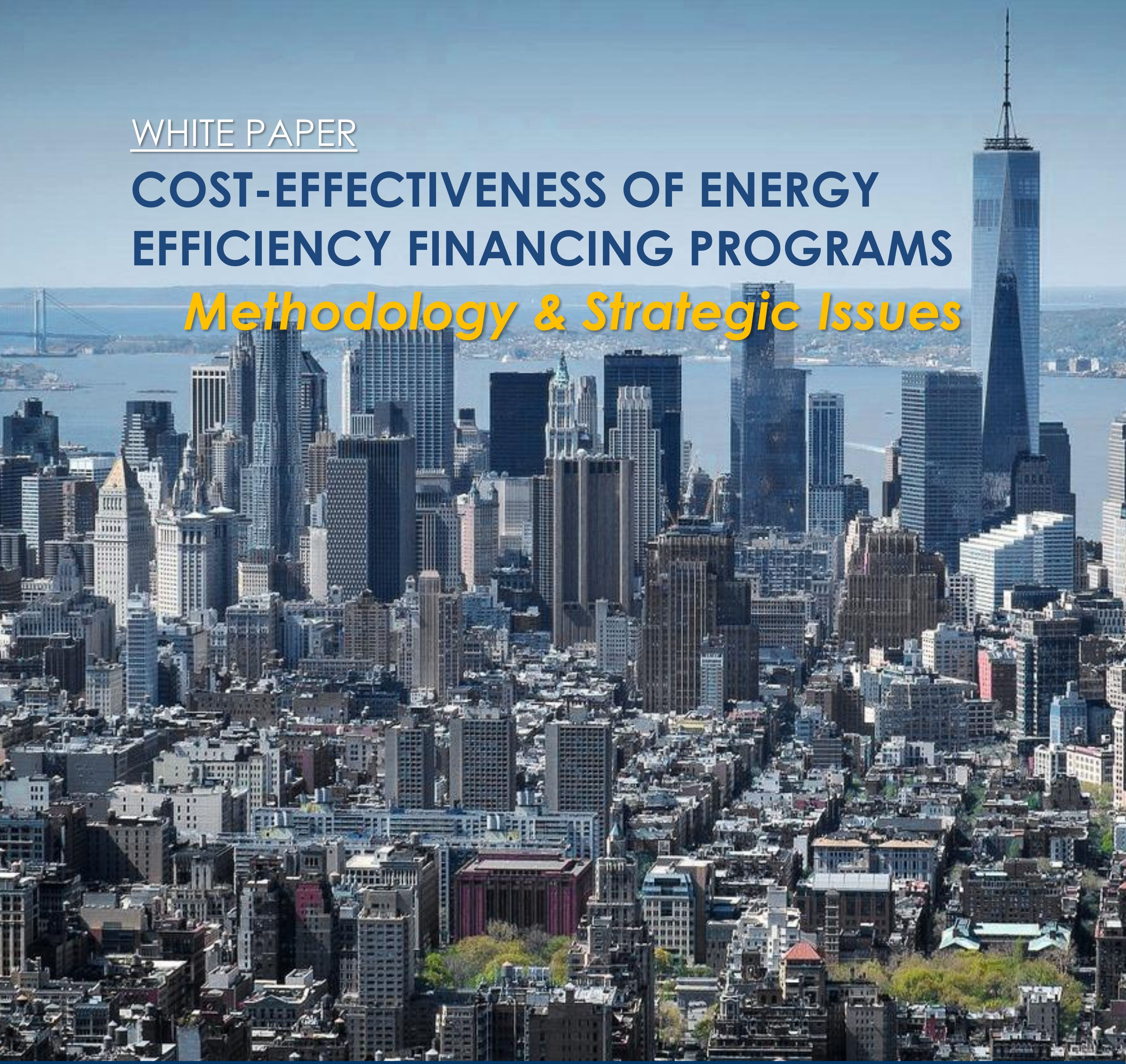
WHITE PAPER

COST-EFFECTIVENESS OF ENERGY EFFICIENCY FINANCING PROGRAMS

Methodology & Strategic Issues



Submitted to: **CALIFORNIA PUBLIC UTILITIES COMMISSION**
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NOTES TO READER

ACKNOWLEDGMENTS

This paper has benefitted from the thorough reviews and commentary of the CPUC, its technical advisors, and experts at Pacific Gas & Electric and Southern California Gas. **We wish to thank reviewers for their thoughtful comments and suggestions, many of which are incorporated herein.**

Reviewers have also taken the opportunity to provide their comments on key strategic questions raised that this paper is intended to raise, but not answer. We appreciate these comments, and look forward to the opportunity of discussing them further in the coming months, as appropriate.

INTERPRETATION

The purpose of this paper is to define an appropriate framework and set of algorithms for assessing the cost-effectiveness of innovative financing programs.

To this end, we use a series of assumptions to test the algorithms we propose on a sample financing program, one that was only beginning to enter market at the time of initial analysis. **While we believe the assumptions are reasonable at this juncture, neither they nor the resulting cost-effectiveness ratios are intended to suggest actual evaluated outcomes.**

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SUMMARY

The California Public Utilities Commission (CPUC) recently approved a series of energy efficiency program pilots aimed at accelerating adoption of energy efficiency across the state, notably through credit enhancements designed to attract third-party capital at favorable conditions.

This paper seeks to address the implications of the Statewide Finance pilots for cost-effectiveness screening. It uses as a test case the largest of the pilots – the Residential Energy Efficiency Loan (REEL) program – and in so doing defines an appropriate methodology to accurately reflect the program's true cost- effectiveness under both the Total Resource Cost (TRC) and Program Administrator Cost (PAC) tests.

The test case, and the model we built to assess its cost-effectiveness, allows us to define:

1) *What* needs to be assessed, i.e. the key components of finance program cost-effectiveness, for both the Total Resource Cost test (TRC) and Program Administrator Cost test (PAC), especially to the extent they differ from standard program components;
2) *How* these components ought to be assessed, i.e. appropriate inputs and algorithms for each; and
3) The strategic implications of applying standard cost-effectiveness tests to innovative finance initiatives.

As the reader will see, properly assessing the cost-effectiveness of REEL (and by extension, similar financing programs) will require adaptations to California's current cost-effectiveness algorithms – primarily the addition of new inputs not previously considered, as well as reconsideration of others. We recommend specific adjustments to the TRC and PAC tests to accommodate these needs, and thus to ensure that they are able to provide a reasonably accurate and appropriate reflection of their intended perspectives. This exercise also raises broader questions regarding the value of the TRC test itself, which we recommend considering.

PURPOSE OF THIS WHITE PAPER

California recently launched a series of statewide pilots to test the efficacy of various new financing mechanisms for energy efficiency. These pilots aim to answer a number of questions, including:

- Whether financing can increase savings cost-effectively, and
- Whether financing can reduce the ratepayer cost of delivering savings.

These questions are fundamentally about cost-effectiveness. Yet answering them raises new questions, principally because the standard cost-effectiveness tests and algorithms were designed to assess programs focused on incentives – primarily rebates and similar payments – rather than on financing. [1]

This paper seeks to address two types of questions raised by innovative financing programs:

- **Methodological Issues:** How do we treat Financing's unique cost and benefit characteristics in our current tests? Are new inputs needed? Do algorithms need to be adapted? And which variables do we need to focus our attention on, in order to minimize uncertainty and "get it right" without getting lost in complexity? **This paper will recommend specific adaptations to current tests to ensure they properly reflect the cost-effectiveness of financing programs.**

- **Strategic Issues:** Even if adapted, are both of the current tests relevant to finance program goals? Do they answer the key questions being asked? And if not, do we need to reconsider whether and/or how to apply these tests to financing programs so that they remain relevant? **This paper raises concerns regarding the value of one of the tests for finance programs.**

As a corollary benefit, this exercise's sensitivity analysis can also help prioritize future evaluation efforts.

Below we begin to address these questions, using the largest of the pilots as an initial test case.

[1] California's cost-effectiveness framework currently uses two standard tests: the Total Resource Cost (TRC), and the Program Administrator Cost (PAC) tests. The California Public Utilities Commission seeks to ensure that approved "resource" programs can reasonably expect to achieve positive TRC and PAC results. Meanwhile, investor-owned utilities are offered performance-based shareholder incentives, determined by 2/3 based on *ex-post* TRC results, and 1/3 on *ex-post* PAC results. The finance pilots are deemed to be "resource" programs, and thus subject to these rules and incentives. Of note, while the IOUs play an important role, ultimately the California Alternative Energy and Transportation Finance Authority (CAEATFA) is responsible for their implementation.

CASE STUDY: "R.E.E.L."

INTRODUCTION

To answer these questions, we developed a model to test the cost-effectiveness of innovative financing programs, and chose the Residential Energy Efficiency Loan (REEL) program as a test case.

The REEL program offers a credit enhancement to lenders in the form of a loan loss reserve (LLR). Specifically:

- The LLR covers 90% of losses on a per project basis, to a maximum of 20% of the loan book associated with Low and Moderate Income (LMI) borrowers, and 11% of the loan book with non-LMI borrowers. Per-project loans are capped at $35,000 for LMI borrowers and $50,000 for non-LMI borrowers.
- REEL has a soft target of one third of the credit enhancement funds being directed to support projects in LMI single-family households.
- REEL caps the rates lenders can charge borrowers at no more than 750 basis points above 10-year treasury rates as of the first business day of the applicable calendar quarter.
- REEL is targeted primarily at eligible energy efficiency measures (EEEMs), but allows for up to 30% of loans to finance non-EEEM measures. These can include measures unrelated to energy (e.g. cosmetic upgrades), as well as certain measures that save energy but are not specifically incented under other energy efficiency programs.
- CAEATFA has been designated as the California Hub for Energy Efficiency Financing (CHEEF), and will administer the program.

REEL was chosen as the test case for three reasons:

1. Of all the pilots, REEL involves the most significant investment of resources – $21 million is committed to credit enhancements over a two-year period, on top of roughly $9 million in setup, administration and marketing costs.
2. REEL's credit enhancement (a loan loss reserve) is a critical new component of most pilots, and one that California's cost-effectiveness framework for efficiency programs has never had to address until now.
3. At the time of writing, REEL was the only Pilot for which CAEATFA had published the program Rules and Regulations, providing the most clearly defined costs (incurred and budgeted) and financial parameters.

Below we discuss the assumptions and parameters we applied to our test case, present the resulting cost-effectiveness test values and sensitivities, and discuss what they mean for assessing the cost-effectiveness of finance programs.

BUILDING THE MODEL: KEY ASSUMPTIONS & SENSITIVITIES

In order to develop appropriate test methodologies for REEL, we began by identifying each of the program's key cost and benefit components, and defining to which cost-effectiveness tests they apply (some components apply to only one or the other test, while others apply to both). We further defined *how* each component ought be calculated, in keeping with the principles of each test, and developed working assumptions for each required input, based on best available knowledge and/or professional judgment (as noted earlier, inputs should be revised once the program is more advanced).[2] We then built a model to test the resulting algorithms. Given significant uncertainties in some cases, we elected to run sensitivity tests around certain critical parameters.

