. The main benefit of this approach, as one UC highlighted, is the flexibility that the Pilot granted to customers interested in selecting any energy-saving measure (compared to a prescriptive program). One main disadvantage of the approach—as echoed by all three UCs and several participating property owners—is that the whole-building incentive structure is more complex than other multifamily programs and therefore may be perceived as a "guessing game." Several of these UCs and participating property owners struggled to translate a given suite of upgrades into incentive payments, finding that the process was not always transparent. All three UCs ultimately suggested that, before a full launch, the program should consider simplifying aspects of the incentive structure.

The tiered savings incentive structure was intended to motivate participants to install a mix of deeper-savings retrofits and lead to a high percentage of total site savings, but these outcomes did not occur at all participating properties. Tracking data reported that among the mix of 23 measures that participants installed, 12 key measures drove savings for at least one site each (see Section 4.3.2 above). However, of these 12 measures, only three (condensers, HVAC upgrades, and efficient windows) were not already offered through existing prescriptive multifamily programs, including MIDI, ESAP, and MFEER.

Suggested improvements on the incentive structure include the following:

- Property owners did not recommend changing the whole-building incentive structure, but can imagine benefits of either using a deemed approach in certain situations (e.g., smaller units) or reorganizing the tiers into bundles. Property owners generally feel that bundling measures could be feasible depending on what measures are bundled. Two respondents suggested that either lighting or bathroom appliances could be bundled, whereas appliances or windows could not be bundled because the overall project costs may be too high.

- Property owners also suggested general efforts to provide more clarity about how program incentives were going to be determined.

5.3 The Closed-Rater Model

Three UCs formed the "closed-rater model"; in other words, a small number of preapproved contractors conducted all Basic and Comprehensive Assessments, provided technical assistance, calculated energy saving expectations, and verified all projects. The design intended to achieve more consistent, reliable, and efficient program delivery than an open-rater model, as well as leverage the selected UCs' market experience and existing project pipeline of properties for participation. Aside from one UC who used a subcontractor for two Basic Assessments,[30] all the UCs completed the Pilot work in-house. AEA completed 12 Basic Assessments, of which eight properties completed upgrades (67%); Partner Energy completed 31 Basic Assessments, of which four properties completed upgrades (13%); and TRC completed 8 Basic Assessments, of which three properties completed upgrades (38%).

[30] After these two properties, the UC decided not to continue using a subcontractor for remaining assessments given the large amount of time needed to train and provide support to the subcontractor's staff. Based on our analysis it does not appear that the UC's limited use of a subcontractor lengthened implementation timelines or produced a lower conversion rate.

From the perspective of the IOU staff, the closed-rater model was one of the program's main successes. In terms of recruitment, as hoped, the UCs brought established market experience to the Pilot. For example, all UCs leveraged existing contacts when recruiting property owners into the study and felt that this approach worked well overall and was appropriate for the Pilot. Further, using a small number of experienced UCs allowed the IOUs and the UCs to work collaboratively in developing reporting templates based on prior experiences and best practices.

Having several experienced raters facilitated a high degree of technical assistance that helped better shepherd property owners through the Pilot. Technical assistance included the following:

- Basic Assessment: Conduct assessment, develop and revise report
- Comprehensive Assessment: Conduct assessment and CAS test-ins, communicate with property owner, and produce reports
- Verification: Conduct CAS tests for QC and safety at a sample of units, produce reports and incorporate revisions, prepare closeout files and other paperwork
- Other support: As needed, conduct recruiting and review sites, help the property owner translate the Comprehensive Assessment Report into upgrade specifications and review contractor bids, support contractors with measure selection and installation. One UC provided benchmarking support.

For most properties, the UC served as the *de facto* lead point of contact with the customer, which streamlined communication with the utilities. The IOU staff recalled a beneficial level of communication and collaboration with the UCs, across both early phases (development of reporting templates and protocols[31]) and later ones (communication during the reporting cycle, including review and revisions). Property owners also highly valued the UCs' technical assistance, but felt that, overall, the program should consider providing more assistance in developing the project scope, particularly in the selection of energy-efficient equipment.

Although the UCs followed similar procedures when implementing the program, they report spending different amounts of time on key tasks like the Basic Assessment, the Comprehensive Assessment, and verification (Table 22). Table 22 shows that conducting the Comprehensive Assessment was the most time-intensive task (on average, 58% of time spent on each property).

Table 22. Utility Consultants' Self-Reported Time Commitment per Pilot Task

Task	Hours to Complete Task, per Project	
	% of Hours	Mean (Range)
Basic Assessment	9%	19 (13 to 25)
Comprehensive Assessment	58%	127 (80 to 158)
Verification	20%	45 (25 to 72)
Other	28%	30 (1 to 76)

We explored several possible reasons explaining why some UCs achieved higher conversion rates than others. No clear patterns emerged in terms of conversion rate relative to total time the UC reported spending per property, or the relative amount of time that each UC spent to complete the main Pilot tasks per property. Anecdotes from the IOUs suggest that variation in time to complete assessment and verification tasks partially could be due to variations across UCs in terms of their quality of reporting (and thus time spent on revisions),

[31] Despite investment in the shared templates, IOU and UC feedback indicates that the closed-rater model did not necessarily streamline the process of reviewing materials and reports.

or could have varied across the Pilot phase as each UC became more adept at completing given tasks. On the other hand, UCs with higher conversion rates tended to have recruited fewer properties into the Pilot. Additionally, market-rate properties made up a larger percentage of those UCs' total recruits. Last, UCs with higher conversion rates tended to work with owners of multiple properties more frequently than UCs with lower conversion rates.

5.4 Customer Recruitment and Marketing

The Pilot's intent was to recruit customers from the UCs' existing client base. The UCs did leverage their existing contacts to recruit properties into the program, which they feel worked well for the Pilot. IOUs agreed with this approach, indicating that the number of potential participants provided by the UCs was sufficient for the Pilot. Moving forward, all UCs indicated that targeted marketing would be critical to ensure adequate recruitment in a full-scale program. The UCs suggested that while their companies could deliver the marketing, a single IOU might take the lead in developing materials to streamline the marketing approach. Based on feedback from the property owners that we spoke with, property owners may prefer to receive program information through trade groups, real estate websites, housing authorities, or direct mail.

The UCs added that, in the future, the IOUs could improve recruitment by providing UCs with more information about prior upgrades at potential sites. One UC pointed to the need for more frequent communication about remaining program funding to better support the UCs' recruitment efforts, noting that their firm would have been interested in enrolling more participants in the Pilot had they known better about budget expenditures and remaining opportunities in the pipeline.

5.5 Energy Assessments and Reports

The UCs completed up to two energy assessments at each participating property: a Basic Assessment and a Comprehensive Assessment. Based on the screening-level Basic Assessment findings (an ASHRAE Level I audit), properties expected to achieve the minimum 10% savings target were recommended for a Comprehensive Assessment (an ASHRAE Level II audit). These two assessments—and the reports summarizing findings from each—served as the UCs' primary way to determine and report on each property's baseline conditions, level of need for energy efficiency upgrades, eligibility to complete upgrades through the Pilot, and likely site savings and expected incentive payment associated with cost-effective measures.

Early in the Pilot, the IOUs held a meeting with all UCs to develop standard reporting templates and protocols. The IOUs expected that standard templates would streamline reporting and minimize the time needed for review and revisions. However, the IOUs requested changes to the template throughout the course of the Pilot. The IOUs indicated that they revised report templates based on their review of early reports. These changes caused some confusion among the UCs about what the IOUs expected of them. If the Pilot launches at full scale, settling on a consistent template before full launch (based on lessons learned in the Pilot) could streamline the reporting process.

In this section, we provide additional detail about the UCs' approaches to completing the assessments and elaborate on the contents of each assessment report. We also discuss Pilot stakeholders' feedback on each assessment and report and provide an overall assessment of the reports' strength and usefulness for the Pilot.

5.5.1 Basic Assessment

The Basic Assessment was a screening tool used to determine whether a recruited property was likely to achieve the Pilot's minimum 10% site savings requirement. Termed as the "on-ramp" to the Pilot in the SCE/SoCalGas Pilot Guidelines, the Basic Assessment typically included an interview with the property owner to determine baseline energy performance of the property, the level of interest and managerial and financial capacity, and any property health and safety issues that could pose barriers to participation. Based on identified building and site characteristics, broad energy-saving opportunities, and the range of savings likely from these opportunities, the UCs determined whether the property seemed likely to achieve the 10% site savings threshold within the Pilot's period, and, if so, recommended the property for a deeper Comprehensive Assessment.

The UCs completed this Basic Assessment for nearly all properties.[32] They conducted the assessment interviews and site review either on the property grounds (2 of 3 UCs) or over the phone (1 of 3 UCs). Some of the UCs noted that on-site assessments are a relatively time-intensive way to estimate potential property savings; to better manage the lengthy process, two of the three UCs suggested that the Basic Assessment be completed over the phone. The third UC disagreed and said that on-site assessments more reliably capture property characteristics. After interviewing property owners for this evaluation, it seems that some property owners would have difficulty reliably describing property characteristics via telephone.

Basic Assessment Reports

At conclusion of the Basic Assessment, each UC provided the property owner with a report summarizing findings of the assessment. This report typically included a description of the property's existing conditions (e.g., existing building shell, HVAC systems, fixtures, appliances, and lighting), noted energy-saving opportunities, and recommended a list of cost-effective types of energy efficiency upgrades that the property owner could make to save energy at the property. The reports also described the UC's qualifications to complete the Pilot.

The IOUs requested that these reports also convey information about other multifamily programs offering incentives for the recommended upgrades. In the 29 Basic Assessment Reports provided to us for review, the UCs did provide this list of up to nine other multifamily energy efficiency rebate programs relevant to the property at the time of the assessment,[33] including MFEER, MIDI, and ESAP. Contact information listed in the Basic Assessment Reports was limited to a high-level program description and program website link, provided as future reference. All of the reports also noted which specific program offers incentives for each type of energy-efficient measure recommended for the property in the report (e.g., roof insulation rebates are available through the SCE/SoCalGas Pilot, SoCalGas MFEER, and SoCalGas ESAP). However, only half (48%) of these reports provided more than basic contact information for the alternate programs, which places the burden of following up on recommendations on the property owner.[34] The UCs confirmed that they provided

[32] Based on our review, the Pilot granted exceptions for one UC's work at two properties. This UC was granted permission to forego the Basic Assessment because the UC had already scoped out energy efficiency opportunities at the properties prior to involvement with the Pilot.

[33] Listed programs included the SCE/SoCalGas Pilot; MFEER programs offered by SCE and SoCalGas; On Demand Efficiency, Energy Smart, and Energy Savings Assistance programs offered by SCE and SoCalGas; and the California Solar Initiative (CSI).

[34] In-depth interviews with participating property owners confirmed that most did not enroll in the other programs, but two said that they stayed with the SCE/SoCalGas EUC MF Pilot to maximize their per-unit rebate. Two also said that, independent of any recommendations provided to them, they participated in other programs (California Housing Partnership on-bill financing, low-flow toilet rebates from a local water district).

little additional detail or assistance to the property owner in connecting with program staff at the other programs.

5.5.2 Comprehensive Assessment

The Comprehensive Assessment built on the Basic Assessment and involved a more thorough examination of the property's energy consumption. Here, the UCs also model specific upgrade recommendations (e.g., quantities and technical specifications) and projected savings estimates via EnergyPro building energy use simulations. Overall, completing the Comprehensive Assessment (including reporting) accounted for half of the UC's time in helping administer the Pilot. The UCs reported no major difficulties in completing the Comprehensive Assessment site work, but indicated that this element's primary issues relate to EnergyPro model calibration and the reporting process.

