Incremental Measure Costs in New Construction Programs

White Paper on Best Practices and Regulatory Issues

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Incremental Measure Cost (IMC) is a key concept in the economics of energy efficiency. Simply put, it is the difference in the cost of a base case energy efficiency measure compared to the cost of a higher efficiency alternative. It represents the incremental cost that the customer must pay in order to gain the energy savings benefits from the higher efficiency measure. The IMC, then, is important in determining the cost effectiveness of the measure. For example, if the IMC is twice the annual energy cost savings, the measure has a two year simple payback. IMC plays a similar role in calculating the lifecycle cost savings, the net present value, the internal rate of return, the total resource cost, and other economic metrics developed for energy efficiency measures and programs.

IMC is also important in determining how much of an incentive or rebate to pay for the measure. Program theory generally posits that IMC is the primary barrier to preventing a given measure from being installed; incentives are paid to reduce this barrier by offsetting part of the IMC. The incentive is usually limited to an amount no greater than the IMC. If there are barriers other than IMC, however, incentives limited on the basis of IMC may not prove adequate to encourage measure installations.[1])

Incremental Measure Cost (IMC) presents a problem in the new construction energy efficiency arena, because the CPUC's cost effectiveness metrics are built around assumptions appropriate to simple retrofit measures, such as CFL change-outs. For new construction projects, the paradigm breaks down. First, the "measure" for a new construction project is often the whole building, rather than a collection of individual measures. In many such cases, the whole building IMC can be very small (or even negative), because of cooling equipment downsizing, fewer light fixtures, reduced installation labor costs, or other design changes that result in economies for the whole building. Second, it is impossible, in many cases, to document whole building IMCs, either because the base case building design was never developed or specified, or because the general contractor is unable or unwilling to break out his/her materials costs (which are embedded in a whole building bid package). Third, when there is a small or negative IMC, the CPUC cost effectiveness paradigm can produce puzzling results: payment of incentives becomes questionable, total resource cost (TRC) can come out better than the program administrator cost (PAC), and program funding may become hard to defend. This is a perverse outcome, given the many benefits of energy efficiency captured at the new construction phase.[2]

There are possible solutions to this dilemma. One could be to recognize that the cost effectiveness calculation results will be different for new construction projects than for many retrofit measures. Another could be to recognize "soft costs," such as extra design effort or new product risk, as part of IMCs. A third solution might be to develop deemed

[1] Note:paying incentives greater than incremental measure cost does not necessarily mean the measure is not cost-effetive, because the cost effectiveness of energy efficiency measures depends on the avoided cost, which is often far above the measure incremental cost.

[2] This may be an extreme outcome, but it is possible. There are other costs that are incurred that are not measure costs, but such costs as commissioning, design assistance, or siting that create incremental TRC costs. This will be discussed in detail in this White Paper.

ICMs for new construction projects, based on survey research, similar to the approach that has been used for years in utility program filings.

This White Paper lays out the details of these problems, discusses the precedents and CPUC decisions that apply, and proposes solutions. These recommendations are offered in the spirit of finding rational, realistic and fair solutions to the IMC problem for new construction programs, in ways that are compatible with the current CPUC's policies and cost effectiveness practices.

1.1 Executive Summary

Incremental Measure Cost (IMC) presents a problem in the new construction energy efficiency arena, because the CPUC's cost effectiveness metrics are built around assumptions appropriate to simple retrofit measures, such as CFL change-outs. For new construction projects, the paradigm breaks down. First, the "measure" for a new construction project is often the whole building, rather than a collection of individual measures. In many such cases, the whole building IMC can be very small (or even negative), because of cooling equipment downsizing, fewer light fixtures, reduced installation labor costs, or other design changes that result in economies for the whole building. Second, it is impossible, in many cases, to document whole building IMCs, either because the base case building design was never developed or specified, or because the general contractor is unable or unwilling to break out his/her materials costs (which are embedded in a whole building bid package). Third, when there is a small or negative IMC, the CPUC cost effectiveness paradigm can produce puzzling results: payment of incentives becomes questionable, total resource cost (TRC) can come out better than the program administrator cost (PAC), and program funding may become hard to defend. This is a perverse outcome, given the many benefits of energy efficiency captured at the new construction phase. There are possible solutions to this dilemma. These are discussed in this report, and recommendations are presented for better treating IMC in the context of new construction programs.