Below we lay out our treatment of each of REEL's defined cost and benefit components:

> SYMBOLS BELOW
>
> *identifies parameters with **sensitivity testing***
> *addresses the **cost-effectiveness test** to which the input applies.*

COSTS

On the cost side of the equation, we identified four broad categories that are consistent with REEL:

1. **Setup Costs:** Prior to launching the program, both IOUs and CAEATFA will have incurred material setup costs (budget of approximately $5 million), including costs relating to administration, overhead, and marketing and outreach to lenders and others. Depending on the perspective sought, there can be value in including them for cost-effectiveness purposes (retrospective view), or excluding them (prospective view, treating them as sunk costs).

   Our model allows for including or excluding setup costs.

   Setup costs, if included, apply to both the TRC and PAC test perspectives.

2. **Administration & Marketing Costs:** We account for the IOUs' budgeted operating costs (including administration, overhead, and implementation) for years 2016 and 2017. We also added CAEATFA's budgeted marketing and outreach costs for the same period.[3] This is

[2] In keeping with the principles and guidelines of the *California Standard Practice Manual for Economic Analysis of Demand-Side Management*. The Standard Practice Manual defines the contours of five cost-effectiveness tests, including the TRC and PAC, that are designed to reflect different perspectives on the relative value of energy efficiency and related programs.

[3] Marketing and Outreach costs include funds provided for that purpose to the Center for Sustainable Energy (CSE).

straightforward, and no different from the non-incentive costs that would be applied to the cost-effectiveness analysis of conventional energy efficiency programs.

Operating costs apply to both the TRC and PAC test perspectives.

3. **LLR Costs:** One of the fundamental differences between the innovative financing pilots and conventional energy efficiency programs relates to time. Specifically, while rebate costs are incurred as measures are adopted, costs associated with the loan loss reserve are primarily incurred *after* loans are made, typically over a period of many years, and at amounts that are unknown at the outset.[4] In the case of REEL, we identified three types of post-pilot costs associated with the LLR:

    a. ***Direct Losses**: The LLR's function is to provide lenders greater security by offering to cover a share of their potential loan losses (e.g., payment defaults). The model assumes a certain level of losses will occur – roughly in line with early results from similar programs elsewhere – for standard (non-income-tested) loans. It also assumes losses will be nearly twice as high for low and moderate income (LMI) borrowers, in keeping with the 20%/11% coverage ratios allowed for LMI and non-LMI borrowers, respectively, in the program's design. Finally, we assume that annual losses diminish gradually over time, consistent with traditional lending experience.*[5]

    Sensitivities test for lower (half) or higher (double) anticipated default rates.

    Direct LLR losses apply to the PAC and TRC perspectives. We do not consider them a transfer payment because they are used to compensate lenders (third parties, which we assume lie outside the boundaries of California's TRC), not borrowers (participants). While borrowers may benefit from the LLR through lower interest rates, we account for this separately (see Benefits section, below).

    b. ***Lost Opportunity Cost of Capital (LOCC)**: Because an LLR requires cash liquidity to cover potential loan losses, it can be expected to generate lower returns than equivalent longer-term investments, leading to a spread between the value of the capital outside of the LLR, and the interest generated within it. The extent of this LOCC depends on two factors: the LLR fund's anticipated rate of return – which was provided to us by CAEATFA – and that capital's assumed value (or cost) if not used for an LLR (which we assume to be equal to the discount rate). The spread, and associated costs, can be significant.*

    Our model allows to test for different assumptions regarding the value of capital outside of the LLR. Specifically, we opt for three approaches: the IOUs' weighted average cost of capital

[4] For example, a rebate may pay $100 upon purchase of an eligible measure. The LLR may have to cover a portion of a participating lender's losses if, when, and to the extent such losses occur over the life of the loan.

[5] Our model assumes a gradual ramp-down, such that annual losses are reduced by 50% by year 10, and by two-thirds by year 15, the final year.

(WACC), a societal cost of capital (State of California bonds), and a value halfway between these two extremes.

The lost opportunity cost of capital applies to both PAC and TRC perspectives.

c. ***Fees and Costs**: In order to administer the LLR, CAEATFA will incur fees for the trustee contractor, the master servicer contractor, and the contractor manager. Our assumptions are based on fee estimates communicated to us by CAEATFA. While it may also incur data management costs, these are currently assumed to be negligible.*

Fees and related costs apply to the PAC and TRC perspectives.

We note that while the items above represent the actual *cost* of LLR funds, they are not expected to be equal to the funds themselves. Indeed, funds set aside by IOUs for the loan loss reserve (LLR) are intended as a backstop, with only a portion (see above) expected to be used. For this reason, it is important that the LLR funds as a whole not be treated as a cost *per se*.[6]

4. **Participant Costs:** The Total Resource Cost test is designed to account for the sum of program and participant costs. Specifically, this includes program administration and marketing, incentives paid to consumers to cover all or a portion of incremental measure costs, as well as any remaining incremental costs covered by participants[7].

   REEL may operate alongside incentive programs, raising important methodological issues for allocation of savings (*what share of net savings should be claimed by REEL vs by incentives that may have been provided to the same measures?*). Nevertheless, from a cost-effectiveness standpoint, it is relatively straightforward: in order to avoid double-counting, participant costs are assumed to be the incremental cost of REEL-driven measures, which we assume to be the total loan book times a weighting factor that reflects the share of savings that a future evaluation determines was driven by the loan as opposed to by incentives or other factors.

   Allocating impact to the loan is one of the primary focuses of the evaluation work yet to be undertaken. For purposes of this scenario analysis, we use working assumptions of 10%, 40% and 70% to reflect a wide range of possible outcomes

   Participant costs apply to the TRC, but not to the PAC test, per standard practice.

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[6] It is also worth noting that because they are focused on credit enhancements, neither REEL nor the other Statewide Pilots that we are interested in here involve IOUs loaning money (or buying down interest rates) directly. As a result, we do not address interest buy-downs here. However, to the extent that CPUC wants to compare the cost-effectiveness of Statewide Pilots and more traditional financing programs (including the On-Bill Finance program), the final test algorithms will need to be adapted accordingly (this would be straightforward).

[7] In California, only *net* participant costs are accounted for, i.e. the remaining incremental costs covered by participants is multiplied by the impact attribution factor. See CPUC's Energy Efficiency Policy Manual (2013), available at: http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy/Energy_Programs/Demand_Side_Management/EE_and_Energy_Savings_Assist/EEPolicyManualV5forPDF%20(1).pdf.

BENEFITS

On the benefits side of the equation, we also identified four broad categories:

1. **Energy Benefits:** Energy benefits associated with the pilot are based on a number of critical assumptions: the cost of energy savings measures, the value of utility avoided costs, the leveraging effect of the LLR broadly, the percent of LLR-covered loans that finance eligible energy efficiency measures (EEEMs, assumed to be 80%), the share of non-EEEMs that may nonetheless generate energy savings and, last but certainly not least, the relative influence of the LLR versus of incentive programs that are also available. We developed what we believe to be reasonable assumptions for these key inputs, based on discussions with CPUC and IOU staff as well as a review of a variety of key documents.[8]

   As noted above, the model tests for three assumptions re. the relative influence of REEL (instead of incentives): 10%, 40% and 70%. This wide range reflects the large uncertainty that prevails at this stage.

   Energy benefits apply to both TRC and PAC tests.

2. **Non-Energy Benefits:** While the CPUC has not historically accounted for non-energy benefits (NEBs), the REEL program raises an important concern. Because it allows for up to 30% of loans to be allocated to non-EEEM expenditures, neglecting NEBs would effectively *require* the TRC test to make an arguably untenable assumption: that consumers would voluntarily assume debt for zero benefit. Since economic theory would have it that consumers only spend (or borrow) where the value to them exceeds their costs, it stands to reason that the benefits *of non-energy saving EEEMs* should be *at least as valuable* as the costs incurred.

   Given that CPUC has not historically addressed participant NEBs, our model allows for three scenarios for non-EEEM NEBs: one in which the non-energy-saving portion of loans taken by consumers (and supported by IOU LLR funds) are deemed to have zero value for those same consumers; another in which value is assumed equal to participants' incurred cost, which would represent the minimum acceptable value from the standpoint of economic theory, and a third in which the value is deemed to

[8] For the cost of energy savings measures, we reviewed a variety of data related to Energy Upgrade California (EUC) and related residential HVAC data included in tracking sheets provided by Jennifer Caron at CPUC. Specifically:

- *Avoided costs:* Aggregated values are based on gas avoided costs and end-use specific electric avoided costs provided in the most recent (Dec. 2011) e3 report, which we validated by phone with e3, as well as an assumption of the electric / gas savings blend that REEL would generate based on past results provided in a CPUC tracking sheet as well as the EUC evaluation report;
- *Leveraging:* The leveraging effect of the LLR is based on program design parameters (LLR is designed to generate 5x lending on LMI accounts and 10x lending on non-LMI accounts); and
- *Non-EEEMs:* We assume that 80% of spending is directed at eligible energy efficiency measures (EEEMs); 20% (less than the maximum 30%) is therefore directed toward non-eligible measures.

Other assumptions are addressed with sensitivity analysis; see above.

be twice as much as what consumers pay, i.e., a 2-to-1 participant benefit/cost ratio on non-energy saving investments.

Non-energy benefits derived from non-energy saving measures apply only to the TRC, since they provide no value to the program administrator.

The case for accounting for participant NEBs from *non-energy saving* investments is particularly strong, since not doing so implicitly assumes that consumers would borrow and invest money for literally zero anticipated value. Yet addressing these NEBs raises a related question: for consistency's sake, should we also address participant NEBs for energy saving EEEMs as well? This is currently being discussed in a separate CPUC proceeding.

Given that CPUC does not commonly account for participant NEBs, our model allows for three scenarios for eligible energy efficiency measures: one that ignores NEBs (values them at zero), a second that values them at 50% of their energy benefits, and a third that values them at 100% of energy benefits. These scenarios offer conservative bounds based on studies elsewhere, which commonly find weatherization-specific NEBs to exceed the value of energy avoided costs, as well as on a 2014 Opinion Dynamics assessment of how participating PG&E customers value NEBs from the EUC program (they valued NEBs far more than bill savings).

We also note a possible alternative approach that could minimize the inconsistency: removing participant costs for non-EEEM measures. We have not built this option into the model, but would consider it preferable to simply assuming a non-energy benefit value of zero for participant investments in non-energy saving measures.

Non-energy benefits associated with EEEMs apply only to the TRC, since they provide no value to the program administrator.

3. **Reduced Borrowing Costs:** Program theory would have it that by largely de-risking eligible loans for lenders (through an LLR that backstops 90% of individual loans up to 20% and 11%, respectively, of the total book value of loans to LMI and non-LMI borrowers), consumers should benefit through lower interest rates (and/or better overall loan terms).