Comprehensive Assessment Reports

The UCs concluded the Comprehensive Assessment with a detailed report of assessment findings. These reports described building conditions, identified applicable energy efficiency measures, and reported on expected property-level savings. The UCs provided draft reports to the IOUs, who reviewed them for quality and completeness. After review and approval, the UCs provided the approved report to property owners.

Property owners indicated that they reviewed the report internally and that most discussed the report findings with the UCs. Thereafter, most property owners worked closely with UCs in developing their property's final scope (discussed below in Section 5.6). Only one property owner noted that his company did not need to communicate extensively with his UC after receiving the report because he already knew what he wanted and the report aligned with his upgrade plans.

Property owners were split in terms of their satisfaction with the Comprehensive Assessment Report. Three property owners were highly satisfied (satisfaction scores of 9 or 10 on a scale from 0 to 10, with 10 being most satisfied), whereas two property owners were less satisfied (scores of 3 and 5 on a scale from 0 to 10). Satisfied property owners generally found the Comprehensive Assessment Report findings more useful than the dissatisfied property owners did, with one satisfied property owner describing the findings as "highly educational." While all property owners recall the Comprehensive Assessment Report's upgrade recommendations, less-satisfied property owners felt that the recommendations were not useful: One already knew exactly what he wanted, and others felt that the recommendations were "too technical" and not actionable enough to aid in developing the project scope. These sentiments align with findings from our engineering review and IOU interviews that the Pilot's reports provided a level of detail that is appropriate for IOU review and verification, but that is not useful for many property owners (too technical or arrived after property owner decided on scope).

5.5.3 Overall Findings for Energy Assessments and Reports

Overall, we find that the Pilot's two-phased approach to assessing properties worked well to provide early feedback about which properties were likely able to complete enough retrofits to meet the program's minimum 10% site savings threshold. Roughly 70% of recruited projects did not move forward with the Pilot because they could not save more than 10% for their property; thus, Basic Assessments are likely to remain an important screening tool for the Pilot. On another note, one concern that came out of the PG&E Pilot was that providing free assessments to market-rate property owners would "lead to many costly assessments on properties with no intention of completing retrofits" (SBW Consulting, 2014, p. 22). However, it appears that the Basic Assessment or telephone approach was a good way to mitigate this concern while still offering free Comprehensive Assessments to truly viable program candidates.

Although the overall program design seems to work well, the Comprehensive Assessment Reports could be improved to better meet the needs of nearly all stakeholders who use these reports. Based on property owner and UC feedback, we suggest several ways to improve the Pilot's Comprehensive Assessment reporting process:

- **The Pilot should require UCs to justify why specific measures are recommended for a property.** In conducting our engineering review, we found that the UCs did not fully justify why proposed equipment was selected for the properties. We recommend that UCs describe their decision-making process in the assessment report so that external reviewers can understand which factors went into equipment selection (cost, available incentives, customer preference, space, or other limitations, etc.). This detail will both help in the QA/QC of the modeling approach and provide context that could help property owners translate suggestions into project scopes. For a full-scale program, these justifications could also help determine instances of free-ridership.

- **The Pilot could restructure reports so that they provide more support for customers still developing their upgrade scope.** Primarily, the Pilot should focus on making reports to property owners more actionable. For example, to reduce property owners' time searching for appropriate products, reports could include a list of products that meet program performance requirements. To make the report more digestible for property owners with limited technical background, the Pilot could also simplify the report and provide a table summarizing all upgrade recommendations, estimated costs, and site savings.

- **The Pilot should be more transparent about which measures are eligible for rebates.** Further, Pilot documentation should clarify which, if any, ancillary upgrades made at the time of the retrofit would be eligible for rebates. For example, documentation should clearly state whether the Pilot will reimburse costs of structural changes needed to accommodate Pilot upgrades. Property owners also seek more information about whether program requirements are based on code standards or are specific to the program. The Pilot should provide these definitions directly to property owners, as well as to the UCs.

5.6 Selecting and Installing Measures at Participating Properties

Property owners selected which recommended upgrades to install at their property and hired a contractor of their choice to perform installations. Property owners tended to select contractors with whom they had existing longer-term relationships, but most contractors do not hold special certifications beyond general contracting licenses.[35] In most cases, the UCs provided ad hoc technical support to property owners and contractors during installation, such as helping the property owner translate the Comprehensive Assessment Report into upgrade specifications, review contractor bids, and provide contractors with further information throughout the project.[36] Overall, these informal processes seemed to have worked reasonably well.

The primary issues with measure selection and installation relate to translating Comprehensive Assessment Report recommendations into practice. First, smaller properties and contractors less experienced with whole-building upgrades tended to lack clarity about how to select products to install. Some property owners also

[35] Appendix D provides additional detail from interviews with a sample of the Pilot's installation contractors.

[36] Even though measure installation was officially the property owners' sole responsibility, all the UCs reported remaining somewhat involved with property owners and contractors during installation. The UCs' time commitment during installation varied across projects based on property owners' level of need. Based on their involvement with installations, the UCs generally felt that the installation process was neither a particularly long stage nor a consistent or noticeable source of delay in the overall project schedules. Property owners and contractors valued the technical assistance they received.

struggled to understand how their installation choices would impact the total site savings and what their rebate payment would be. Additionally, other property owners experienced confusion about whether costs of structural changes made during installation to accommodate measure upgrades would be eligible for rebate. Both issues can be particularly confusing in whole-building design programs when several cosmetic and non-energy-related renovations are happening concurrently with energy efficiency upgrades.

Ultimately, most property owners did not install (or installed but did not claim savings from) all measures recommended in the Comprehensive Assessment Report. In some cases, property owners did not install certain measures for financial reasons. In other cases, property owners installed the measures recommended to them, but did not claim savings because they could not provide required documentation to the Pilot. Given the resource-intensive nature of creating upgrade recommendations for each property individually, the program may wish to consider ways to better link recommendations with practice. The Pilot might be able to address these issues at relatively low cost by simply enhancing its documentation and property owner informational materials.

5.7 Energy Savings Calculations

A key feature of this EUC MF Pilot was the use of EnergyPro models calibrated to match utility billing data. Per the Program Guidelines, all UCs were to use the Non-Residential Performance module of EnergyPro Version 5, and were to attempt to calibrate models so that pre-upgrade energy models resulted in property-level energy use, "within 10% of the actual annual utility use and 20% of the monthly utility use upon availability of utility data" (p. 27). The IOUs provided guidance to the UCs about proper model inputs (e.g., building zones, building elements, heating and cooling schedules, room occupancy, etc.). Overall, the EnergyPro modeling approach consisted of the following key steps:

1. Develop a baseline model of the property's existing conditions, pre-upgrade.

2. Calibrate the baseline model to 12 months of property-level energy usage history so that model estimates are within 10% of annual energy use and within 20% of each month's energy use. Where needed to bring the modeled baseline into agreement with actual energy use, the UC adjusts assumptions about baseline energy use until total building energy use reflects billing data. Common adjustments include assumed temperature set-points, occupancy, lighting schedules, hot water demand, and HVAC system use and efficiency.

3. Develop a "proposed conditions" model that projects energy use at the property if the property were to install all measures recommended in the Comprehensive Assessment Report. The UCs develop this model by adjusting the baseline model to reflect specific energy efficiency measure upgrades. The Comprehensive Assessment Report presents the expected Pilot savings as the difference between property energy usage in the "proposed conditions" model and energy usage in the baseline model.

4. After measure installation, the UC develops a "verification" model that reflects post-upgrade conditions. This verification model is based on the "proposed conditions" model, but is updated to reflect final installed conditions. Typical updates involve adjusting installed measures' efficiency and/or measure quantities. Final site savings are the difference between property energy usage in the "verification" model and energy usage in the baseline model.

To assess the relative effectiveness, value, and soundness of this approach, we collected feedback from the UCs and IOUs and conducted an independent engineering review of EnergyPro model files and outputs.

The approach was designed as a way for the UCs to account for detailed building conditions and equipment settings that could improve property-level savings relative to uncalibrated models or deemed savings approaches alone. However, it was not clear to the UCs that model calibration changed customer incentive payments under the current tiered incentive structure, relative to savings estimated in an uncalibrated EnergyPro model. Moreover, the IOUs and UCs observed that the approach took more time than alternatives used in other multifamily programs, due to the time it took to query, transfer, and reshape billing data; to calibrate and run models; and to review models and reports. Overall, the IOUs and UCs are not convinced that calibration's intended benefits outweigh its costs.

The remainder of this section discusses the detailed findings from our independent engineering review.

5.7.1 Independent Review of the EnergyPro Approach

We examined the Pilot's use of calibrated EnergyPro models by reviewing EnergyPro model files, supporting Excel-based calculations and documentation, and reports. Not all data sources were available for each site (see the MS Excel table embedded in Appendix E). We used each project's assessment reports as the primary sources for determining EnergyPro model reasonableness (15 of 15 sites). For four sites, we supplemented the review with information in the property write-up (n=2), a description of the site found on the web (n=1), and/or EnergyPro models of existing (pre-upgrade) conditions as provided in the assessment phase of the project (n=2).

Based on a detailed data-driven review of project and measure-level modeling assumptions, we identified key project-wide issues and recommendations (Table 23). Foremost among these findings is that the Pilot's written records are insufficient to retrace all steps that the UCs took in modeling building energy use.

The major theme throughout the review is missing information in the reports and missing documentation. In our view, the Pilot is not requiring the UCs to document enough of their model estimation process for the reader to be able to assess the accuracy of the UCs' results. This lack of documentation likely created unnecessary additional time in the IOUs' technical reviews. Our teams completed a fairly involved review of most of the measures, but only after we reviewed assessment reports in detail. However, missing information prevented the evaluation team from being able to do as thorough an evaluation as we could have if all the information was more readily available (e.g., missing assessment models, missing sources and justifications for model inputs, unexplained inconsistencies). For future iterations of the Pilot, we recommend that the UCs work on providing more-thorough documentation, such that all necessary information is provided in the reports to do an efficient and thorough review. Moving forward, if the Pilot addresses these documentation shortfalls, the IOUs will be in a much better position to improve their energy savings estimation and review processes.

We developed several thematic findings and recommendations in addition to the detailed recommendations we present in Table 23 below. These broader recommendations include the following observations about EnergyPro model quality and the energy savings organization and reports:

EnergyPro Model Quality

- **All baseline models appear to have reasonably captured the most important components of building conditions, but gaps in calibration records prevented us from determining the reasonableness of all calibration decisions.** This includes correct modeling of property size and existing conditions, which would drive baseline energy use. We were also able to retrace the bulk of decisions that the UCs made in calibrating baseline models to billing history. Nonetheless, the UCs did not fully document all decisions made during the calibration approach. Because calibration is both a science and an art, calibration can only be assessed as reasonable if the UC provides sufficient documentation and

justification for the changes made. That the Pilot does not have a record of all judgment calls made in calibration raises some concern that the energy savings have not been calculated using a transparent and reproducible approach.

- **Only "baseline" models were calibrated to actual building energy use.** The Pilot's modeling guidelines state that calibration is required, but do not state whether calibration is required for models of baseline conditions, or the installed case, or both. While baseline models were calibrated to billing data representing pre-upgrade conditions, no verification models (post-upgrade installed case) were calibrated to installed conditions. Calibrating the verification models would require waiting at least one year post-upgrade to obtain one year of post-upgrade billing data, but would more closely represent actual energy use post-upgrade. Waiting for this billing data is not likely to be feasible for any EUC-MF pilot, as it would further extend the pilot implementation timeline and delay customer incentive payments. However, a post-Pilot billing analysis would help determine an ex post realization rate. We recommend that CPUC conduct a billing analysis that revisits all EUC-MF pilots to study the benefits of calibrating models in ex ante estimates.