1.2 Acknowledgements

This White Paper was initiated and supported by the program managers of the Savings By Design nonresidential new construction program. The Joint Utilities included Pacific Gas & Electric, Southern California Edison, Southern California Gas, San Diego Gas & Electric, and the Sacramento Municipal Utility District. The Heschong Mahone Group, Inc., Douglas Mahone, Principal, was retained to prepare this report. Valuable suggestions, comments and contributions were made by the program sponsors. Additional input was provided by Shahana Samiulah, SCE, and by Ken Keating of the CPUC's Master Evaluation Contractor Team. However, any errors or omissions are solely the fault of the author.

Douglas Mahone, January, 2009.

2. RECOMMENDATIONS

This section presents our recommendations, based on a careful balancing of the issues and facts presented in this white paper.

- **Use Deemed IMC Values -** Adopt the 4th option presented below in section 4.2: Derive Deemed IMC Values. In addition to the advantages presented, we believe this approach has the least serious disadvantages. The disadvantages of the recommended approach are primarily policy issues. If stakeholders understand and accept the difficulties in determining IMCs for whole building projects, and appreciate the need for avoiding lost opportunities and encouraging new construction program participation, then the policy decision to use deemed IMC values can be made. That said, some stakeholders may object to the IOUs setting these costs – low enough to be cost-effective, but high enough to ensure large incentives. Determining these costs as a result of the proposed research (following recommendation) may be a more acceptable solution, but it may not be any more accurate.
- **Sponsor New Construction Measure Cost Research** - The research methodology used in the new construction potential study, discussed below, could be further developed and tested against real building designs. Such research would pay design teams to develop their base building designs in sufficient detail that qualified cost estimators could prepare detailed whole building cost estimates for both the base and proposed designs. This work would be illuminating, but there is a risk that it might be inconclusive - IMCs may not be generalizable and may be too specific to individual project conditions.
- **Sponsor Research Into Soft Costs** - Process evaluation research and program experience indicates that building decision makers (owners, architects, engineers, etc.) are often unwilling to develop highly energy efficient building designs. Reasons cited include reluctance to adopt new technologies, lack of information on energy savings reliability, concern for project schedules or budgets, concern for increased maintenance costs, mistrust of vendors/contractors, etc. These soft costs are often not even monetized by decision makers, yet they present real barriers to the development of highly energy efficient buildings and, ultimately to making high efficiency standard practice. Identifying and quantifying these risk factors and costs could allow better estimation of total costs, rather than simply relying on hardware costs, as the DEER[3] currently does.

[3] DEER - Database of Energy Efficient Resources - see www.deeresources.com

3. IMC AND THE CALIFORNIA REGULATORY FRAMEWORK

This section explains the regulatory framework that governs the use of Incremental Measure Costs (IMC) in California energy efficiency programs, including the Standard Practice Manual, recent decisions, and past practices. These are important to an understanding of the issues relating to IMC in new construction programs, and of the possible solutions.

3.1 Standard Practice Manual (SPM)

IMC's importance in California's energy efficiency programs stems initially from the Standard Practice Manual (SPM)[4], which defines how the various cost effectiveness tests for programs and measures are to be calculated. The two tests of current interest are the Program Administrator Cost (PAC) test and the Total Resource Cost (TRC) test. These both calculate the benefit/cost (B/C) ratio for programs. They are essentially the same, except that the PAC does not include participant IMC as part of the total cost, while the TRC does. A third, less significant test, the Participant Test, examines cost effectiveness from the perspective of the individual participating customer, with the customer's out-of-pocket expenses on the cost side and the rate payment savings on the benefit side.