Our team recently conducted a Mystery Borrower analysis to assess the interest rates (hereafter "APRs") that residential consumers of various stripes can access, on both a secured and unsecured basis. Among other things, we found an average APR spread of approximately 4.3% between secured and unsecured loans. From this, we built three scenarios for REEL-driven APR savings into our model: A "high" scenario assumes that lenders pass the full risk protection value (approx. 4.3%) to borrowers through reduced rates. Since the impact of the LLR on lenders is arguably analogous to moving from unsecured to secured loans, this scenario assumes that borrowers who previously would have obtained unsecured loan rates, now obtain the rates offered on asset-backed loans; their benefit is in effect the spread between the two. A more pessimistic "low" scenario assumes that lenders will "pocket" the spread as much as allowed by program rules, such that consumers' APR benefit is limited to the spread between unsecured loan rates, and the program's predefined rate ceiling. A third, "mid" scenario assumes the spread falls halfway between these two extremes.

In all cases, we assume that the APR spread benefit applies to only 75% of participants, i.e. that one in four would, in the absence of REEL, have had access to capital at the same cost as offered by the program (through internal cash or secured loans). Note that early spreads offered by REEL's initial participating lenders appear more consistent with the mid and low scenarios.

The model also tests for assumed loan duration. While the high scenario assumes that loan terms will equate to the weighted average life of financed measures (effective useful life, or EUL), mid and low scenarios assume that loans will last, respectively, 2/3 and 1/3 of the average EUL. Note that the benefits that accrue to consumers from reduced borrowing costs are directly related to the duration of loans (i.e., the time over which consumers benefit from lower rates).

Reduced borrowing costs apply only to the TRC, since they provide no value to the program administrator.

It is worth noting that while most benefits are based on (or applied to) only the portion of savings that are assumed to be driven by the financing, APR benefits differ: participants reap the benefit of lower rates on *all the capital* they borrow through the program. In other words, the reduced APR applies to the *full (not incremental) cost of all (not strictly finance-driven) investments*. For this reason, APR benefits can be a substantial share of total TRC benefits, leading at times to factual but counterintuitive results, as we will see further.

4. **Market Transformation Benefits:** Finally, we note that while the Finance pilots are formally categorized as "resource" programs, they were at least partly driven by a desire to transform markets (specifically, energy efficiency lending practices). This longer-term, market transformation expectation is in fact built into REEL's own logic model. Given this goal, there may be value in considering that the pilots will generate at least some degree of market effects, leading to continued incremental activity *after* its initial 2-year life.

We built three scenarios into the model to test the impact of assuming a longer-term market effect: our "low" scenario assumes zero effect beyond the initial two-year pilot; our "mid" assumes a market effect that retains and perpetuates 10% of the pilot's incremental savings over the subsequent 10 years, without continued program efforts; and our "high" scenario assumes 20% of incremental annual savings are perpetuated over the same period. For the sake of being conservative, we applied these effects only to the direct value of energy savings, even though conceptually they should be applied to non-energy benefits as well.

Post-pilot energy benefits would apply to both TRC and PAC tests.

DISCOUNTING

As noted previously, we considered three discounting scenarios: an IOU weighted average cost of capital (WACC), a societal discount rate, and a rate halfway between these two extremes. See "Lost Opportunity Cost of Capital" in the costs section above for more information on these.

APPLICATION TO EACH TEST

The table below provides a summary of how REEL's key cost and benefit components identified above apply to each cost-effectiveness test.

Fig. 1. Summary of Key Components and Applicability to Each Test

PARAMETER	TESTS		NOTES
COSTS	**TRC**	**PAC**	
Setup	*see notes*		Not included in primary scenario; however, the sensitivity analysis allows for including them in both tests under the "low" scenario.
Admin & Marketing	▼	▼	Provided by CAEATFA and IOUs (includes CSE funds).
Participant Costs	▼		Full amount of LLR-leveraged loans, adjusted for program attribution per CPUC's Energy Efficiency Policy Manual of 2013.
LLR Direct Losses	▼	▼	Based on projected annual default rates times 90% coverage.
LLR Lost Opportunity	▼	▼	Spread between discount rate and anticipated short-term interest rate.
LLR Fees & costs	▼	▼	Provided by CAEATFA.
BENEFITS	**TRC**	**PAC**	
Energy Avoided Costs	▲	▲	Loan book (LLR x leverage) x attribution x assumed unit costs x assumed avoided costs (electricity/gas blend)
Non-Energy Benefits	▲		Participant non-energy benefits associated with attributable, non-energy saving investments as well as investment in EEEMs
Reduced APR	▲		Spread between market and REEL rate scenarios (based on Mystery Borrower results) for select terms, applied to 75% of loan book.
Market Effects	▲	▲	Assumptions to reflect program design theory of longer-term market effects (scenarios of continued incremental savings over 10 years).

PRIMARY RESULTS

Using the assumptions noted above, we modelled “high”, “low” and “main” projected cost-effectiveness results for REEL under each of the two tests. As noted previously, the purpose of this exercise is not to estimate the program’s cost-effectiveness *per se* – this will be done at a later stage when the program’s actual impacts can begin to be measured. Rather, it is to define appropriate algorithms for assessing cost-effectiveness of innovative financing, as opposed to more conventional incentive-based programs, while also highlighting whether and to what extent each test is relevant to these types of programs. The modelling exercise, which pinpoints key sensitivities, can also help to guide prioritization of future research efforts.

As indicated below, the assumptions and sensitivities we applied suggest a **Total Resource Cost (TRC) ratio for the pilot ranging from a low of 0.3 to a high of 2.0, with our main scenario landing at 1.06. From a Program Administrator Cost (PAC) perspective, we find a range of 0.1 to 1.8, with our main scenario landing at 0.55.**

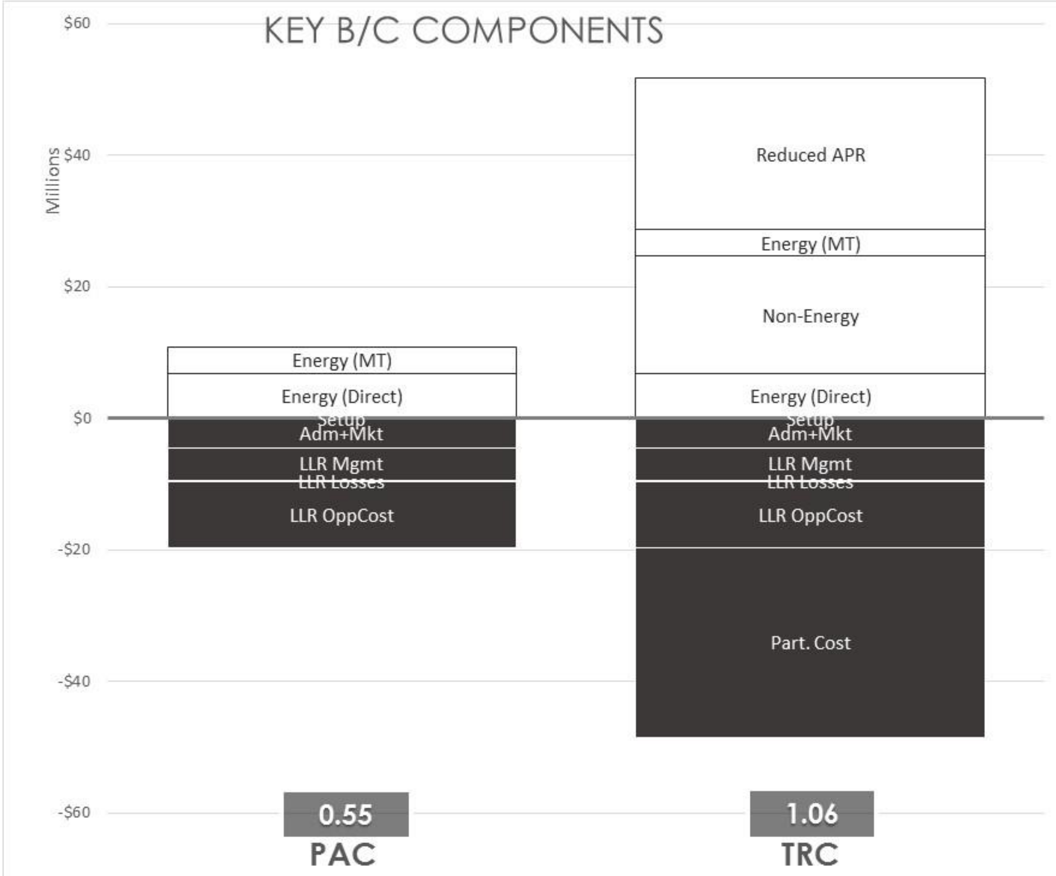
Fig. 2. REEL Cost-Effectiveness: Primary and Low/High Scenario Results

	B/C RATIOS		NPV (2016$)	
	PAC	TRC	PAC	TRC
MAIN	**0.55**	**1.06**	**($8.8 M)**	**$3.1 M**
Low	0.06	0.28	($20.5 M)	($13.7 M)
High	1.81	1.97	$12.3 M	$65.1 M

Appendix A provides specific assumptions and additional notes for each of the nine sensitivities that comprise the scenarios.

These results can be better understood when broken down by each of the key components presented previously (Fig. 1. on page 10). The chart below presents the net present value (NPV) of each such cost and benefit, for the Main scenario, under both PAC and TRC tests.

Fig. 3. Benefits and Costs by Component (Mid Scenario)



As we can see, the direct value of energy (and related savings, including capacity and environmental benefits, per California's avoided cost values) is small when compared with costs. This is all the more true in the case of the TRC, where participant costs alone appear to dwarf avoided energy cost savings. This is not too surprising in that it is a function of the assumptions we made regarding the cost of eligible measures, for which we used a blend of previously-reported EUC and HVAC program results. The former, as reported, were exceptionally not cost-effective under the TRC (0.2). Whether REEL's financed measures end up similar to or different from this assumed blend remains to be seen.

More surprising, however, might be the extent to which avoided energy cost savings are similarly *dwarfed by other benefits*, including reduced interest on loans ("APR") and other non-energy benefits (in particular those associated with consumer investments in non-energy saving measures). We previously described the logic of including these components; we will return to discuss the implications of these results later in this paper.