- **The Pilot could benefit from more consistency in how domestic hot water heater replacement measure efficiencies are modeled.** This includes recovery efficiency (i.e., thermal efficiency), stand-by losses, and energy factor (total efficiency, which is a combination of recovery efficiency, stand-by losses, cycling losses, etc.). In California, energy factor is used to describe storage water heaters of a capacity smaller than 75 kBtu/hour. For boilers larger than 75 kBtu/hour, stand-by loss and recovery efficiency should also be specified.

Organization and Reporting

- **The Pilot did not appear to require the UCs to name model files using any particular naming convention.** As such, we spent some amount of time manually determining file contents and file purpose, by opening each file and comparing model file dates to dates of Assessment Reports and Verification Reports. To avoid confusion in the future, we recommend that the Pilot adopt a single naming convention to clearly identify each model as either an assessment (pre-upgrade) model or verification (post-upgrade) model. File names could include both the date of the model, the assessment stage, and the model version (draft revision numbers or "Final" for final model versions).

- **In most cases, for the test-in/test-out conditions, photographs of the equipment were included in the report.** However, these photographs generally did not show the equipment's nameplate A photograph of the overall piece of equipment is insufficient to prove that the installed equipment is efficient. In addition to the photographs documenting that equipment was installed in the property, there also should be a nameplate photograph or some other identifier in the photographs that shows make/model, size, efficiency, etc. In addition, a full-scale program should record this information in a program-tracking database in addition to documenting it through photographs.

Table 23. Summary of Identified Energy Savings Model and Reporting Issues

Document Type	Issue[A]	Main Implication(s) of This Issue	Recommendation to Improve for Future
Assessment and Verification Reports	Reports are missing a complete list of EnergyPro assessment model inputs (6 properties, 7 measures)	Reviewers cannot fully verify all assessment model savings because available information does not allow reviewers to trace the reasoning for differences between assessment and verification models. This creates confusion and adds additional cost and time to technical reviews.	The IOU program managers should consider archiving assessment models (as run for the assessment report) before proceeding with verification model development so that assessment models can be compared to verification models.
	Sources behind EnergyPro modeling assumptions are not documented (8 properties, 8 measures)	Without source citations, reviewers cannot assess the appropriateness of the assumptions made to calculate savings. This calls into question the accuracy of the results and adds additional cost and time to technical reviews.	UCs should clearly justify all assumptions made when modeling the measure savings. If UCs draw a value or technique from modeling guidelines or another approved source, clearly state the source.
Building Energy Use Models	EnergyPro inputs are inconsistent with reported property description (2 properties, 2 measures)	In the cases we identified, the discrepancies found were not a major cause for concern about savings accuracy, but the level of review needed to make this determination is an unnecessary cost. These errors, although minor and rare, create some confusion and add additional cost and time to technical reviews.	Ensure that UCs' Comprehensive Energy Assessment Reports and Post-Upgrade Verification Reports accurately describe the inputs to the final models and detail known discrepancies between models and actual conditions (e.g., to achieve calibration).
	Incorrect or unreasonable model schedules and set-points (8 properties, 8 measures)	Many of the modeled heating/cooling schedules appeared unreasonable; it appears that the UCs used these schedules to achieve calibration. In other cases, no justification is provided for the modified schedules. This calls into question the accuracy of the models and the calibration activities, and may lead to inaccurate savings. It also adds time and cost to technical reviews.	UCs should base schedules on modeling guidelines and should provide written justification where schedules do not follow guidelines. Schedules and set-points should be reasonable wherever possible (i.e., what would be expected for the building type). If calibration can be achieved only by using unreasonable inputs, this either suggests a larger problem with the EnergyPro model or signals that some attributes of the actual building haven't been captured in the model.
Overall Documentation	Inadequate documentation of adjustments made for calibration (15 properties, 15 measures)	Reviewers cannot clearly see what changes the UCs made to assumptions in creating the calibrated model and cannot assess the reasonableness of the changes. This adds time and cost to technical reviews.	UCs should detail modifications made for calibration (e.g., "The heating set-point was changed from 70°F to 72°F to match existing conditions," instead of "The heating set-point was adjusted"). This level of documentation will save time in future technical reviews and ensure that input changes are reasonable.
	No documentation explains differences between assessment and verification conditions (10 properties, 18 measures)	Reviewers cannot fully trace savings calculations. Reviewers cannot see what changed from the original assessment estimate or why the UC made changes. For example, *does the quantity of a measure in the verification model differ from the quantity in the assessment model because the property owner installed a different quantity of equipment than planned? Did the efficiency change because the proposed efficiency was unavailable from the manufacturer?* This type of information is essential for a reviewer to identify areas for improvement for future assessment estimates. Providing this information also saves time and cost in technical reviews.	Ensure that UCs clearly and completely explain any differences in savings between the Comprehensive Assessment Report and the Verification Report.

[A] Issues identified out of 15 properties and 30 measures reviewed (2 per property).

5.8 Data Tracking Systems

The IOU program managers manually compiled property information and Pilot participation details in an Excel database. The database includes information about each property that completed a Basic Assessment, including property ownership and structural characteristics. For properties that completed the full upgrade, the tracking data include information about the upgrade, including names of measures included in the planned and verified scope, planned and verified energy savings, the dollar amount of the planned and final property rebate, the dollar amount of the owner's investment, and the dates when the UCs submitted program deliverables. Overall, the tracking data are easy to understand, and the data tracking approach makes sense for a Pilot program in that it requires little effort to develop on a limited Pilot budget, can be adapted midway through a Pilot given emerging lessons learned, and captures the main components needed for process evaluation. The evaluation team did experience some minor difficulty filling in data gaps to complete our review, which slowed, but did not prevent, our review of the Pilot. For a full-scale program, the IOUs mentioned that they would plan to implement an automated tracking system for a full-scale program.[37]

The rest of this section lists data tracking items that the IOUs may wish to consider in developing the tracking systems for a full-scale program, based on our ability to use Pilot tracking data in this evaluation.

- A full-scale database should list, in database format, the types of measures, measure quantities, and installation locations for each property, in addition to the names of each measure as provided in the Pilot's system. A full-scale program would need to be able to efficiently cross-reference tracking data, EnergyPro model files, and property reports.
- The tracking system could also include a central list of property-level status reports, that provide a place to keep track of why some properties drop out of the program; this would make it easier to gather information for analyzing the Pilot's conversion rate, relative to the Pilot evaluation in which we gathered the information project-by-project from multiple property-specific reports.
- To ease the process of identifying installation contractors who installed measures, the database could also track contractor company names, phone numbers, and names of the person most knowledgeable about the upgrades installed.

Again, the benefit of these improvements is likely to be realized only at a full-scale program with more projects and measures. While the Pilot's data-tracking process did not lead to major errors for the Pilot, the small hurdles we observed could impose significant time costs on a full-scale program. For any full-scale version of this Pilot, we recommend investing in automated data tracking systems. The upfront costs of doing so would not be worth it for a Pilot, but would likely smooth out data entry, better monitor data quality, and be more robust to changes in data over time.

5.9 QA/QC

The Pilot's QA/QC systems evolved over time in reaction to the level of effort it took to review and revise savings calculations and reports early in the Pilot period. By the end of the Pilot, QA/QC systems included a number of activities. Main QA/QC activities, and their strengths and weaknesses, include:

[37] IOUs mentioned that "direct input" data entry systems exist, but the IOUs did not use them for the Pilot. Future data entry systems would allow the contractors or UCs to upload data on IOU-specified forms.

- The UCs verified upgrade installation, and did so relatively consistently. Upon measure installation, the UCs inspected the upgrades, conducted health and safety tests, reviewed any rebate application documents, and (as stated above) summarized their findings in a final Verification Report. One IOU's staff also visited completed properties to verify installation. One UC felt that on-site verification was a time-intensive program step, and all three UCs were unanimous in noting that the reporting requirements were extremely time intensive, particularly due to CAS tests. Despite this level of effort, and even though the IOUs and UCs worked together to set up reporting templates at pilot initiation, the IOUs noted that the UCs produced reports with varying quality and completeness, levels of detail, and organization.

- The IOU engineers reviewed 100% of the UCs' engineering estimates and project documentation. One IOU engineer led the majority of technical QA/QC reviews, but both IOUs reviewed project reports and documentation.

  - IOUs reviewed Basic Assessment Reports and Comprehensive Assessment Reports before approving them for dissemination to the property owner. For this and other reports, the IOUs considered reports "finalized" once the majority of savings-related issues were addressed. The IOUs noted that the typical review checked for the following discrepancies and errors, as they were the most common:

    - Checks on whether existing and proposed equipment was modeled correctly in EnergyPro (e.g., correct volumes and quantities of measures, measure efficiencies)

    - Editorial review of Assessment Reports and Verification Reports to determine that they accurately reflected EnergyPro models

    - Specific discrepancies addressed with the UCs via comments on draft reports, emails, and phone calls; the UC was requested to revise EnergyPro models or documentation where the change was expected to materially affect savings calculations (e.g., >5% change)

  - The IOU staff noted that, in general, the UCs completed sound engineering analyses, and the IOUs requested only minor corrections to baseline assumptions based on their QA/QC review (e.g., to clarify Verification Report findings and modeling assumptions). However, resolving minor corrections typically involved working with the UCs over three to five revision cycles. Once major reporting omissions or discrepancies were resolved, the IOUs considered the Verification Reports finalized. At this phase, the IOUs allowed some minor typographical errors to remain in reporting, but the IOU staff indicated that they permitted these small errors to persist in an effort to manage reporting costs relative to the limited benefit of perfecting reports.

- The IOUs processed the property owner's rebate after verifying compliance with all program requirements. The IOUs noted that bottlenecks in the report review and rebate processing occurred as the Pilot progressed and the UCs started submitting Verification Reports in batches. One property owner reported that 5 months elapsed between project completion and receipt of the rebate.

Based on our review and interviews, the QA/QC system appears to have identified and addressed major errors in property savings calculations and documentation. Anecdotally, it appears that marginal errors (e.g., those introducing less than 5% variance in final savings estimates) may have persisted even after detailed review.

Overall, the IOUs and UCs felt that these QA/QC systems improved the quality and accuracy of program savings estimates. However, most parties conveyed a general sense that the detailed QA/QC protocols used for the Pilot were more time intensive than those used in other multifamily programs. UCs and IOUs both found that

the two-IOU review process lengthened review time lines, and that the approach could be streamlined for a full-scale program. Depending on the volume of a full-scale program, the Pilot's extensive QA/QC processes may neither be necessary (if additional review determines that calibration and associated QA/QC do not materially affect savings estimates and incentive payments) nor be scalable due to their high costs.

5.10 Fuel-Switching Policy

The current fuel-switching policy had some interesting implications for the Pilot. The evaluation team documents and recognizes the issue below and encourages the IOUs and CPUC to queue up further discussion on this topic.

The current fuel-switching policy precludes California's IOUs from incentivizing any fuel-switching measures unless it passes the three-prong test outlined in the CPUC's current Policy Manual. The EE Policy Manual 4.0 states that fuel-substitution programs, whether applied to retrofit or new construction applications, must pass the following three-prong test to be considered further for funding:

1. The program must not increase source-Btu consumption. Proponents of fuel-substitution programs should calculate the source-Btu impacts using the current California Energy Commission-established heat rate.

2. The program must have a total resource cost and program administrator cost benefit-cost ratio of 1.0 or greater. The total resource cost and program administrator cost tests used for this purpose should be developed in a manner consistent with these rules.

3. The program must not adversely affect the environment.

The Pilot was able to pass projects through the first and third tests. However, the second test disclosed some interesting issues for the gas and electric IOUs administering this pilot. The Pilot was unable to pursue certain measures because the EUC umbrella program is not cost-effective at this time. Therefore, no EUC pilot projects will pass the second test. The Pilot has not been able to pursue the following energy efficiency opportunities because of this fuel-switching policy:

- The Pilot cannot incent for some heat pump activity.
- The Pilot cannot introduce ductless mini-splits.
- Many multifamily properties have gravity furnaces that could be phased out during EUC multifamily retrofits.

As long as the EUC umbrella program is not cost-effective, then the EUC-MF sub-program is prohibited from providing incentives for fuel-switching activities.

6. Comparison to Other Multifamily Pilot Programs

In addition to the Pilot, the multifamily sector in SCE/SoCalGas territories can receive assistance for installing energy efficiency measures through several different programs. MFEER, ESAP, and MIDI offer rebates or direct installation services for tenant units or common areas and have been available for more than a decade.[38] In contrast, the EUC design promotes comprehensive energy efficiency retrofits and emerged in California only over the past few years. As shown in Table 24, the SCE/SoCalGas Pilot was one of six pilots that provided whole-building solutions, including energy efficiency measures such as building shell upgrades, high-efficiency HVAC units, domestic hot water heating, and central heating and cooling upgrades.

[38] The Cadmus Group, 2013a.

Table 24. EUC Multifamily Program Design Summary

	SCE/SoCalGas EUC MF Pilot	PG&E EUC-MF Pilot	SDG&E EUC-MF	SoCalREN EUC-MF Pilot	MCE	BayREN EUC-MF
Program Participation Status as of March 2014	• Pilot launched in September 2013 • Target 1,700 units • Completed 1,919 units	• Launched in February 2013 • Target 500 units • Completed by Dec 2013: 513 units	• Launched in 2012 • Target: 2,800 units • Pipeline: 3,078 units/18 bldgs[A] • Paid: 12 units[A]	• Launched in 2013 • Target: 8,000 units • Pipeline: 7,245 units[B] • Reservations: 2,906 units[B]	• Launched in 2013 • Goal: 1,680 units • Pipeline: 2,563 units/17 bldgs[A] • Reserved: 264 units[A] • Paid: 790 units[A]	• Launched 2013 • Goal: 5,000 units • Pipeline: 20,782 units/868 bldgs[A] • Reserved: 4,000 units
Eligibility	• 3+ units • SCE and SoCalGas service • Use a program-approved UC for the assessment • No income restrictions	• 5+ units • PG&E gas and electric service • Use program-approved raters and contractors for assessment and upgrade • No income restrictions	• 5+ units • SDG&E gas and/or electric service • Install 3+ eligible measures • Use program-approved rater • No income restrictions	• 5+ units • SCE and SoCalGas service • Install 3+ eligible measures • Use program-approved rater • No income restrictions	• 4+ units • MCE service territory • Income restrictions unknown	• 5+ units • Located in 9 Bay Area counties • PG&E gas and/or electric service • Install multiple measures • No income restrictions
Rater Model	Closed	Open	Open	Open	Closed	Closed
Assessment Incentives	Assessment free of charge	$2,500–10,000 depending on unit # and income restrictions	n/a, incorporated in upgrade incentive	$5,000 for 5–49 units, $10,000 for 50–100 units, or $20 for more than 100 units	Free-of-charge site visit	Free-of-charge site visit
Installation Incentive	Rebates paid per dwelling unit using a tiered approach ($700–$1,600) based on energy savings estimates (10%–35% or more)	Rebates paid per dwelling unit using a tiered approach ($600–$1,500) based on energy savings estimates (10%–40% or more)	Rebates paid per dwelling unit using a tiered approach ($550–$1,500) based on energy savings estimates (10%–40% or more)	Rebates paid per dwelling unit using a tiered approach ($200–$1,200) based on energy savings estimates (10%–30% or more)	Tiered based on estimated savings and payback period, plus common area and tenant support bonus (minimum 10%)	Fixed at $750 per unit (minimum 10%)
CAS Procedures	• No-cost test-in/sampling approach • Owner responsible for 100% test-out; program tests sample of units	• Test-in required • Rater conducts CAS test-out for 100% of units	• 100% test-in • 100% test-out	• Owner responsible for test-in/sampling • Owner responsible for 100% test-out	• No information available	• No information available
Energy Savings Data	Bill history	Savings estimates	Savings estimates	Savings estimates	Savings estimates	n/a

[A] Multifamily Programs PCG Status Update July 31, 2014.
[B] Provided by BKI on September 25, 2011.

Table 25 summarizes the strengths and weaknesses of the Pilot's design and implementation differences in comparison to the other pilots. We discuss these in greater detail in the next section.

Table 25. Summary of Differentiating Design Elements and Implications

Component	Implications	
	Strengths	Potential Weaknesses
Free Comprehensive Assessment Incentive and Higher Project Incentive Levels	Reduced barriers, greater participation, potentially deeper retrofits because owners have more money available for measures	Greater program costs, potential for more attrition after the Comprehensive Assessment leading to lower conversion rates from assessment to projects
Tiered Incentive Structure	Deeper energy savings, encourages more units to participate	Complex to communicate to customers; customized approach makes program budget planning challenging
Eligibility Criteria: Allowing properties with 3 or more units to participate	More properties qualify	Smaller projects will still have the fixed costs associated with all projects and therefore may not offer as cost-effective savings as the larger projects
Program Administration: 3 UCs doing implementation for two IOUs (gas and electric)	Consultants can serve as one contact with the customer to streamline communication with two IOUs; program can incent for both gas and electric savings	The more parties involved, the costlier and more time-consuming; all application processing goes through two internal companies with two different internal approval processes
Closed-Rater Model	Consultants bring market experience that can lead to best practices, fewer coordination efforts, and closer collaboration with raters; customer convenience; reduced training costs; ability to share building usage data; streamline labor-intensive review processes	Limited market transformation; reduced number of stakeholders for program outreach and recruitment
Two-Step Assessment Process	Quick assessment can determine if customer is eligible for EUC or another multifamily program	Baseline Assessments can be more labor intensive than phone and subsequently costlier to the program; however, Basic Assessments are provided only to customers with upcoming projects that could be good candidates for the EUC comprehensive approach
Estimating Energy Savings with the Non-Residential EnergyPro Module	Allows for more flexible inputs. Measures not currently included in EnergyPro can be evaluated using supplemental manual calculations (such as simplified spreadsheet-based calculators)	Two parallel paths for IOUs to review all engineering estimates is time consuming and not scalable
CAS Test-Out Sampling of Units: Customer responsible for testing of all	Lower program costs; increased customer satisfaction	Potential of overlooking a CAS issue with sampling approach; potential increase of customer cost/time; program inequity across projects given increased cost of gas projects; gas customers may be less

		likely to participate with this added barrier

At this time, we are able to qualitatively document how the Pilot compares to similar programs and speculate on the potential implications of these differences. It is too early to determine what kind of an effect these differences have on actual outcomes as only ex ante data were available for this evaluation (Table 26).

Table 26. Comparison of Ex Ante Savings by EUC-MF Pilot

				Average Savings per Unit (Ex Ante)			Pilot Savings Totals			
Pilot	# of Properties	# of Units	% Market Rate	kWh	Therms	MMBtu	kWh	Therms	MMBtu	Total Incentives Paid
SCE/ SoCalGas	15	1,919	27%	443	50	6.47	849,724	95,177	12,417	$1,791,589
PG&E[A]	7	513	0%	1,303	48	9.26	668,536	24,687	4,750	$527,470
SDG&E[B]	6	574	DK	858	26	5.54	492,290	14,981	3,178	$614,834

[A] Source: SBW/Opinion Dynamics (2014).
[B] Source: TRC (2013). Includes savings and incentives associated with several coordinated and overlapping programs: SDG&E's EUC-MF pilot, SDG&E's ESAP, and program incentives from the County of San Diego and City of San Diego.

A valid comparison of all the costs and savings for all pilots should be conducted based on ex post savings and final program costs that account for both incentives and administration. A comparison of the gross savings realization rates across the pilots will also help determine the effectiveness of SCE/SoCalGas's unique approach of using billing data to calibrate the ex ante modeled savings estimates. ***We recommend that the six EUC multifamily pilots collectively report on the following information in the future: conversion rates (full assessment to project), implementation cost (total, cost per project, cost per unit per project), and ex ante savings levels (ex ante savings per unit, ex ante savings per project, measure mix per project). We also recommend that the pilots report on savings accuracy as indicated by realization rates comparing ex ante savings to ex post savings per project.*** Moreover, to determine how comparable estimates are across Pilots, each Pilot should provide sufficiently-detailed information about EnergyPro calibration and it's percent impact on baseline building energy use assumptions. It will be important that the pilots report on these data both on average per project and the actual data per project, for which the analyst will need to know the measure mix, realization rate, and cost for each project. For example, if a pilot had three completed projects, it should provide the following information demonstrated in the table below.

Table 27. Example Pilot Outcome Data Needed for Comparison (Demonstration Purposes Only)

	Realization Rate	Ex Ante Savings	Measure Mix	Program Cost	# of Units Retrofitted	Gas/Electric/Combo	Conversion Rate
Project 1	XX%	kWh, kW, Therms	Windows, Insulation, etc.	$15K	200	Combo	n/a
Project 2	XX%	kWh, kW, Therms	Windows, Insulation, etc.	$13K	100	Electric	
Project 3	XX%	kWh, kW, Therms	Windows, Insulation, etc.	$17K	230	Combo	

Total	Xx%	n/a	n/a	$	n/a	n/a	70%

The realization rate would be calculated as the ratio of the final reported ex ante savings per project (as claimed through the program) relative to ex post savings per project (as verified in a billing analysis conducted after pilot completion).

We recommend calculating the conversion rates following methods we used in this analysis (see Section 4.1). The conversion rates are:

Conversion from Basic Assessment to recommendation for a Comprehensive Assessment

CR1 = (# Properties recommended for Comprehensive Assessment) / (# Properties completing Basic Assessment)

Conversion from Comprehensive Assessment to completed Pilot upgrades

CR2 = (# Properties completing program upgrades) / (# Properties recommended for Comprehensive Assessment)

Overall Conversion Rate

CR3 = (# Properties completing program upgrades) / (# Properties completing Basic Assessment)

We note that the SCE/SoCalGas Pilot is the only one of the EUC-MF pilots that two different companies administer; one for gas and one for electric. When comparing program designs in California and determining what will work best for SCE and SoCalGas, be cognizant that as long as SCE/SoCalGas administer the program it will be subject to the internal approval processes of two different companies. Therefore, a program design that might work well for an IOU operating both gas and electric may be too cumbersome for SCE/SoCalGas to manage.

At this time, we are able to qualitatively document how the pilot compares to other EUC multifamily programs and speculate on the potential implications of these differences. It is too early to determine what kind of an impact these differences will have on actual outcomes. Therefore, we document the key differentiating factors at this time and recommend that the pilots across the state report on the same program outcomes upon completion to determine what the most effective approach is (Table 28).