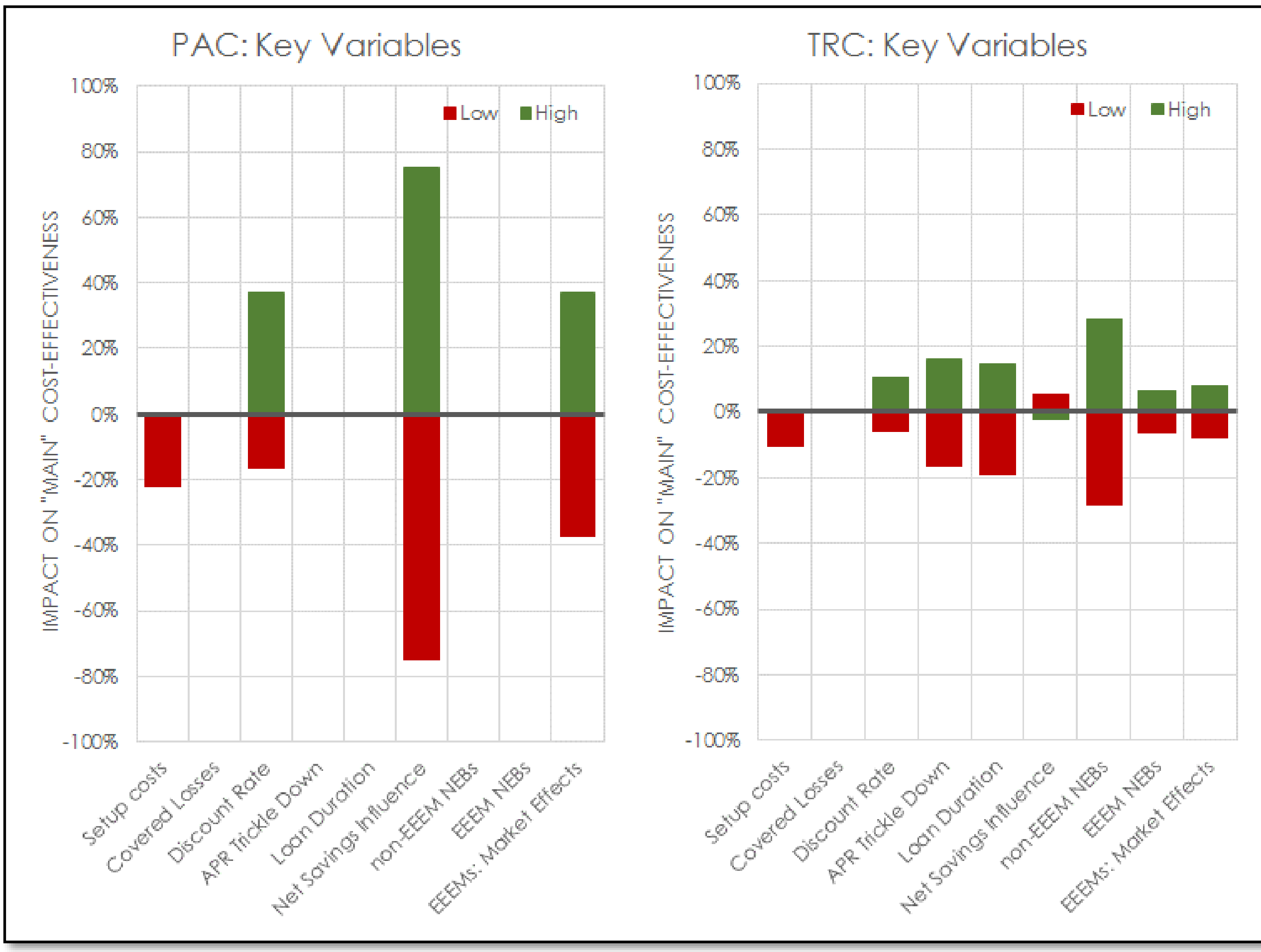
SENSITIVITIES

The Low and High scenario values above are extremes: the sums of *all* sensitivities going one way or another. More valuable is to understand how big of an impact *each sensitivity* has on final results; put differently, how sensitive results are to any one variable.

The charts below illustrate this. Each green bar reflects the impact of the "High" scenario of each variable alone on total cost-effectiveness, while each red bar reflects the impact of the "Low" scenario for each such variable.

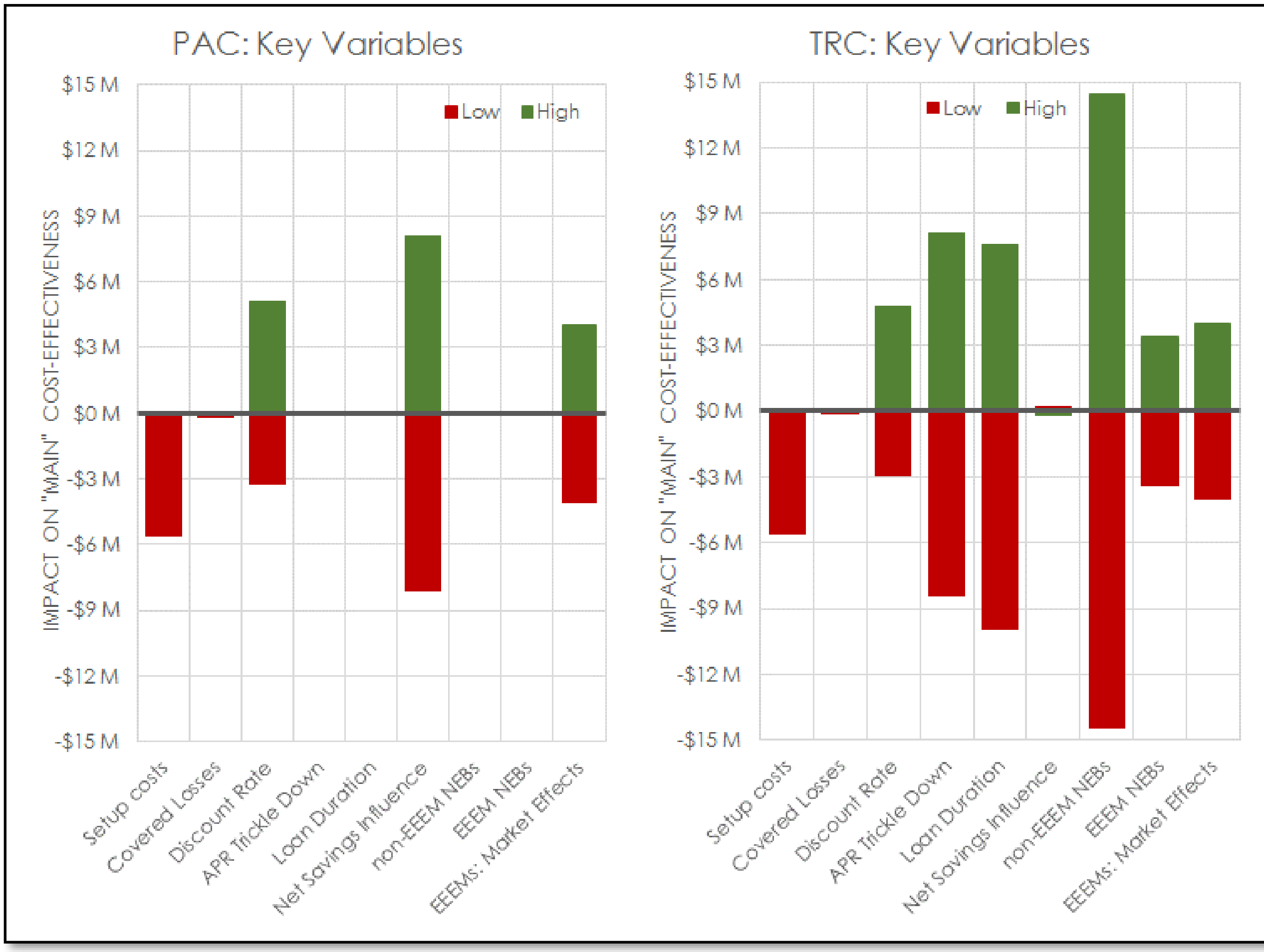
The first chart expresses the impacts of each sensitivity test as a % impact on overall B/C ratios:

Fig. 4. Sensitivity: Impact of Key Variables (% of B/C ratio)



The second chart, below, expresses the impact in absolute (NPV) terms:

Fig. 5. Sensitivity: Impact of Key Variables (absolute NPV)



To understand these charts, consider the second variable: the discount rate. As noted previously, if all "mid" scenarios are chosen, we anticipate a PAC of 0.55 and a TRC of 1.06. If, however, the "low scenario" discount rate (the IOUs' WACC) were chosen instead, while all other variables were maintained at their mid points, results would be reduced by 17% on the PAC and by 6% on the TRC. Inversely, if the "high scenario" discount rate (a societal rate) were chosen, all else being equal, results would improve by 37% on the PAC and by 11% on the TRC. Overall, the choice of discount rate can impact PAC and TRC ratios by 54% and 17%, respectively.

As we can see above, <u>PAC results are most impacted by three variables</u>:

1. ***Relative influence:*** Unsurprisingly, the relative influence of LLR-backed loans – as compared with other incentives available to customers – is critical. For example, if net energy savings supported by loans are found to be driven 70% by REEL and only 30% by other available incentives (rather than our primary scenario of 40%/60%) – meaning that the advent of financing will have more than doubled net program savings – then overall PAC results will

increase by 75% (as we will see below, this is *not* the case for the TRC). Teasing out financing's impact from that of incentives is one of the primary goals of the impact evaluations that will take place in later years.

2. ***Market effects:*** The extent to which the pilot generates market effects beyond its two-year timeframe has a significant impact as well, under our sensitivity ranges. Indeed, increasing or decreasing by 10% the assumption of annual REEL-generated impacts that recur and persist over the decade after the pilot's end, augments or reduces PAC results by 37% in each direction.

3. ***Discount rate:*** The choice of discount rate has the third largest impact because of the potentially large spread between the opportunity cost of LLR capital (being the assumed discount rate), and the exceedingly low anticipated returns from unused LLR funds. Indeed, CAEATFA currently anticipates near-zero (0.02%/yr) returns from dedicated but unused LLR funds. The difference between an IOU WACC discount rate and a societal discount rate – the two primary options we assessed – represents a roughly 54% change to PAC results.

Treatment of setup costs also has a significant impact: a decision to include them rather than treat them as sunk costs would reduce PAC results by 22%. Since this is a binary option (they are either included or excluded), and since our mid scenario assumes they are excluded, there is no "high" scenario.

As the reader will note, most other key variables (e.g. participant non-energy benefits, which provide no value to the utility system) do not apply to the PAC. As for the rate of covered loan losses, they have negligible impact on the PAC.

Meanwhile, <u>TRC results appear most sensitive to three *different* variables</u>:

1. ***NEBs (non-EEEM):*** The extent to which we assume that participants will benefit from the non-EEEM portion of their investments has a very large impact. Specifically, the spread between assuming they receive zero value for their money (an economically untenable assumption) and assuming they value their investment at twice the level of debt they incur, swings TRC results by 56%. Evaluation research could help quantify this value.

2. ***Loan Duration:*** The extent to which loans are made on a short (e.g., 5 years) or long-term basis (e.g., 15 years, the anticipated weighted average life of the measures) also has an important effect: moving TRC results by some 34%.

3. ***APRs:*** As noted earlier, the pilot's ability to drive down interest rates has significant bearing on TRC results, as do our key scenarios. Indeed, the difference between lenders passing all savings to consumers (our high scenario) and them passing only the minimum savings required by program parameters (our low scenario), can move TRC results by 32%. Evaluation can help assess how lenders will have "passed" or "pocketed" the risk-reducing benefits of the LLR.

Four other variables also appear to matter, though to a lesser extent: treatment of setup costs, the choice of discount rate, the degree of market effects, and treatment of NEBs associated with EEEMs.

With the exception of NEBs (which do not apply to the PAC), each of these have similar absolute dollar impacts on the TRC as on the PAC (see discussions above), but appear *proportionally* smaller on the TRC's larger base of costs and benefits.[9]

One additional item worth noting is that the impact of changes to the program's assumed influence on savings differs between the two tests in two unexpected ways: magnitude *and direction*. Indeed, while this variable has a significant impact on PAC results, its impact on the TRC appears not only negligible (in both percent *and absolute values*), but also directionally reversed.

This is not an error. While counterintuitive, it is in fact the reflection of two important factors:

- *Magnitude:* On the PAC, savings impact affects benefits (attributed energy savings) but not costs, resulting in a significant direct effect: the higher the assumed influence, the higher the net benefit. This is what one might normally expect. On the TRC, however, those same benefits are *offset by the effect of higher savings on participant costs*: the higher the influence, the higher the costs. This explains the differences in magnitude of impact on the two tests.

- *Direction:* As can be seen in Figure 3, energy benefits are relatively small compared with costs, including notably participant costs. As a result, as program influence increases, participant costs grow faster than benefits (most non-energy benefits, including reduced APRs, are not affected by influence). In practice, this means that from an energy perspective alone, benefits are outweighed by costs.

The fact that the overall impact here is small may be unimportant: as we will discuss later, this points to an important strategic consideration in terms of how we try to value innovative financing programs. In a sense, we might consider this result somewhat of a "canary in the coal mine".

Finally, the extent of actual **loan defaults** has a negligible impact on TRC results (similarly to PAC results), although this may be a function of the full range of scenarios themselves all reflecting somewhat low default rates.

[9] Regarding inclusion of setup costs, we note that the "low" scenario includes such costs, which are considered sunk and are therefore excluded in the main scenario. Since this is a binary option (included or excluded), there is no corresponding "high" scenario.

DISCUSSION OF FINDINGS

INTRODUCTION

We noted previously that the primary purpose of this exercise is not, *prima facie*, to determine the cost-effectiveness of the REEL or other finance programs. Rather, it is to determine if and how the current cost-effectiveness test algorithms require adaptations to properly reflect the costs and benefits of financing programs, while also verifying the extent to which the tests themselves remain relevant indicators of the value of investing in these types of initiatives.

Below we discuss our findings from both methodological (changes to the tests) and strategic (value of the tests) standpoints. Since these differ by test, we do so distinctly for the PAC and TRC, respectively. We also propose next steps.

METHODOLOGICAL FINDINGS

Using the REEL pilot as case study, we previously defined each cost and benefit component, and described the key parameters and sensitivities we sought to test. In doing so, we developed and tested a model, and a core algorithm or set of algorithms. This model functioned as intended, allowing us to appropriately reflect core costs and benefits associated with the financing pilot, and to test sensitivities, in order to determine cost effectiveness under each test.

Below we present the algorithms we used, and that we now recommend to ensure that each test properly accounts for the unique characteristics of REEL specifically (these should be and large extend to other financing programs). We provide simplified versions of the adapted formulae below; see Appendix C for a more comprehensive set of mathematical formulae.

PROGRAM ADMINISTRATOR COST (PAC) TEST

Of the two tests, the PAC is the least impacted by the unique characteristics of financing. Nonetheless, to properly account for REEL's cost-effectiveness under the PAC, a limited number of adjustments should be considered.

- **Loan Loss Reserve Costs:** The most significant difference, from the PAC perspective, between incentive programs and the REEL financing pilot relates to costs: specifically, the cost of incentives is replaced with the costs associated with the Loan Loss Reserve. As noted previously, these include three distinct components: management costs, the lost opportunity cost of capital (LOCC), and finally, covered losses. The cost function under PAC will need to be adjusted to explicitly account for each of these, the latter two of which are subject to high uncertainty. Below is a simplified version of the formula we recommend:

$$\textit{LLR Costs} = \textit{Losses} + \textit{Lost Opportunity Cost of Capital}\ (\textit{LOCC}) + \textit{MgmtCosts}$$

where:

Losses	=	PV of (LLR capital x annual default forecast[10]) for duration of LLR
LOCC	=	PV of (LLR capital x (discount rate – forecast interest rate) for duration of LLR
MgmtCosts	=	PV of all anticipated fees associated with LLR management[11]

- **Market Effect Benefits:** Finally, the option of accounting for forecast market transformation effects, while not unique to finance programs, should perhaps be given greater weight for innovative finance programs whose primary drivers include sustainably transforming lending practices to drive more capital to energy efficiency.

  Below is a simplified version of the formula we recommend:

$$\textit{MKTeffects} = PV(\textit{rate}, \textit{EnergySavings} \times \%\textit{Recurrence})$$

where:

rate	=	applicable discount rate
EnergySavings	=	cumulative annual energy savings defined as incremental annual savings from the last year of the pilot, recurring over the assumed duration of market effects, and lasting for their full EUL[12]
%Recurrence	=	assumed % incremental activity that continues after pilot's end

- **Treatment of Setup Costs:** Treatment of setup costs is not unique to finance, but applicable to any new area that requires significant startup costs.[13] Nonetheless, this issue applies to the Finance pilots, and a determination must be made as to whether to account for setup costs or, as we have done here, consider them sunk and thus excluded from the analysis.

- **Remove Incentive Costs:** Finally, while participants may apply for incentives from other programs, the REEL program itself offers no direct incentives. Incentives can thus be removed from the equation to avoid confusion, or merely treated as zero.[14]

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[10] Default rate should normally decline over time, consistent with lending experience.

[11] In the case of REEL, these include annual Trustee Contractor and Master Servicer Contractor fees over the full life of the LLR (15 years), as well as Contractor Manager fees over the life of the pilot and one additional year (3 years in total).

[12] This equation is difficult to represent in a simplified formula; a more complete formula is presented in Appendix C1: draft formulae for Total Resource Cost (TRC) Test (see page 37). The reader will note that it results in essentially a bell curve of savings: incremental savings persist for the assumed duration of market effects, producing growth on a cumulative basis over that period, and subsequently fall off as savings from the incremental activity in the earlier years reach the end of their effective useful lives.

[13] In essence, the question might be written as "*Should startup costs be included (provides a clear retrospective picture of the cost-effectiveness of the initial years) or excluded (provides a forward-looking view to help determine whether to proceed) from the analysis?*"

[14] Of course, doing so assumes that other incentive programs which may exist in parallel are being evaluated separately, and that accounting of savings between the financing and incentive offers is properly coordinated. We address this on page 22.

TOTAL RESOURCE COST (TRC) TEST

To properly account for REEL's cost-effectiveness under the TRC requires a significantly greater level of adaptation than under the PAC. Specifically, the TRC should be adapted by incorporating each of the changes described previously for the PAC, as well as by considering three additional adjustments, as follows.

- **Net Participant Costs:** While not a new input, calculation of participant TRC costs under financing programs may need to be done differently than under incentive programs. Whereas with incentive programs, participant costs are assumed to be the difference between incentives and the incremental cost, in the case of financing, gross participant costs are equal to the *total loan book* (plus any participant spillover, i.e., additional spending for which participants did not borrow), itself a function of the loan loss reserve and its anticipated leveraging effect. From there, we must adjust for attribution (per CPUC's policy on TRC calculation) as well as for the share of such borrowing that covers only the *incremental cost* of the measures (again, per CPUC standard practice). Below is a simplified version of the formula:

$$\boldsymbol{ParticipantCost} = \boldsymbol{Net\ Incremental\ Measure\ Cost}\ (\boldsymbol{NIMC})$$
$$\text{where } \boldsymbol{NIMC} = [(\boldsymbol{LLR} \times \boldsymbol{Leverage}) + \boldsymbol{NonBorrowed}] \times \boldsymbol{Attribution} \times \%\boldsymbol{increm}$$

where:

LLR	=	loan loss reserve
Leverage	=	assumed or required weighted average fund leverage[15]
NonBorrowed	=	Non-borrowed participant contributions to measure costs, if any[16]
Attribution	=	share of savings attributable to the finance pilot or program
%increm	=	assumed percent of incremental cost over total cost

- **APR Benefits**: Possibly the most important distinction, from a TRC (but not PAC) perspective, between incentive programs and the REEL example of innovative financing, is the added benefit to participants of reduced cost of capital. Indeed, in lieu of an incentive payment, participants are expected to benefit from reduced borrowing costs resulting from credit enhancements like the LLR.

  These reduced borrowing costs – the lower interest rates that participants should access – apply to the *full cost of eligible loans*. This is a fundamental distinction that needs to be reflected in the TRC algorithm. Indeed, while incentives paid out under traditional programs can be treated as a transfer payment (costs and benefits are the same), this assumption no longer holds for credit enhancements. Instead, participant benefits from lower interest rates apply to (a) the full

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[15] Leverage determines the total loan book that is supported by the LLR fund. For example, under the REEL pilot, the size of the LLR is 20% of eligible loans to low and moderate FICO score borrowers (5x leverage), and 10% of the book for all other borrowers (10x leverage). Given the program's targeted distribution between the two categories of borrowers, the LLR is expected to result in a weighted average leverage of 8.9x.

[16] Note that for purposes of our REEL test case, we assumed zero non-borrowed participant spending.

cost of measures (not merely incremental costs), and (b) to *all eligible spending*, including the share that a financing program like REEL allows to fund things other than eligible energy efficiency measures (EEEMs).

To understand how this may differ from traditional incentives, take for example a hypothetical residential HVAC equipment measure with a baseline cost of $6,000 and an efficient equipment cost of $8,000. A traditional program may have offered an incentive equal to 50% of the incremental cost of the high-efficiency central air unit; say $1,000 of the $2,000 incremental cost. Under REEL, however, the program leads instead to a lower interest rate (say, a 4%/yr rate discount) on the full cost of the HVAC equipment (the $8,000) *as well as on the additional spending the customer is allowed to borrow for* (say, $2,000 for new kitchen cupboards). The corresponding benefit is therefore 4% APR on a $10,000 loan. For a 10-year loan, in this example the participant benefit would amount to approximately $1,900, or 95% of eligible measure's incremental cost.

In addition, it is worth noting that while presumably most participants would borrow because of the improved loan terms and conditions, some may participate despite having access to capital at similar terms. These are not necessarily "free riders" nor "free drivers" per se, but rather net participants who are driven to participate for reasons other than the APR (e.g., because of reduced hassle or transaction costs). While the same occurs under traditional incentive programs (e.g. a customer is driven to adopt because of marketing or reduced hassle more than by the incentive), there is, yet again, a fundamental difference: with incentives, the participant benefits irrespective of her motivations (i.e. she receives the cheque); with financing, the participant *does not benefit* from the reduced cost of borrowing (their cost of capital would have been the same). These participants must thus be netted out of the assumed participant benefit associated with reduced APRs.