Table 28. SCE/SoCalGas EUC MF Pilot Key Differentiators and Implications for Outcomes

Design Component	SCE/SoCalGas's Unique Approach	Outcome Implications	Outcome Research Questions	Potential Outcome Indicator
Calculating ex ante energy savings	Uses 24 months of bill history to calculate ex ante savings	Ex ante energy savings should be more accurate than pilots that do not use billing history.	Do the savings approach differences lead to more accurate ex ante savings estimates? Test the hypothesis that EnergyPro non-res module and calibrating based on usage give more accurate savings.	Realization rates from ex ante to ex post gross for each project and on average across all projects

Design Component	SCE/SoCalGas's Unique Approach	Outcome Implications	Outcome Research Questions	Potential Outcome Indicator
Entire Design Strategy	Trying to get deeper, holistic savings with measure mix, incentive structure, EnergyPro modeling, ASHRAE Level II assessment, and custom approach; different from MCE or BayREN approach with simpler path/more prescriptive approach	The Pilot should get deeper savings per project with its current design compared to BayREN or MCE.	What approach gets the deepest savings? Test the hypothesis that the custom whole-building approach that the IOUs are trying is getting deeper savings than the prescriptive/direct install approach that MCE is doing.	Ex ante savings estimates per unit, ex ante savings per project, and the measure mix for each project
Rater Model	Closed Model	Potential cost efficiencies throughout the staff training, assessment, and modeling phases	What approach gives the most cost-effective savings?	Cost and savings per project, cost and savings per unit
Assessment Approach	Free assessment and two levels of assessments	More participants but lower conversion rates	Does offering the assessment for free lead to more assessments that do not convert to projects? Does offering the assessment for free attract more interest in the program?	Conversion rates, participation rates (post-pilot period since participation rates were controlled for the pilot)

Assessment Incentives

The SCE/SoCalGas Pilot offers both assessments and CAS test-ins free of charge to the prospective participant. This approach is consistent with the BayREN and MCE programs but differs from other programs under the EUC multifamily umbrella, which rebate the assessment.[39] These assessment rebates range from $2,500 to $10,000 depending on the number of units or the expected energy savings to encourage deeper retrofits.

The Pilot's free-assessment approach intended to remove participation barriers that are associated with high upfront costs and enabled participation from properties that would not participate otherwise. We can therefore expect to see higher participation rates in comparison to other programs, in particular with respect to market-rate building owners. The free assessment may further entice deeper retrofits as the free assessment lowers the overall upgrade costs to the customer.

Conversely, a free Comprehensive Assessment could encourage free ridership among customers already committed to retrofits and may increase attrition among those who are not fully committed. The free assessment can thus contribute to higher program costs in the future, especially at scale when existing relationships with customers who will likely complete the upgrade have been exhausted. While a rebated assessment that is linked to project completion could offset attrition and save project funds, the IOU program

[39] PG&E pays $2,500–$10,000; SDG&E based its assessment incentive on envisaged savings to encourage deeper retrofits; SoCalREN and NYSERDA provide rebates between $5,000 and $10,000 depending on number of units; Sacramento Municipal Utility District (SMUD) pays $85 per unit and 65% only after project completion.

managers and the UCs generally supported the free assessment as the benefits related to low entry barriers offset the disadvantage of possible dropouts.

Installation Incentives

The Pilot offers installation incentives per remodeled unit using a tiered structure based on total building energy savings. Depending on verified savings, installation incentives can range from $700 to $1,600, paid directly to the property owner.

Table 29 shows that SCE/SoCalGas's approach to providing tiered installation incentives was consistent with most other EUC multifamily programs[40] with slightly higher incentive levels. Only BayREN offered a fixed incentive at $750 per unit and no benefits for further incremental savings. MCE's installation incentives are tiered but vary by customers as the incentives incorporates both the percent of energy savings and an estimated payback time if the property owner utilizes the program's finance component.

Table 29. EUC-MF Installation Incentives

Energy Savings	SCE/SoCalGas	SDG&E	PG&E	SoCalREN	BayREN
10%	$ 700	$ 550	$ 600	$ 200	$ 750
15%	$ 800	$ 625	$ 750	$ 400	$ 750
20%	$ 1,000	$ 800	$ 900	$ 700	$ 750
25%	$ 1,200	$ 1,000	$1,050	$ 950	$ 750
30%	$ 1,400	$ 1,200	$1,200	$ 1,200	$ 750
35%	$ 1,600	$ 1,350	$1,350	$ 1,200	$ 750
40%	n/a	$ 1,500	$1,500	$ 1,200	$ 750

Note: All EUC-MF programs require at least 10% energy savings. MCE uses a tiered approach that is tied to estimated kWh and therm savings and based on payback period.

While installation incentives intend to partially offset upgrade costs, the chosen approach has two key benefits: a "per-unit" unit payment enables participants to experience economies of scale with larger multifamily properties, and a tiered approach rewards participants for realizing deeper energy savings. As a drawback, the tiered approach is more complex to communicate to customers and is more challenging when planning program budgets.

The slightly higher incentives in the SCE/SoCalGas Pilot are expected to reduce retrofit costs to the customer. We may therefore see a higher take-up and perhaps projects with deeper energy savings in comparison to other programs. However, the higher incentives also correspond with higher program costs and may, at times, not justify the expenditure from one of the two partner utilities when either gas or electric savings do not play a significant role in achieving the 10% threshold. While we can expect imbalances between projects, it will be important to examine the program-level electric and gas savings to understand if a more cost-effective direct install program could better serve certain projects or measures.

In addition, there are smaller differences in the delivery of incentives. Most programs, including the SCE/SoCalGas Pilot, pay the incentive upon project completion to ensure that savings are captured and dropout rates are minimized. Only two programs outside the EUC multifamily group (SMUD and NYSERDA) offer partial installation incentives to ease the cash flow during retrofits. However, as experiences from the two programs show mixed responses in the uptake of the partial incentive, the pilot should uphold its approach

[40] NYSERDA and SMUD also use a tiered approach based on energy savings.

of one full payment. Interesting incentive features from other programs include a persistence incentive offered through NYSERDA and tenant bonuses in the MCE program.

Eligibility Criteria

SCE and SoCalGas offered the Pilot to customers who had a minimum of three dwelling units per property. Properties in both the affordable housing and the market-rate sector could participate in the pilot. To qualify for incentives, property owners must have achieved at least 10% energy savings, used one of the three program-approved UCs, and planned to complete the retrofit by December 2014.[41]

Eligibility criteria were mostly consistent across programs. However, in contrast to other EUC multifamily programs, the Pilot allowed smaller properties with only three instead of five[42] dwelling units and further restricted the building height of a participating complex.

Delivery Model

The Pilot used a consultant model, in which three UCs functioned as raters to conduct the energy assessment and analysis, provided technical assistance to property owners during the application process, and completed the measure verification upon completion of the retrofit. The property owner was responsible to hire independent contractors for the installation of measures and the completion of CAS test-outs.

While only SCE could give work directives to the UCs, both IOUs engaged program managers, engineering staff, account representatives, and legal teams in the delivery of the Pilot. A shared program between two distinct IOUs is unique under the EUC multifamily umbrella, which may result in slightly different experiences in comparison to other programs.

Open-Rater versus Closed-Rater Model

A program's approach to the selection of raters is a key differentiator between EUC multifamily programs. The Pilot, as well as the BayREN and MCE programs, applied a "closed-rater model" in which the IOUs limit the number of energy raters who delivered assessments and energy savings calculation. The remaining EUC multifamily programs, as well as similar multifamily programs under SMUD and NYSERDA, follow an "open-rater model" in which customers choose from a pool of program-trained, certified Home Energy Rating System (HERS) II raters. Table 30 provides an overview of raters under the "closed" and "open" rater approach.

Table 30. Rater Approach in EUC Multifamily Programs

Closed-Rater Model		Open-Rater Model	
Organization	Rater Role	Organization	Number of Participating Raters
SCE/SoCalGas	AEA, TRC, Partner Energy	PG&E	10[A]
BayREN	AEA	SDG&E	Not available
MCE	AEA	SoCalREN	43[B]

[A] Source: IOU Statewide Public Workshop-EUC Multifamily Pilots, March 2014.
[B] Source: BKI as per September 25, 2014.

[41] However, program staff noted that some projects would likely be completed and accounted for in 2015.

[42] MCE requires only four shared wall units.

Pre-Qualification Procedures

SCE/SoCalGas's Pilot design encompasses a two-step process to assess property qualification, as well as CAS testing.

As a first step, the UCs conduct a basic assessment on site to meet the property owner and examine both property potential and owner capacity. This basic assessment also serves the purpose of funneling properties to other programs, such as ESAP, MIDI, or MFEER, and educating customers in the multifamily sector of energy efficiency upgrades more broadly. In addition to the basic assessment, the UCs collect some property information on building operations and systems over the phone while scheduling the site visit. Upon completion of the assessment, the UCs provide results to the owner and the IOUs for review to seek approval for the second, more-comprehensive assessment. If the UCs deem properties unsuitable for achieving the required savings threshold, they refer the owner to other programs, such as ESAP, MFEER, and MIDI.

The personal site visit to capture basic property information is different from other EUC multifamily programs, as shown in Table 31.

Table 31. EUC Multifamily Assessment Procedures

Energy Savings	SCE/SoCalGas	SDG&E	PG&E	SoCalREN	BayREN	MCE
Basic Assessment	Site visit	Property evaluation form	Phone questionnaire	No information	Phone questionnaire	No information
Comprehensive Assessment	ASHRAE Level II	ASHRAE Level II	ASHRAE Level II	ASHRAE Level II	ASHRAE Level I	ASHRAE Level I

Instead of conducting the basic assessment on-site, other programs screen prospective participants with telephone questionnaires (PG&E, BayREN) or use self-report-based property evaluation forms.[43] SCE/SoCalGas's approach with in-person assessments has the key advantage of building rapport with property owners, which is critical in obtaining owner buy-in for the upgrade process. Furthermore, we can expect the collected data to be more accurate than self-reported data.

However, the main drawback noted by the UCs is that basic assessments are more labor-intensive and subsequently costlier to the pilot. This counteracts industry standards of using the preliminary assessment as a quick and cost-effective way to uncover higher savings opportunities. The UCs believe that the type of information gathered in the basic assessment could be collected over the telephone, or at least be optional. This approach has already been tested in select cases with SCE's approval when property owners could demonstrate substantial retrofit plans and program staff were confident that upgrades through the pilot would go ahead. However, the IOU staff believe that the program should offer an on-site basic assessment in case property owners have little knowledge about energy efficiency and lack the capabilities to relay accurate information over the telephone. Whether in-person or remotely, the Pilot can streamline the current process by ensuring consistent report formats that allow a faster review yet which still serves as the basis for recommending whether a project continues forward with the program. As an alternative to current site visits, program staff could also investigate EnergyPro Lite software as a screening tool to replace unnecessary assessments and analysis. The tool is currently being developed for use by the BayREN EUC-MF program and assumes a flat $/unit incentive for exceeding a set percentage performance threshold.[44]

[43] Based on in-depth interviews with the UCs.

[44] Multifamily Home Energy Retrofit Coordinating Committee (MF HERCC), 2014.

Once the IOUs have reviewed and approved the Basic Assessment Report, the UCs[45] conduct a Comprehensive Assessment to establish a baseline of the property energy consumption, help determine the measure mix to achieve the Pilot's savings goals, and detect any health and safety issues prior to construction. The assessment follows the guidelines of the ASHRAE Level II assessment and evaluates building energy systems in more detail. It typically includes the building envelope, lighting, HVAC, domestic hot water, plug loads, and related usage patterns.[46] In more detail, the UCs take account of existing measures that could be subject to an upgrade and record equipment types and model numbers. At this point in time, the UCs use their own assessment forms, as protocols are being developed.

While we have little information on detailed assessment procedures across all pilots, it appears that the Pilot is consistent with most[47] other EUC multifamily programs in requiring ASHRAE Level II assessments. Although the Comprehensive Assessment represents significant costs to the program, such detailed analysis is necessary to collect model input data that enable energy modelling for comprehensive retrofits.

Combustion Appliance Safety Test-In

To address potential health and safety issues prior to the retrofit, the Pilot requires CAS tests free of charge to the customer on a sample of gas appliances in dwelling units. Where the UCs detect potential hazards, the customer is responsible for remediation prior to beginning any retrofits.