Finally, for traditional incentive programs, cost-effectiveness analysis often uses the same discount rate for bringing all manner of costs and benefits to a present value. This is done for simplicity's sake, and because a more rigorous use of discounting would not likely lead to a material change in results (a different participant rate would apply to discounting future *costs*, nearly all of which happen upfront anyhow). Financing programs differ here too, in that costs occur over the life of the loan, i.e. far more into the future. Furthermore, the calculation of interest rate benefits *requires* assumptions regarding participants' own baseline cost of capital, making it difficult to *not* discount the value of participant benefits (future interest savings) – as opposed to the utility's or society's – by their own time value of money.

Below is a simplified version of the formula we recommend:

$$\boldsymbol{APR\ Benefit} = \left[\boldsymbol{PMT}(\boldsymbol{rate_{base}}, \boldsymbol{nper}, \boldsymbol{LLR} \times \boldsymbol{Leverage}) - \boldsymbol{PMT}(\boldsymbol{rate_{prog}}, \boldsymbol{nper}, \boldsymbol{LLR} \times \boldsymbol{Leverage})\right]$$

where:

PMT = Present value of payments participants would make for loan rate, duration and principal
LLR = Loan loss reserve
$Leverage$ = Assumed or required weighted average fund leverage
$Rate_{base}$ = Participants' baseline cost of capital[17]
$Rate_{prog}$ = Participants' cost of capital under the program
$nper$ = Average loan duration

- **Non-Energy Benefits:** Finally, as discussed previously, while NEBs are not currently addressed in the CPUC cost-effectiveness framework (though we understand that is being reconsidered), the financing pilots provide greater reason to consider their inclusion. In the case of REEL specifically, because up to 30% of loans are allowed to be applied to things other than eligible energy saving measures, it is likely that a material portion of participant costs will be incurred for reasons having nothing to do with energy savings. In this case, valuing non-energy benefits at zero becomes arguably untenable, as it assumes that participants are voluntarily taking on costs (debt) to fund projects with no value to them.

  For purposes of the TRC, which is meant to encompass all costs and benefits for the program administrator *and for participants*, two options could be considered to address the value of non-energy related spending: (a) include a factor by which non-energy benefits are assumed to match or exceed non-energy costs (from an economics perspective this cannot be less than 1), or (b) in the least, exclude all related costs from the equation. While there are arguments to both options, we recommend using the NEB factor, since the alternative may add needless confusion (because other benefits already apply to non-EEEM spending; see APR discussion above).

  For consistency's sake, we also raise the issue of non-energy benefits for the remainder of spending (the minimum 70% to be spent on eligible energy-saving measures, or EEEMs). Here it is not strictly *necessary* to deviate from standard CPUC practice; NEBs from the energy-saving portion of loans can therefore be ignored (or counted as zero), or value can be attributed to them. However, we note that ignoring them would be inconsistent with our recommended accounting of NEBs for non-EEEMs (see above).

[17] Care should be taken to ensure that participants' baseline cost of capital is a weighted average that accounts for the likelihood that some would have had access to capital at the same cost as offered through the program. In the case of REEL, we assumed 75% had access at unsecured rates, and that 25% had access at secured rates (equivalent to program rates).

Below is a simplified version of the formula we recommend:

$$NEBs = NEB_{non-EEEM} + NEB_{EEEM}$$

$$\text{where } NEB_{EEEM} = \text{nonenergy benefits from EEEM measures}$$
$$\text{and where } NEB_{non-EEEM} = (LLR \times Leverage \times \%nonEEEM \times NEBfactor)$$

where:

LLR	=	loan loss reserve
Leverage	=	assumed or required weighted average fund leverage
%nonEEEM	=	share of loan book not invested in eligible (EEEM) measures
NEBfactor	=	factor by which spending on non-energy saving measures is deemed to provide value to participants[18]

BOTH TESTS: INFLUENCE

Of course a challenge for proper analysis of the cost-effectiveness of finance programs in general – one that applies to both PAC and TRC tests – is that of influence on savings. Specifically, to the extent that incentives and financing programs coexist and are not mutually exclusive offers, the greater challenge lies in defining how much of net activity is actually driven by each stream.

This is not an issue of cost-effectiveness per se, but of evaluation more broadly. That said, it is important to ensure that cost-effectiveness screening of relevant incentive and financing programs is done in a coordinated fashion, in order to avoid double-counting.

A NOTE ON THE NEED FOR ADAPTATION

By defining the TRC and PAC tests as described above, we are confident that the true cost-effectiveness of financing programs can be properly assessed. While this entails some adjustments to the algorithms commonly used for incentive programs, we stress the value of adapting to their unique characteristics.

Indeed, *not* adapting tests to these characteristics would be very problematic. For example, ignoring the value of reduced APRs to consumers would miss one of the fundamental objectives of credit enhancements and, according to the tests we ran, perhaps the single greatest consumer benefit (see page 12 above) applicable to the TRC. Similarly, treating a loan loss reserve as a cost *per se*, would fundamentally mischaracterize it (a partial loan guarantee being entirely different from an all-out cash expenditure). **Ultimately, the differences presented by finance programs are simply too large to ignore if we wish to assess their real net value, whether on a TRC or a PAC basis.**

[18] For example, a NEBfactor of 1 implies that participants value their non-energy saving investments at cost.

STRATEGIC FINDINGS

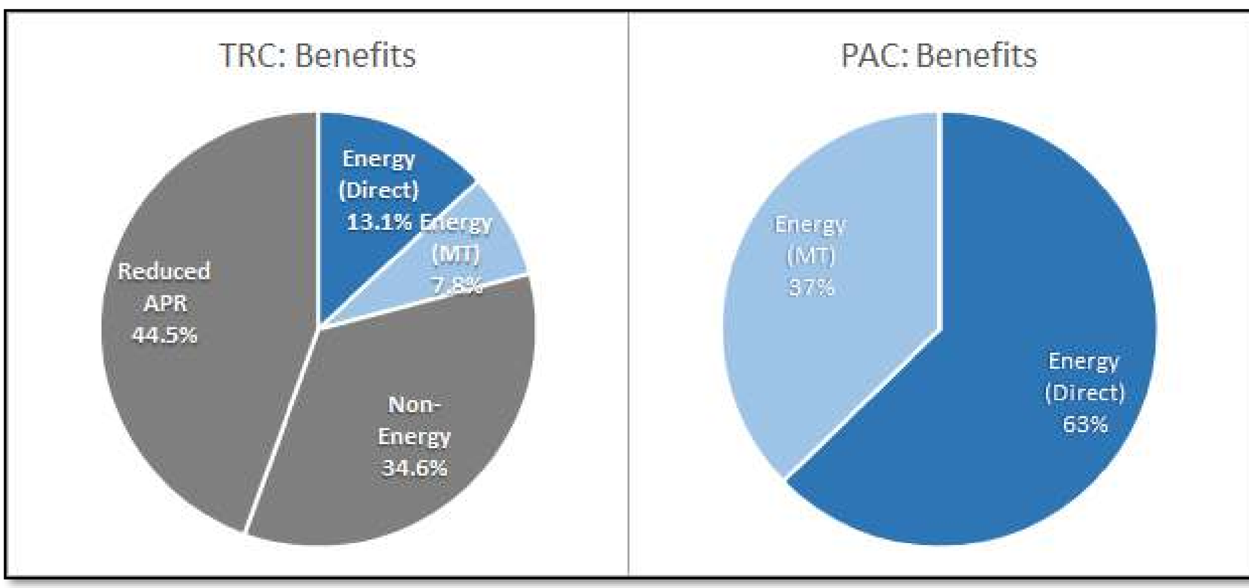
Beyond issues of methodology, the exercise we completed with the REEL pilot raises an issue of a more strategic nature. Recall two of the key questions the statewide finance pilots are designed to answer, as we understand them:

- Whether financing can increase savings cost-effectively, and
- Whether financing can reduce the ratepayer cost of delivering savings.

The second question refers rather explicitly to the PAC test, which measures the cost to ratepayers (through utilities) against their benefits (through utilities' avoided costs). To answer this question, we would want to compare PAC results for financing pilots against PAC results for similar incentive programs. Meanwhile, the first question is less straightforward, in that it does not specify *which* cost-effectiveness – the one measured by the TRC or by the PAC – matters.

As the reader will note from Fig. 3. (see page 12), the distribution of benefits is significantly different for the TRC than for the PAC. While the PAC's benefits are related entirely to energy savings – ostensibly the focus of the pilots and their underlying questions – **energy accounts for less than 20% of REEL's TRC benefits**, according to our analysis. This is reflected in different format in Fig. 6. below.

Fig. 6. Distribution of Anticipated Benefits



This raises an important strategic question: **if nearly 80% of benefits from this program *from a TRC standpoint* can be unrelated to energy savings, then is the TRC an appropriate test for what is primarily an energy efficiency program?** This is not to suggest that the TRC result is of no value; it does indeed reflect a perspective that resembles that of society (with some nuances). But at what point does the TRC lose its ability to answer the pilots' key questions? Specifically, in the case of REEL at least, does the TRC tell us what we need to know to assess the value of moving forward with it, either as a supplement to, or substitute for, incentives?

We urge caution in using the specific results of our REEL case study – built on a series of assumptions that remain to be validated – to draw sweeping conclusions. Indeed, while we have made every effort to ensure assumptions are as realistic as possible, it is too early (especially where the financing programs in California have yet to undergo significant evaluation) to forecast results with any degree of accuracy.

Nonetheless, the results do point to a troubling issue. We believe there is merit in giving serious consideration to this question.

NEXT STEPS

Based on the results of this work, we recommend five steps forward:

1. **Adopt this methodology for purposes of assessing the cost-effectiveness of REEL, retrospectively.** This paper – and the model we built to support it – presents a methodology to appropriately reflect the costs and benefits, under both TRC and PAC tests, of the REEL pilot. The methodology has been rigorously tested, and subjected to the scrutiny of IOU and CPUC advisor reviews, as well as thoughtful comments by PG&E and SoCalGas, all of which were given serious consideration. It is designed to reflect the pilot's unique characteristics, i.e. those that differentiate it from more conventional, rebate or incentive type programs. We note, of course, that applying the methodology retrospectively will require obtaining ex-post cost, saving and attribution inputs, as well as using the CPUC's recently updated avoided cost values. We also note that certain directional issues will need to be resolved (see below).

2. **Test the other pilots and programs against the model developed for REEL, and adapt the model as needed.** REEL was chosen as a test case in part because it uses a credit enhancement mechanism that is common to many of the other financing pilots and programs in place in California. Nonetheless, the methodology proposed herein – and the model itself – may require additional adaptations to account for the nuances of other financing approaches. We propose adapting and applying the model to the upcoming regional pilots (including use of the CPUC's updated avoided cost values). In so doing, we will run all sensitivity analyses and provide all results so that CPUC, IOUs and stakeholders have full information with which to interpret results.

3. **Resolve the "directional" issues raised in this paper.** While some of the sensitivity scenarios will be resolved by additional research (e.g. allocating savings between financing and rebate programs), others are of a directional nature. For example, because of the fundamentally different nature and objectives of financing programs (compared with rebate programs, for example), we argue that for certain issues, the most appropriate methodological approach for financing programs may be different from the one that is suitable – and currently applied to – incentive programs. This may be the case in particular for treatment of non-energy benefits, discount rates, and post-program market transformation effects. We encourage the Commission to begin addressing these directional issues, and suggest that until they are resolved, we continue to conduct and report on sensitivity analyses for each.

4. **Use the sensitivity analyses presented herein to guide prioritization of future evaluation efforts.** We note three variables in particular that appear worthy of strong consideration when prioritizing evaluation research efforts: the relative influence of financing vs incentives; the nature *and value* of non-EEEM measures for which participants may use a portion of the loans;

and the impact of the credit enhancements on loan rates and terms. These each will have significant impacts on cost-effectiveness results.

5. **Consider whether the TRC is an appropriate metric for financing programs.** Finally, we raise a question regarding the value of the TRC in particular in assessing the relative merits of the REEL pilot and of similar financing programs more broadly –, given the likelihood that energy benefits themselves account for only a fraction of total TRC benefits. We encourage a broader discussion of this more strategic issue.

APPENDIX A: KEY SENSITIVITIES

Below are retained values for the low, mid and high scenarios for each of the nine sensitivities tested. On the following page are explanatory notes and sources for each.

Issue	Description	Low	Mid	High	MAIN
Setup costs	Include (Y) or exclude (N) from B/C analysis?	Y	N	N	**N**
Covered Losses	Year-1 LLR-Covered Losses (declines thereafter)	0.66%	0.33%	0.16%	**0.33%**
Discount Rate	Applicable DR rate for PAC,TRC tests	7.5%	4.7%	1.9%	**4.70%**
APR Trickle Down	Reduced consumer APR due to LLR security	2.6%	4.3%	5.9%	**4.3%**
Loan Duration	Average duration of loans	5 yrs	10 yrs	15 yrs	**10 yrs**
Net Savings Influence	Share of net savings driven by financing	10%	40%	70%	**40.0%**
non-EEEM NEBs	Value of NEBs for non-EEEMs spending (X cost)	0.0 X	1.0 X	2.0 X	**1.0 X**
EEEM NEBs	Value of NEBs for EEEMs (% avoided costs)	0%	50%	100%	**50%**
EEEMs: Market Effects	Continued activity beyond pilots	0%	10%	20%	**10%**

Notes	Source
During Oct. 2014 meeting, consensus was to treat setup costs as sunk and exclude them from C-E analysis	binary
Initial years only. Experience suggests losses drop substantially over time; our decline is laid out in individual sheets (see bottom). Decline curve only an internal estimate.	Assumes 0.3% (initial yrs) for non-LMI (roughly based on reports from other programs); assumes 2x that for LMI (based on LLR set at 20% for LMI vs. 11% for others).
IOU weighted average cost of capital (WACC) is typically used in California. Societal discount rate applies in many other regions.	IOU WACC assumed to be 7.5%. Societal rate assumed to be avg of most recent CA 5-yr and 10-yr bond rates (http://www.treasurer.ca.gov/news/releases/2015/20150305.asp).
The de-risking value of LLR will lead to improved rates, terms and conditions; a reduced rate (APR) is used here to reflect those.	Based on early Mystery Shopper results. Low = spread between unsecured APRs and REEL APR ceiling. High = spread between secured and unsecured loans (consistent with program theory).
REEL is designed to encourage financing with long durations where useful. We define max as equal to assumed average EUL. In practice, loan books will include shorter durations too.	Max based on avg EUL; see Impact Assumptions below (EUL assumes mix of weatherization and HVAC equipment consistent with REEL program design)
Note: to test the program as a stand-alone (in lieu of incentives), apply 100% influence (and adjust % cost elsewhere).	Working assumptions. To be determined through program evaluation.
NEBs are by definition the *only* reason consumers would adopt non-energy saving measures, and by economic theory must be equal to or greater than 1X spending. Apply to TRC, not PAC.	Value of 1X spending is equivalent to removing non-EEEM costs from TRC equation, and is minimal value from standpoint of economic theory.
Inclusion of NEBs associated with EEMS may be needed for consistency with proposed treatment of non-EEEMs (see note above). Only applies to TRC.	Studies commonly find NEB values exceed avoided energy costs for residential Wx and HVAC. ODC-RIA study of EUC in PG&E found NEBs at 129% of avoided energy costs (our interpretation). Since EUC is likely to drive higher NEBs than HVAC equipment, we use 50% and 100% as conservative bounds, adding a 0% option if
Financing pilots were driven in part to transform lending markets *vis* EE. Values reflect % of incr. ann. EE loans that would be recurring for 10 years following pilot completion.	rough estimate/range

APPENDIX B: KEY FIXED INPUTS

Below are remaining key assumptions (notes and sources on each subsequent page). Note that some derive from additional calculations and assumptions.

Issue	Description	MAIN
CAEATFA Costs		
Trustee Contractor	Trustee contractor -- annual fees (decreases over time)	**$0.05M**
Master Services Contract	First 3 Years' fees (annual)	**$0.50M**
Master Services Contract	Post-program fees (annual)	**$0.12M**
Contractor Manager	Annual fees (3yrs: pilot+1)	**$0.70M**
Data Management	Annual fees	**$0.00M**
REEL Parameters		
LLR cap	% of per-project losses	**90%**
LMI target	% of LLR to support LMIs	**33%**
LMI target	% of loan book with LMI borrowers	**21.7%**
LLR ratio	max. % of the non-LMI loan book	**11%**
LLR ratio	max. % of LMI loan book	**20%**
LLR start	initial injection (remaining on as-need basis to max)	**$1M**
int.rate cap	ceiling rate premium to be charged to participants (basis points above T-bill rate)	**750**
pilot duration	years of assumed operation	**2**

Issue	Notes	Source
CAEATFA Costs		
Trustee Contractor	After initial years, we assume gradual decrease in line with decrease in annual losses	CAEATFA ("may reduce with time if there is not much activity later on")
Master Services Contract		CAEATFA: $1.5m over 3 years
Master Services Contract		CAEATFA ("10k/mth+transaction costs"); note -- are transaction costs significant?
Contractor Manager		CAEATFA (from A.Hill)
Data Management		CAEATFA ("not sure yet; could be free")
REEL Parameters		
LLR cap	program parameter	A.Hill
LMI target	program parameter	A.Hill
LMI target	calc based on established targets and caps	33% of LLR destined to support LMIs. With 20% LMI coverage vs. 11% non-LMI coverage, that would be achieved if 21.7% of loan book went to LMIs.
LLR ratio	program parameter	A.Hill
LLR ratio	program parameter	A.Hill ("20% for LMI customers - as defined by the state income distribution statistics")
LLR start	not used here	IOUs, communicated to A.Hill
int.rate cap	program parameter	A.Hill
pilot duration	program parameter	known

REEL Impact Assumptions		
Leverage	Non-LMI leverage	**x10**
Leverage	LMI portion	**x5**
Leverage	Total weighted average	**x9**
EEEMs	% of LLR going to eligible energy efficiency measures	**80%**
non-EEEMs	% of non-EEEM $ producing equiv. EE savings	**0%**
EEEM Cost	TRC unit cost of savings ($/kWh)	**0.45**
EEEM Cost	incremental cost as % of total EEEM cost	**40%**
EUL	average effective useful life of savings (years)	**15**
MT Persistence	Years after Pilot end that some (designated %) market effects persist	**10**
Electric Savings Share	% of savings	**33%**
Gas Savings Share	% of savings	**67%**
APR Baseline	Assumed weighted average APR for benefitting participants	**12.0%**
APR % Benefit	% of participants who benefit from reduced APR	**75%**

Issue	Notes	Source
REEL Impact Assumptions		
Leverage: non-LMI		A.Hill
Leverage: LMI		A.Hill
Leverage: All		calc (weighted average)
EEEMs	Assumes average non-EEEM rate is lower than 30% cap.	Working assumption
non-EEEMs	non-EEEM spending could be on non-eligible but still energy-saving measures (e.g. PV, windows, etc.), but impact would be small and no realistic source assumption for now	none for now
EEEM Cost	Should be similar to TRC cost of relevant incentive programs	Working assumption, based on CPUC Tracked Data re. IOU Spending and assumptions re. % of total measure costs covered by the incentive portion of that spending. See Tab.
EEEM Cost	Needed to account for fact that financing applies to *total cost* of measures, whereas incentive costs typically account for only the incremental costs (some exceptions).	Working assumption, based on assumed 25% whole home retrofit (incr.=100%total) and 75% equipment (assume incr.=20%total). Need to validate.
EUL	working assumption, based on HVAC and weatherization EUL range of approx. 12-20yrs	note: higher than usual because I assume financing enables/focuses on longer-term payback measures
MT Persistence	working assumption; note designated % is in Sensitivity parameters table	assumption
Electric Savings Share	Sum of reported 2013-2014 savings from Residential EUC and HVAC programs, based on CPUC Tracking Report. See Tab in this file for details.	File "Track1314Q1Q8_byRoadMapSummary_Sent20151102.xlsx". See tab "Tracking_vs_Monthly_byPrg", rows 13,15,167,168,395 (PG&E,SCE,SoCalREN). File sent by Jennifer Caron (CPUC), 2015-11-24.
Gas Savings Share	See above.	See above.
APR Baseline	See mystery borrower results tab; weighted by LMI and non-LMI per above.	Mystery Borrower analysis conducted by ODC/Dunsky for CPUC in 2015 -- see Tab in this worksheet.
APR % Benefit	Assume 25% of customers are influenced by program but they would otherwise have been able to finance at similar rates (i.e. their baseline would have been cash or secured debt).	assumption

Economic Parameters		
Electric Avoided Costs	All-in average ACs (2016$/kWh)	**$0.28**
Gas Avoided Costs	All-in average ACs (2016$/MMBtu)	**$11.00**
Avoided Costs	average 2016 Avoided Cost ($/kWh-equiv. for Elec + NG)	**$0.116**
Inflation	assumed	**2.00%**
Misc		
LLR Duration	Years	**15**
LLR interest	annual interest on LLR funds	**0.02%**
Collection Costs	IOU annual costs to collect payments	**$0**
Incentives	% assumed to also take incentives	**100%**

Issue	Notes	Source
Economic Parameters		
Electric Avoided Costs	All-in proxy value reflects energy, capacity, environment and RPS values specific to the residential HVAC load shape.	e3's *EE Avoided Cost 2011 Update* : charts suggest range for HVAC-savings of ~25-30¢/kWh; we took midway point. Validated by Katie Wu on call of 2015-11-24.
Gas Avoided Costs	Proxy based on e3 2011 update (chart: ~$9 gas value over 2016-2030 timeframe) + $1.76 emissions (see Tab) + marginal add'l costs (compression, losses, avoided gas T&D)	e3's *EE Avoided Cost 2011 Update* .
Avoided Costs		calc from above
Inflation		working assumption
Misc		
LLR Duration		A.Hill
LLR interest		CAEATFA assumption, communicated to A.Hill Oct.22, 2015.
Collection Costs		simplification; assumed negligible
Incentives		CAEATFA assumption, communicated to A.Hill Oct. 2015.