The Pilot references the MF HERCC Combustion Appliance Safety Protocols, which are part of the MF HERCC Audit Protocol. These protocols lay out test procedures based on the *Building Performance Institute's Technical Standards for the Building Analyst Professional*.[48] The protocols also discuss sampling procedures, which provide a minimum and recommended number of sampling points depending on the number of units in the building, as listed in Table 32.

Table 32. Recommended Number of Units to Sample Based on Total Number of Units in a Building from Nationwide Weatherization Assistance Program (adopted by MF HERCC Protocols)

Building size (total number of units)	Number of units to sample	
	Minimum	Recommended
2–9	2	3
10–19	3	5
20–29	4	7
30–49	5	9
50–74	6	11
75–99	7	13
100–149	8	16
150–200	9	20
>200	10	25

[45] TRC uses a subcontractor (AESC).

[46] Energy Vanguard, 2014, available at: http://www.energyvanguard.com/blog-building-science-HERS-BPI/bid/74136/Are-We-Off-Track-With-Combustion-Safety-Testing.

[47] MCE's program requires ASHRAE Level I assessments. While there is no information on BayREN's approach, we assume this is also true for BayREN's program.

[48] Amended by MF HERCC in 2011 to make the guidelines more applicable to the multifamily market.

As most other EUC multifamily programs[49] reference the same protocols, we can expect the pilot's CAS requirements to be consistent with other programs. The extent to which other programs provide CAS test-ins free of charge cannot be determined with the limited data available. We expect the Pilot's approach of providing free test-ins to lower participation barriers for property owners. However, concerns about the added liability and potential remediation costs will likely continue to discourage participation among some property owners.

Energy Savings Modeling

The UCs evaluate potential measures based on least-cost maximum benefit and determine energy savings related to the scope of work. Consistent with most other EUC multifamily programs, the Pilot uses EnergyPro to model ex ante savings estimates. However, in contrast to some EUC programs, the Pilot is using the Nonresidential Performance module in EnergyPro, which allows for more flexible inputs than the Residential Module. The Pilot also allows for manual calculations of measures that EnergyPro cannot model currently. Once the UCs have established energy savings estimates, engineering staff from both SCE and SoCalGas review these estimates to ensure consistent methodology and adherence to IOU requirements.

A key differentiator and core strength of the Pilot is the use of customer billing data to estimate energy savings. Other programs calculate ex ante savings by comparing a model of energy use under baseline conditions with a model of use assuming the recommended upgrades are in place. While the IOU engineering staff generally accept the UCs' estimates, minor issues arose where the IOUs had work papers in place that required more conservative estimates. As part of the Pilot, program staff is currently developing modeling guidelines to help streamline the expectations from the UCs and IOU engineering staff during the review process. This will be critical as the review process in its current form is described as extremely time consuming for IOU staff, which would impede the scale-up of the pilot.

Measure and Savings Verification

Consistent with other EUC multifamily programs, QC inspections are required upon project completion and done during construction only if deemed necessary. While some programs hire inspection contractors, QC inspections are the responsibility of the UCs or their subcontractors[50] in the Pilot. As part of this process, the UC verifies the proper installation of measures, as well as their compliance with product specifications outlined in the scope of work. This includes 100% of common area and central system upgrades, but only a sample of in-unit upgrades.

While QA/QC tasks are relatively consistent, the EUC multifamily programs structure their responsibilities differently. For example, SDG&E's program hires an independent QA/QC contractor for measure verification and uses the program implementer, TRC, to review the QA/QC report and ultimately approve the incentive. The BayREN EUC-MF program on the other hand leaves both measure verification and incentive approval with the implementer AEA. While specific QA/QC protocols that describe roles and responsibilities are still being developed for the Pilot, a hybrid model may emerge where measure verification is done by the UCs but assessment review and incentive approval lie with the IOU.

[49] According to the MF HERCC, the MF HERCC Audit Protocols were "referenced and modified for use" by a number of EUC-MF programs, including SoCalREN, PG&E, SDG&E, and BayREN. Source: MF HERCC, 2014.

[50] TRC uses subcontractor AESC.

Combustion Appliance Safety Test-Out

In addition to the verification of measures, SCE/SoCalGas requires CAS test-outs to ensure that the retrofit does not negatively affect residents' health and safety. In the SCE/SoCalGas Pilot, the owner is responsible for conducting CAS test-outs in all remodeled units. CAS/CAZ testing also can find deficiencies in measure installations that sample-based QC would not find otherwise. The UCs further test a sample of the units following MF HERCC Combustion Appliance Safety Protocols while specific documents are being developed.

Shifting the costs of the CAS test-out to the property owner is different from PG&E's EUC-MF program, where raters undertake 100% of test-outs. Making owners of properties with gas service responsible for the test-out may dis-incentivize participation, all else equal. By making the owner responsible for the CAS testing costs, this can increase the workload and project costs for the owner and can subsequently discourage participation in the program.

The SCE/SoCalGas Pilot supports evidence from other EUC-MF pilots that CAS tests may pose a barrier within the EUC-MF design. Two of three Pilot UCs felt that CAS testing poses hurdles to property owner participation and/or that the amount of time needed to complete CAS tests was overly lengthy. Additionally, some property owners (3 of 5 interviewed) also cited the program's CAS requirements as a challenge. The three individuals who felt that CAS testing was a challenge each noted different issues with the requirements. One respondent would have preferred to do a staggered test-out as units were completed, to maximize tenant safety and ensure tests represent as-installed conditions. One had three appliances fail a CAS test, but although the results were still within California standards, no repairs were needed; overall, he judged this process "a pain" as it caused confusion. The final respondent noted that the potential for costly mandatory repairs (should an issue be found) poses a deterrent to participation given that repair costs may exceed rebate incentives. On the other hand, one of the two property owners who did not feel CAS tests were an issue noted that he was able to resolve CAS test issues with water heaters without problems. These findings are similar to lessons-learned documented in the PG&E EUC-MF Pilot evaluation. Together, these findings suggest that the EUC-MF's test-in and test-out procedures might pose a barrier to at least some participants in a full-scale program.

Overall, CAS remains a disputed topic in multifamily programs and is unpopular with property owners who are concerned about the liability and project costs, as well as additional workload related to the remediation of health and safety issues. While there are valid reasons to keep CAS testing in place, strict definitions of test and remediation requirements can help manage expectations and test-out delays. Moreover, the IOUs and the CPUC may find it beneficial to consider how a full-scale EUC-MF design might adjust CAS testing procedures to reduce time and cost barriers for UCs and participants while maintaining a commitment to tenant health and safety.

7. Secondary Data Source References

Table 33. Secondary Literature

Reference	Resource
EPC, 2013	EPC (2013): *Multifamily Energy Efficiency: Reported Barriers and Emerging Practices*
Hartkopf, McCollum & Robbins, 2012	Hartkopf, McCollum & Robbins (2012): *Coast to Coast: Piloting Multifamily Retrofit Program Delivery Models*
Multifamily HERCC, 2014	Multifamily HERCC (2014): *Update to the 2011 Multifamily HERCC Recommendation Report, Second Draft 9.3.2014*
Oh et al., 2002	Oh et al. (2002): *Market Segments in the Multifamily Sector*
SBW/Opinion Dynamics, 2014	SBW/Opinion Dynamics (2014): *Process Evaluation for PG&E's Energy Upgrade California Multifamily Pilot Program*
Smith, Gray & Harrington, 2014	Smith, Gray & Harrington (2014): *Making Efficiency Efficient: Using Low Cost Internet Technology To Reinvent The Traditional Utility Rebate Program*. ACEEE Summer Study on Energy Efficiency in Buildings
Southern California Edison, 2013	Southern California Edison, Customer Energy Efficiency and Solar Division (2013): *2013 – 2014 Energy Efficiency Program Plans*
The Cadmus Group, 2013a	The Cadmus Group (2013): *2010-2012 PG&E and SCE Multifamily Rebate Program (MFEER) Process Evaluation and Market Characterization*
The Cadmus Group, 2013b	The Cadmus Group (2013): *2010-12 PG&E & SCE Multifamily Property Owners & Managers General Population Survey and Study*
TRC, 2013	TRC (2013): *Lessons Learned through Piloting Energy Upgrade California™ Multifamily Programs*
Various California IOUs, 2014	*IOU Statewide Public Workshop-EUC Multifamily Pilots, March 2014*

Appendix A. Detailed Findings: IOU Program Managers and UCs

The evaluation team conducted in-depth interviews with two IOU program managers and three UCs in February and March 2016.

Table 34. Detailed Findings from Program Manager and Utility Consultant Interviews

Findings by Thematic Discussion Topic
Property Recruitment Process
▪ The recruitment strategy to leverage existing UC and IOU contacts was appropriate for the Pilot. ▪ The UCs did not experience major challenges in recruiting participants, but highlighted that the following would have been helpful: 1) Information about past property upgrades, and 2) more frequent updates on budget expenditure and the remaining pipeline/opportunity. ▪ UCs highlighted a few barriers to participation, including the program's health and safety requirements and the Pilot's short implementation time. They explained that owners of market-rate properties prefer building upgrades upon tenant turnover and that it all comes down to timing. One further explained that some property owners simply don't want to wait for program and simply go ahead with the upgrades ▪ All UCs felt that targeted marketing will be critical to ensure sufficient participation in the future. They suggested that UCs are in the best position to market the program, for example through property owner workshops, email blasts and existing relationships. Nevertheless, they recommended that one IOU should take the lead to streamline marketing and outreach efforts between the UCs. ▪ Generally, property owners were already planning to do a property upgrade when being recruited the program. For some properties, upgrade plans already included energy efficiency measures, other properties added these upon Energy Assessment Report recommendations. ▪ To attract market-rate properties, a program should allow a unit-at-a time upgrade. UCs estimated that the unit-at-a-time upgrade would involve a program cycle of about 3 years. ▪ UCs recommended that program cycles should be 3 years at a minimum, better 5 years, to allow for phased upgrades, but also to account for longer project implementation in multifamily properties in general. (One UC explained that equity projects are fairly quick but lower-income projects take longer)
Referrals to Other Energy Efficiency Programs
▪ All UCs referred property owners to other energy efficiency programs, including MFEER, MIDI, ESAP, and others ▪ UCs reported following a consistent referral process: The Energy Assessment Reports included a list of energy efficiency programs that provided a high-level program description and web-links. However, the program descriptions did not provide detailed incentive information, and it was the property owner's responsibility to follow-up with the respective programs.
Single Point of Contact Feature
▪ UCs and program staff had mixed reactions regarding the success of the single-point-of-contact. IOU program managers thought that it worked well using the UCs or dedicated IOU staff as single point of contact for the program. The UCs also felt that their handholding helped the customer throughout this program. ▪ However, one UC mentioned that a property owner still has to go through multiple programs, so having one contact at the utility or the UC is of limited help to the customer.
Basic Assessment
▪ UCs conducted Basic Assessments for most properties. One UC noted that two of its properties received permission to forego the first assessment because they had already scoped out energy efficiency upgrades sufficiently. ▪ Implementation differed slightly between the UCs. Two conducted all assessments on-site, whereas the third compiled the necessary information through a phone call with property owners. ▪ The UCs did not experience major difficulties in completing the basic assessment, but noted some back and forth related to reporting. ▪ Nevertheless, there is opportunity to reduce program spending: Two UCs suggested that this assessment could be done via phone. They reported that they have made positive experiences with this approach in other programs such as the BayREN EUC-MF program. One also highlighted that a more extensive upfront review may be more critical in an open-rater model, but less critical given the experience of all parties involved. Only one of the three UCs preferred on-site assessments to collect all necessary information and provide better recommendations to property owner.