APPENDIX C1: DRAFT FORMULAE FOR TOTAL RESOURCE COST (TRC) TEST

ORIGINAL TRC

$$BCR_{TRC} = B_{TRC}/C_{TRC}$$

$$B_{TRC} = \sum_{t=1}^{N} \frac{UAC_t + TC_t}{(1+d)^{t-1}} + \sum_{t=1}^{N} \frac{UAC_{at} + PAC_{at}}{(1+d)^{t-1}}$$

$$C_{TRC} = \sum_{t=1}^{N} \frac{PRC_t + PCN_t + UIC_t}{(1+d)^{t-1}}$$

Where

BCR_{TRC}	Benefit-cost ratio of total costs of the resource
B_{TRC}	Benefits of the program
C_{TRC}	Costs of the program
UAC_t	Utility avoided supply costs in year t

TC_t	Tax Credits in year t
UAC_{at}	Utility avoided supply costs for the alternate fuel in year t
PAC_{at}	Participant avoided supply costs for alternate fuel in year t
PRC_t	Program Administrator program costs in year t
PCN_t	Net Participant Costs in year t
UIC_t	Utility increased supply costs in year t

ADAPTED TRC (HIGH-LEVEL)

$$B_{TRC} = EB_{EEEM} + EB_{NEEEM} + NEB_{EEEM} + NEB_{NEEEM} + CCS + MTB$$

$$C_{TRC} = PRC + LLRC + PCN + UIC$$

Where

BCR_{TRC}	Benefit-cost ratio of total costs of the resource
B_{TRC}	Benefits of the program

EB_{EEEM}	Energy benefits from eligible energy efficiency measures
EB_{NEEEM}	Energy benefits from non-eligible energy efficiency measures
NEB_{EEEM}	Non-energy benefits from non-eligible energy efficiency measures
NEB_{NEEEM}	Non-energy benefits from non-eligible energy efficiency measures
CCS	Capital Cost Savings
MTB	Benefits from Market Transformation
C_{PAC}	Costs of the program
PRC	Program Administrator program costs
LLRC	Loan Loss Reserve Costs
PCN	Net Participant Costs (net of free ridership)
UIC	Utility increased supply costs

ADAPTED TRC BENEFITS (BY COMPONENT)

EB_{EEEM}: ENERGY BENEFITS FROM ELIGIBLE ENERGY EFFICIENCY MEASURES

$$EB_{EEEM} = \sum_{t=1}^{N} \frac{CAES_t \times AC_t}{(1+d)^{t-1}}$$

Where

$CAES_t$	Cumulative Annual Attributable Energy savings in year t
AC_t	Avoided costs in year t
D	Discount rate

EB_{NEEEM}: ENERGY BENEFITS FROM NON-ELIGIBLE ENERGY EFFICIENCY MEASURES

$$EB_{NEEEM} = (1 - PLLR_{EEEM}) \times (PLLR_{NEEEM}) \times EB_{EEEM}$$

Where

$PLLR_{EEEM}$	Percent of Loan Loss Reserve (LLR) going to eligible energy efficiency measures
$PLLR_{NEEEM}$	Percent of non-EEEM funds producing equivalent energy efficiency savings

NEB_{EEEM}: NON ENERGY BENEFITS FROM ELIGIBLE ENERGY EFFICIENCY MEASURES

$$NEB_{EEEM} = VNEB_{EEEM} \times EB_{EEEM}$$

Where

$VNEB_{EEEM}$	Value of NEBs for EEEMs as a percent of avoided costs

NEB_{NEEEM}: NON ENERGY BENEFITS FROM NON-ELIGIBLE ENERGY EFFICIENCY MEASURES

$$NEB_{NEEEM} = L_{ALL} \times SA \times (1 - PLLR_{EEEM}) \times (1 - PLLR_{NEEEM}) \times VNEB_{NEEEM} \times \sum_{t=1}^{N} \frac{LLR_t}{(1+d)^{t-1}}$$

Where

LLR_t	Loan Loss Reserve in year t
L_{ALL}	Total weighted average leverage
SA	Savings Attribution which is the share of activity attributable to the program
$VNEB_{NEEEM}$	Value of NEBs for non-EEEMs spending (X cost)

CCS: CAPITAL COST SAVINGS

$$CCS = APR_{BENEFIT} \times \left[\frac{r}{1-(1+r)^{-n}} - \frac{r'}{1-(1+r')^{-n}} \right] \times \sum_{t=1}^{N} \sum_{i=1}^{LD} \frac{I_t}{(1+d)^{t+i-2}}$$

Where

$$r = APR_{BASELINE}$$

$$r' = APR_{BASLINE} - APR_{TRICKLE}$$

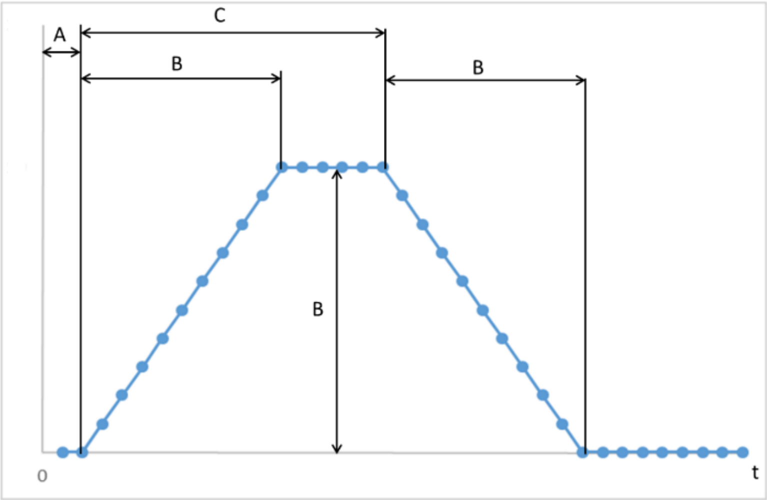
$APR_{BASELINE}$	APR Baseline: Assumed weighted average APR for benefitting participants
APR_{TRICKE}	APR Trickle Down is the reduction in participant APR attributable to LLR security
n	Number of periods
I_t	Investment in year t
$APR_{BENEFIT}$	Percent of participants who benefit from reduced APR

MTB: MARKET TRANSFORMATION BENEFITS

$$MTB = ME \times IAES_{LY} \times \sum_{t=1}^{N} \frac{MTBC_t \times AC_t}{(1+d)^{t-1}}$$

Where

$IAES_{LY}$	Incremental Annual Energy Savings form the last year of the program
ME	Market Effects is the continued activity beyond pilots as a percent of $IAES_{LY}$
$MTBC_t$	Market Transformation Benefits Curve value in year t



MTB_t =	0	$t < A$
	$t - A$	$A \leq t < A + B$
	B	$A + B \leq t < A + C$

	A + B + C – t	A + C ≤ t < A + B + C
	0	t ≥ A + B + C

There are two cases, when the Effective Useful Life is greater than the Market Persistence and when the Effective Useful Life is lesser than or equal to the Market Persistence.

	(EUL > MP)	**(EUL ≤ MP)**
t =	PY	PY
A =	PD	PD
B =	MP	EUL
C =	EUL	MP

Where

PY	Program Year
PD	Program Duration

MP	Market Persistence
EUL	Effective Useful Life

ADAPTED TRC COSTS (BY COMPONENT)

LLRC: LOAN LOSS RESERVE COSTS

$$LLRC = LLRL + LOCC + LLRMC$$

Where

LLRL	Loan Loss Reserve Losses
LOCC	Lost Opportunity Cost of Capital
LLRMC	Lost Opportunity Reserve Management Costs

> *LOAN LOSS RESERVE LOSSES*

$$LLRL = \sum_{t=1}^{PD} \sum_{i=1}^{LD} CL_i \times \frac{LLR_t}{(1+d)^{t+i-2}}$$

Where

LLR_t	Loan Loss Reserve fund in year t
CL_i	Covered Losses expressed as a percentage of LLR in year i of the loan
LD	Loan duration

> *LOST OPPORTUNITY COST OF CAPITAL*

$$LOCC = (d - r_{LLR}) \times \sum_{t=1}^{PD} \sum_{i=1}^{LD} \frac{LLR_t}{(1+d)^{t+i-2}}$$

Where

r_{LLR}	Annual interest rate on LLR funds
LD	Average duration of loans

> *LOAN LOSS RESERVE MANAGEMENT COSTS*

$$LLRMC = \sum_{t=1}^{N} \frac{LLRF_t + LLRO_t}{(1+d)^{t-1}}$$

Where

$LLRF_t$	Loan Loss Reserve Fund Fees in year t
$LLRO_t$	Loan Loss Reserve Fund Other Costs in year t

PCN: NET PARTICIPANT COSTS

$$PCN = \sum_{t=1}^{N} \frac{(LLR_t \times L_{ALL}) + PC_{NB,t}}{(1+d)^{t-1}} \times SA \times PC_{EEEM}$$

Where

PCNB,t	Amount of non-borrowed participant contributions in year t
PC_{EEEM}	Incremental cost as a percent of total EEEM cost

APPENDIX C2: DRAFT FORMULAE FOR PROGRAM ADMINISTRATOR COST (PAC) TEST

ORIGINAL PAC

$$BCR_{PAC} = B_{PAC}/C_{PAC}$$

$$B_{PAC} = \sum_{t=1}^{N} \frac{UAC_t}{(1+d)^{t-1}} + \sum_{t=1}^{N} \frac{UAC_{at}}{(1+d)^{t-1}}$$

$$C_{PAC} = \sum_{t=1}^{N} \frac{PRC_t + INC_t + UIC_t}{(1+d)^{t-1}}$$

Where

BCR_{PAC}	Benefit-cost ratio of Program Administrator costs
B_{PAC}	Benefits of the program
C_{PAC}	Costs of the program
UAC_t	Utility avoided supply costs in year t
UAC_{at}	Utility avoided supply costs for the alternate fuel in year t

PRC_t	Program Administrator program costs in year t
INC_t	Incentives paid to the participant by the sponsoring utility in year t
UIC_t	Utility increased supply costs in year t

ADAPTED PAC (HIGH-LEVEL)*

$$B_{PAC} = EB_{EEEM} + EB_{NEEEM} + MTB$$

$$C_{PAC} = PRC + LLRC + UIC$$

Where

BCR_{PAC}	Benefit-cost ratio of Program Administrator costs
B_{PAC}	Benefits of the program
C_{PAC}	Costs of the program

* All individual cost and benefit components described previously under TRC formulae.

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