Findings by Thematic Discussion Topic

Comprehensive Assessment

- The Comprehensive Assessment involved multiple tasks, including on-site property assessments, health and safety inspections, interviews with property owners and facility staff, EnergyPro energy savings modeling and analyses, baseline model calibration with IOU billing data, and financial analyses including identification of funding sources. In addition, all UCs communicated with the property owners before and throughout the assessment to compile property information, ensure tenant notification, and inform property owners of preliminary assessment findings.
- Implementation was generally consistent between the UCs. Only one UC initially worked with a subcontractor, but found that it was less time-effective to train partners and therefore decided to complete the remaining assessments in-house.
- The energy assessment is the most time-intensive task for UCs.
- IOU program managers reported that the UCs energy savings analyses were generally sound. Only few corrections were necessary, these were mostly related to baseline assumptions.

Challenges in Model Calibration

- UCs and program staff experienced a few issues related to reporting and model calibration. They highlighted the following issues and discussed strategies for improvement.
- The development and review of the Energy Assessment Reports took longer and was more work-intensive than originally anticipated for both IOU program managers and UCs. This was due to variations in the reporting styles, and both IOUs reviewing the full report including savings. The program used the Pilot to develop a report template and there were several rounds of comments to Energy Assessment Reports in which the utilities requested changes the report format to make reporting more consistent between UCs. Although these inefficiencies improved over time, they resulted in several months of IOU reviews and subsequent project delays.
- There was agreement that standardized report templates will be important to streamline the report development and review processes in the future. Additionally, both UCs and IOU staff suggested that the review could be done by one IOU (i.e. SCE for electric measures/SoCalGas for gas measures).
- Using billing data to calibrate baseline EnergyPro models required more staff time and rigor than initially expected, due to a combination of factors. First, the collection and transmission of billing data was more cumbersome than anticipated. IOU program managers explained that most properties that completed the program are sub-metered, rather than master-metered. IOU program managers explained that obtaining meter readings was more labor-intensive for the properties that are not master-metered. Second, UCs pointed to labor-intensive data preparation because they had to match unit and meters even though property-level data would have sufficed.
- Given the above, although there was agreement that calibrated models are beneficial in that they more accurately depict energy usage and measure savings, both the IOU program managers and the UCs had mixed reactions to whether it is worth the time investment.
- One UC commented more broadly that the whole building assessment model is too cumbersome and expensive for the amount of energy savings the IOUs can claim. The UC suggested a simpler model with less modeling that uses EnergyLite to avoid site assessments. The drawback of such approach were less accurate is that it energy saving, but believes that overall it would balance out (some estimates are higher some are lower)

Measure Installation

- Although measure installation was the property owners' responsibility, all UCs communicated with property owners throughout the measure installation and with contractors as needed. The more comprehensive upgrades required more liaison, and in some cases, UCs helped with the review of contractor submittals, the development of product specifications, and the liaison with contractors.
- UCs did not experience major issues during the installation process. Furthermore, they did not find that the project implementation time was particularly long for multifamily properties or that it was the measure installation that held up projects.
- UCs noted that their time commitment differed depending on the property owners' needs. Two of the UCs reported that time spent consulting with contractors and property owners during installations was about 1% of the total time spent on the project.

Findings by Thematic Discussion Topic
Verification, QA/QC, and Reporting
▪ Verification processes are consistent between UCs: Upon measure installation, they inspect the upgrades, conduct health and safety tests, review any rebate application documents, and summarize their findings in the Verification Report. IOU program managers review the Verification Report before making rebate payments. ▪ UCs reported that several properties had inspection failures related to CAS issues but not related to incorrect installation. The Verification Reports list the types of failures in detail. o Health and Safety Inspections: One UC said that the CAS test-ins take the most amount of time and pose the biggest barrier to program participation. o The level of detail of the report: UCs commented on the level of information provided in the assessment report. They explained that the level of detail is useful for IOU review and verification later on. However, they explained that often property owners are mainly interested in the measure recommendations and rebate levels and suggested the report could be more succinct for this purpose. ▪ One UC reported that the verification stage the most time-intensive process in this program, particularly due to CAS tests. The UC's average time commitment was 54 hours about one fifth of the total time spent on a project. ▪ However, UCs also highlighted that closeout file reporting requirements were extremely time intensive because the program required an itemized list of measures per unit. o UCs suggested reporting the different measures at the property level. From their perspective, this approach has worked well in other multifamily programs (for example: measure=aerator type X, qty=150). o UCs also explained that in this Pilot, all units within the same property generally received the same upgrades ▪ Similarly, IOU program managers noted that they complete a project tracking database/spreadsheet, which they populate with information from program forms and reports.
Discussion of bigger picture topics
What worked well
▪ The closed-rater model worked well from the perspective of IOU staff. UCs worked closely with decision-makers at the properties, who often manage multiple properties in a portfolio. ▪ The closed-rater approach allowed for a high degree of technical assistance, hand-holding/shepherding, and educating property owners about other program opportunities. UCs also highlighted the technical assistance and hand-holding. ▪ Both IOU staff and UCs highlighted the good collaboration between all parties involved. UCs noted that the program managers were open to making improvements as far as possible, and that they were satisfied with the protocols developed during the Pilot. One also highlighted that the IOU program staff was willing and eager to meet with participants. ▪ The program allowed properties to claim savings for any energy efficiency measures, one UC highlighted that this as a great strategy and a good benefit to attract participants.
Why Pilot could not finish within envisaged time frame
▪ The program took longer than anticipated. IOU staff underestimated the complexity of large projects, but there were also project-specific delays such as CAS tests and turnover in property management staff. ▪ One UC also pointed to slower ramp-up because the program took a collaborative approach to developing protocols. However, UCs also explained that comprehensive multifamily projects take a long time and that program cycles have to consider this.

Findings by Thematic Discussion Topic
Retrofit Depth
▪ The program fell short of its savings goal despite reaching its target for upgraded units. ▪ There was agreement between the UCs and IOU program staff that the shortfall in savings was due to "trimmed down" project scope. UCs explained that the installed scope of work differed from what was listed in the assessment report due to budgetary constraints by the property owner. For example, some CAS tests revealed costly duct insulation issues that the owner did not initially budget for. ▪ There were mixed reactions regarding the depth of retrofits and whether properties pursued "low hanging fruit." One UC did not feel like their project pursued the low hanging fruit, whereas another acknowledged that projects installed a lot of lighting and water heaters. ▪ IOUs felt that higher incentives did not translate to deeper savings or more-comprehensive projects. They felt that properties pursued, that the tiered incentive structure tried to incentivize. They explained they are still trying to find the right incentive structure. ▪ UCs and IOUs discussed the following options to achieve deeper retrofits: o A fixed deemed rebate for select measures (one UC thinks this is a good idea, another UC thinks it would save energy assessment time, but under that structure, the program won't educate customers and would not help attract market-rate properties) o Bundling of measures: One UC suggested a point system for a bundle of measures, but other UCs felt such approach only works if flexibility in measure selection remains. One of the dissenting UCs doesn't see a need for bundling because they don't think that property owners have problems comprehending the Pilot's existing structure. o One UC suggested increasing the incentive for higher-savings projects (total % site savings) but reducing the incentive for lower-savings projects.
Improvements
▪ One UC suggested providing one single program for multifamily programs. Currently, the program is not truly following the SPOC approach because property owners still have to go through other programs after the UC referred them. ▪ UCs agreed that unit-at-a time upgrade would be a feasible option to attract more market-rate properties. One UC highlighted that PG&E's trial (phased implementation) showed slightly higher administrative costs. UCs estimated a project implementation time of 2 to 3 years based on a 50% turnover rate in each year and suggested that a program cycle should at minimum be 3 years, but better five years. One UC also suggested a P&A add-on to upgrade equipment (SEE TRANSCRIPT FOR MORE) ▪ One UC recommended a stronger benchmarking element to improve persistence of savings. This could include an operation and maintenance plan, owner training (i.e. thermostat settings) ▪ UCs suggested that the program cycle length should reflect longer project implementation for multifamily properties. ▪ Simplify incentive structure (Two UCs). One of these UCs described the current approach as too much of a "guessing game" and suggested bundling with point system.

Appendix B. Detailed Findings: Participating Property Owners

This appendix presents additional results of five property owner interviews representing 10 properties (63% of property owners and 67% of properties). Please refer to the main body of the report for a summary of respondent characteristics and general satisfaction with the program.

Program Experiences

Most property owners planned their program-incentivized energy efficiency improvements as part of a larger retrofit. Planned building upgrades included regular repairs, deferred maintenance to complete outstanding repairs, and some energy efficiency upgrades. Only one property owner did not have upgrade plans before learning about the program. The primary driver of program participation is the rebate to help cover the project costs (4/5). Further, two of the five property owners sought to reduce operating costs, and two corporate firms highlighted their commitment to sustainability/energy efficiency.

Although most property owners came into the program with plans to make energy efficiency upgrades within a larger retrofit, respondents indicated that the building upgrades would have been different had the property owners not participated in the Pilot. Property owners indicated that the program did not generally influence the project scope in terms of chosen measures replaced. However, property owners reported that, without the program, they would have installed less-efficient products for most measures. Only one property owner provided statements consistent with complete free-ridership, indicating that his company would have done the exact same project without the program.

Program Satisfaction

Property owners are generally satisfied with the program and report having positive experiences with the program. Four of five property owners described their experience with the Multifamily Program as positive and rated their overall satisfaction with the program as 7 or higher on a scale from 0 to 10. Satisfied respondents described the program as “great,” “easy,” and a good learning experience. Property owners indicated that the most valuable services provided in the program were technical assistance throughout the project (3/5) and the Assessment Report (2/5). Consistent with the high overall satisfaction ratings, all property owners would recommend the program to other multifamily properties, although one would only recommend the program for larger properties with more than 50 units.

In contrast to the generally positive sentiments of most responding property owners, one of the five respondents gave a lower overall satisfaction score (4) and described program participation as exhausting. This property owner owned a smaller multifamily property, and pointed to several challenges related to developing the scope of work, CAS testing, verification procedures and the incentive payment. This property owner would not recommend the program because participation is too time intensive and the rebate is not high enough for smaller properties. Nevertheless, the respondent would consider participating in the future at a larger property.

Despite the high overall levels of satisfaction, participating property owners were more satisfied with some program components than others. While property owners were highly satisfied with the UCs (mean 9.0, range: 7 to 10, n=5) and energy assessments (mean 8.2, range 3 to 10, n=5), their satisfaction with the Energy Assessment Reports was mixed (mean score 7.4). Three property owners were highly satisfied, whereas two gave lower satisfaction scores and described the reports as too technical, too difficult to translate to specific energy efficiency upgrades, or noted that the assessment processes were too time consuming for their property staff. One commented that,

> "They are not the ones who determine what makes sense for us. We have to do that and we tried to become proficient in making those decisions but it is certainly not our field of expertise. But there is a lot of work that goes into making the decision. You don't just look at the report and say 'This looks good.' You look at the report and say, 'Okay we need to meet with contractors and get contractors to price all these items.' And then nothing is simple."

Further, property owners were only moderately satisfied with the program's rebate structure (mean 5.6, range 2 to 10, n=4). Unsatisfied property owners generally commented about the provision of per-unit rebates based on total site savings, explaining that this structure made it more difficult to weigh out costs and benefit of installing a recommended measure. Participants that fell short of the envisaged site-level savings tended to be unsatisfied with the rebate amount. In total, these three property owners represented eight properties, five of which fell in the bottom two incentive brackets. One property owner commented about the savings structure, noting,

> "It was far easier for me to hire another consultant and go in and replace light fixtures, for example. And he would replace light fixtures in my unit and he says, 'Oh well if you use this light fixture I can get a $2,000 rebate.' It was perfect. And then I don't have to deal with it. But this [Pilot]…if you do this then you get 2% and then if you do this thing we will give 2.3% and this will give you 1.4%… It is just too complicated."

Property owners' satisfaction with the quality of work and their interaction with contractors was high (mean 7.8 and 8.0 respectively). Only one property owner gave lower satisfaction scores on both accounts because their contractor installed products that did not meet the minimum performance requirements set out by the program. The property owner believed that the project was more complicated than what the contractor deals with on a regular basis and felt that the contractor did not communicate these problems. From the perspective of the property owner, this resulted in longer installation times, quality concerns and subsequent inspection failures. This property owner commented,

> "These projects were very technical heavy and engineering heavy …The contractor would have liked us to say install this brand, this size boiler. They wanted more specificity in terms of what exactly to do. I don't have that capacity and I didn't have the capacity from [the Utility Consultant] and what they were doing for the program to provide that level of specificity and detail. I think things could have gone a lot faster and a lot smoother had I been able to provide that detail to the contractor at the outset."

In terms of program paperwork, property owners were moderately satisfied with the type of paperwork required by the program (mean score 6.8) given that the UCs completed the majority of the reporting. Only one participant reported issues and gave a low satisfaction score (1). This participant reported that the program lost some of their paperwork and later provided outdated forms requiring the forms to be completed again.

Property owners were moderately satisfied with the length of time it took to participate in the program from the first assessment to incentive payment (mean 6.6, range 0 to 10, n=5). Only one property owner was not satisfied with the project time line (score of 0) because it took six months to receive the rebate. As one property owner commented broadly, projects in multifamily buildings typically take seven months or more.

Appendix C. Detailed Findings: Partial-Participating Property Owners

This appendix summarizes the results of the two partial-participant property owner interviews we completed. The two property owners with whom we spoke both interacted with the program at market-rate properties. Reducing operating costs, saving money, and receiving the Pilot incentives drove these respondents' interest in the Pilot. Neither respondent recalled their level of Pilot involvement prior to dropping out, but according to records each property received a Comprehensive Assessment. Only one of the two respondents recalls why the property in question did not complete Pilot upgrades. This respondent reports that his facility did not proceed with the Pilot because of Pilot requirements, mentioning that his property did not qualify because of the property's layout and per-building unit, which consists of a courtyard of multiple small buildings with two to three units each.

Although they did not complete upgrades through the Pilot, both respondents indicate a likelihood to perform other energy efficiency upgrades in the future. Both partial participant owners we spoke with provided recommendations about ways this Pilot could be improved. Comments are as follows:

- Both respondents feel that technical assistance would be a useful addition to the program, particularly in terms of defining the scope of work, including product specification.
- Improve the Comprehensive Assessment Report by creating an easy-to-understand summary of the assessment, including a clear summary of the property owners' expected costs to install recommended upgrades.
- Consider working with companies earlier in the upgrade process, such as providing information to property owners about to buy a new property. By marketing the Pilot at the due diligence stage (before a company commits to purchasing a property), the company could factor in potential energy efficiency upgrades and incentives into their budget for a property.
- Partial participants offered a mix of comments on the savings requirements and rebate structure. As with full participants, these partial participants wondered whether prescriptive rebates could be offered for select measures instead of custom calculations, whether the Pilot could increase incentives, or whether the Pilot could offer participants the ability to select just several of the measures identified through the assessment process. One suggested that providing loans would be useful, if the rebates could then be used to pay back those loans.
- Property owners also commented on project implementation phases. One thought that staggered participation may not be effective in affordable housing because of the low turnover rates in those properties, but that if it were possible that would be beneficial to impact tenants as little as possible. The other property owner thought that staggered participation would be useful for some larger upgrades such as appliance replacements upon tenant turnover, but other easier upgrades such as aerators should be installed all at once.
- In terms of marketing the program, property owners mentioned several ways that the IOUs could reach multifamily property owners in the future. One noted that his company often hears about energy efficiency programs through vendors and contractors that want to perform the upgrade work at their facility (A), whereas the other indicated that online information and information through trade groups could be effective (B).

Appendix D. Detailed Findings: Contractors

To install measures and complete retrofits recommended for their property or properties, participating property owners chose their own contractors to perform the work. Further, although the Pilot provided guidance about contractor certifications (i.e., company licenses and insurance, staff background checks), the program staff did not verify that contractors met those expectations.

Overview of the Contracting Companies

Participating contractors provided various services such as such as roofing, lighting, plumbing, electrical wiring, and structural engineering. All 10 contractors were certified general contractors. Only one company had additional certifications which included BPI (Multifamily) Building Performance Institute and Certified Energy Plans Examiner (CEPE).

All 10 contractors have experience working in multifamily buildings and report an average of 20 years of experience each, although experience varies substantially, ranging from 2 to 47 years of experience. Overall, multifamily projects represent a majority of (63%) the participating contractor's overall revenue in 2015 (n=10). Of the contractors' multifamily projects, an average of 43% were rented at market costs as opposed to subsidized housing for low-income people (n=8).[51] In addition to working in multifamily buildings, most (n=8) also provide services for single family and commercial buildings.

Program Involvement

Prior to installing upgrades through the Pilot, 8 out of 10 contractors had an existing relationship with the property owner. The contractors have worked with these property owners for 1 to 21 years with an average of 5 years.

As a part of the interview, we also asked the contractors if they had any interactions with the Utility Consultant (UC) who worked with property owners to complete the energy efficient upgrades. Most of the contractors we spoke with had not interacted with the UC (n=6). The lack of interaction can be explained by the number of contractors needed to complete one project. For projects with more than one contractor, one contractor served as the main contact between the UC and the other contractors.

Among the contractors who had interacted with the UC, contractors recalled that the UC discussed project timing and progress, site layout, energy modeling, and documentation required for the program. All of these contractors were highly satisfied with the Utility Consultant's level of communication and coordination and the technical support provided.

Program Recommendations

Due to the high level of satisfaction reported by the contactors, 9[52] of the 10 contractors would participate in the program in the future. Their only major recommendation was to reduce the level of documentation required by the program. According to the contractor, the "excess" level of documentation and the lack of guidance on design-related issues required several back-and-forth interactions with the Utility Consultant before designs could be approved and finalized.

[51] Two contractors did not provide estimates: they did not know how the multifamily properties were being rented out.

[52] One contractor was not in the position to make such a decision.

Appendix E. Detailed Findings: Review of Engineering Approach

In the report, we provided broad findings and conclusions about the EnergyPro modeling approach. This Appendix summarizes project-level findings that support our broader findings and conclusions.

UCs modeled buildings' baseline conditions based on existing conditions observed on site or minimum Title 24 code standards. In general, we found the baseline characterizations an acceptable model of reality, with several exceptions presumably reflecting the UCs' calibration efforts, although we cannot confirm this is the case due to the lack of documentation. Models with observed discrepancies between baseline conditions and typical multifamily building characteristics included six properties where heating set-points were either atypically high or low and six cases where lighting schedules represented atypical conditions. In an additional two cases, we were unable to verify that the models had accurately captured building square footage. In one case, it was not clear why the Utility Consultant had not combined multiple buildings into one model.

We also reviewed modeling assumptions for the two highest-saver measures at each property (30 measures). Table 35 on the next page presents the measures of interest for each property. We assessed modeling reasonableness based on the degree of correspondence between Comprehensive Assessment Report information and EnergyPro assessment models; between final site Verification Reports and EnergyPro verification models; and the extent to which documentation explained differences in measure-level savings between the Comprehensive Assessment Report and the Verification Report.

In 90% of verification models, we found that UCs modeled the top measures using reasonable assumptions (27/30) – for example, we observed reasonable and expected differences between proposed and verification EnergyPro models (e.g., measures' SEER ratings, EFs, hours of use, or flow rates), or we could verify the correct application of EnergyStar calculators or CPUC workpapers. In many of these models that we deemed "reasonable," we were only able to determine reasonableness after cross-referencing several sources of information, or by our own professional judgement given the lack of Pilot documentation.

We observed three measures with clear discrepancies. In one case, a high-efficiency DHW was modeled with a standby loss for tankless water heaters, even though this type of DHW does not have standby loss. In another, showerheads were modeled with a 1.5 GPM flow rate, but were recorded as 2.0 GPM in the verification model. In the last case, a DHW pump was modeled using different assumptions about derating factors in the Assessment Reports vs. Verification Reports, leading to verification savings that were 200% of the reported measure's total savings.

Table 35. Measures Reviewed Per Project

Project ID	Key Measures Reviewed
1383-002	▪ High efficiency windows (improved uvalue, SHGC) ▪ Domestic hot water
7426-004	▪ HVAC (Replace existing with higher efficiency SEER 13 HVAC) ▪ LowFlow Showerheads (2.11 gpm avg showerheads replaced with 1.75 gpm or less)
7426-005	▪ Replace existing windows (u=1.25, shgc=0.8)with higher efficiency windows (u=0.30, shgc=0.30) ▪ Replace existing domestic hot water heaters (efficiencies estimated from CEC database, EF=0.56 used in existing model) with higher efficiency domestic hot water heaters (EF=0.62 or higher)
7426-006	▪ Replace existing packaged rooftop units with SEER 14 AC and AFUE 80% or higher furnaces ▪ Replace existing (EF 0.80) with EF 0.92 or better tankless water heaters, replace existing pumps with new demand control recirculation pumps
8842-002	▪ Install demand control on existing DHW recirculation pumps to reduce unnecessary operation ▪ Replace existing (81-82% efficient) DHW heaters with higher efficiency (95% condensing)
8842-003	▪ Install demand control on existing DHW recirculation pumps to reduce unnecessary operation ▪ Replace existing (80-85% efficient) DHW heaters with higher efficiency (94% condensing)
1383-003	▪ Replace existing showerheads with lower flow showerheads ▪ Replace existing constant volume pool pump with variable speed pump/programmable timer
1383-005	▪ Replace all PTHP's serving studio units with higher efficiency units ▪ Replace existing showerheads with low flow (this measure was separated out from the other fixture types for the verification report)
7426-003	▪ Replace existing residential unit HVAC units (9.7 SEER) with higher efficiency SEER 13 ▪ Replace existing 2.11 gpm with 1.75 gpm showerheads
8842-004	▪ Replace central 80% efficiency DHW heaters with central 94% efficiency tankless water heaters ▪ Add R13 insulation to existing uninsulated exterior walls
8842-005	▪ Replace existing showerheads with low flow, add aerators to existing bathroom and kitchen faucets ▪ Replace 82% efficient boilers with 96% condensing boilers; Boilers serve DHW storage tank which also heats heating hot water via a heat exchanger; Storage tank and heat exchanger remain unchanged
8842-006	▪ Replace 80% efficient boiler with 94% efficient condensing tankless water heater ▪ Insulate existing uninsulated/minimally insulated hot water piping with fiberglass insulation
8842-007	▪ Replace 82% efficient boilers with 96=5% condensing boilers ▪ Install controls on existing DHW pump (which runs continuously) to allow for cycling off during low demand
8842-008	▪ Replace 83% efficient boiler with 96% condensing. ▪ Replace standard efficiency washing machines with Tier 3 high efficiency.
8842-011	▪ Install controls on existing DHW pump (which runs continuously) to allow for cycling off during low demand. ▪ Replace 78% efficient existing boilers with 96% efficient boilers; Replace existing storage tanks with R16 insulated storage tanks

Appendix F. Interview Guides

SCE MF Pilot_IOU IDI Guide_Final_1-2(

SCE MF Pilot_UC IDI Guide_Final_3-3-201

SCE MF Pilot_PropertyManag

SCE MF Pilot_Drop Out PM IDI Guide_Fi

SCE MF Pilot_Contractor IDI

Appendix G. Response to Recommendations

SCE SoCalGas EUC
MF Pilot Evaluation

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