The SPM treats IMC as part of the net cost of the program measure. There is not an explicit discussion of IMC in the SPM, but there is an oblique mention in the verbal description of the costs to be included in the TRC: "…all equipment costs, installation, operation and maintenance, cost of removal (less salvage value), and administration costs, no matter who pays for them, are included in this test. Any tax credits are considered a reduction in costs in this test."[5] A slightly more pertinent treatment of IMC is provided in the definition of costs under the Participant Test: "The costs to a customer of program participation are all out-of-pocket expenses incurred as a result of participating in a program… The out-of-pocket expenses include the cost of any equipment or materials purchased, including sales tax and installation; any ongoing operation and maintenance costs; any removal costs (less salvage value); *and the value of the customer's time in arranging for the installation of the measure, if significant*."[6] (Emphasis added for purposes of later discussion below)

Implicit in both of these definitions is the "incremental" nature of the measure cost. In the new construction context, it is understood that the customer would have had to pay for a base case lighting fixture, air conditioner or other measure, and it is assumed that the higher efficiency versions will cost more. The *difference* in these costs is the customer's out-of-pocket cost for purposes of calculating energy efficiency measure cost effectiveness. In a new construction project, moreover, there are multiple design features and measures installed to make up the ultimate efficiency of the whole building (which is

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[4] *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects*, October, 2001. Available for download at
ftp://ftp.cpuc.ca.gov/puc/energy/electric/energy+efficiency/em+and+v/Std+Practice+Manual.doc

[5] SPM Chapter 4, Definition, p. 18

[6] SPM Chapter 2, Definition, Benefits and Costs, p. 8

the "measure"), and it is the summed incremental cost of all these features that would determine the incremental measure cost for the whole building.[7]

There have been a lot of discussions, filings and decisions recently regarding the TRC, and how it is to be calculated and used, but these have all revolved around clarifications to the procedures for treating rebates, incentives and net-to-gross ratios (see following section). Incremental measure cost has not come up, nor have the methods for treating IMC in the calculations been revised.

3.2 Energy Efficiency Policy Manual

The CPUC's Energy Efficiency Policy Manual provides policy rules, terms and definitions that govern the utilities' energy efficiency programs for 2006 and beyond[8], and so it applies to the new construction program issues addressed in this White Paper. This document also includes, in its Appendix A, a clarification memo, D.07-09-043,[9] which addresses technical details about how the net-to-gross ratio is applied in the TRC test.

The Policy Manual is generally consistent with the SPM in its guidance on cost effectiveness calculations, especially as it applies to IMC. A few items in the Policy Manual that are pertinent to this discussion:

Cost Effectiveness Tests

In the *Cost Effectiveness* section (IV., beginning p.4), there is discussion of the uses for the TRC test and for the PAC test. Specifically, on p.6 item 4, in a discussion of the Dual Cost Test, it says:

> 4. Applying both the TRC and PAC tests of cost-effectiveness is called the "Dual-Test". In almost all instances, an energy efficiency program that passes the TRC test will also pass the PAC test. However, if deployment of the program requires rebates or financial incentives to participants that exceed the measure cost, then the program may pass the TRC test, but fail the PAC test. Considering the results of both tests when evaluating program proposals ensures that program administrators and implementers do not spend more on financial incentives or rebates to participating customers than is necessary to achieve TRC net benefits.

This points to the possibility that incentives could exceed IMC, in which case the TRC would be higher than the PAC. If the incentives greatly exceed the IMC, then it would be

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[7] This statement applies to a whole building design project, which is the primary target of new construction programs. However, the programs usually provide for treating projects that only apply a single measure. This depends on when in the design process the implementer gets involved and how amenable the developer is to the possibility of further improvements. If the implementer misses the early design phase, the project takes on more of the character of a retrofit project, substituting an already-selected measure with a more efficient one.

[8] There have been and will be periodic updates to this Manual, but to date none of those changes have altered the treatment of IMC.

[9] Energy Efficiency Policy Manual, Version 3.1 - Applicable to post-2005 Energy Efficiency Programs, updated November 2, 2007. Available for download at http://docs.cpuc.ca.gov/EFILE/RULINGS/74969.pdf. The previous version 3 is available at: ftp://ftp.cpuc.ca.gov/puc/energy/electric/energy+efficiency/ee+policy/eepolicymanual_v03.pdf

hard to justify the program under these tests. In the E3 calculator, there is automatically a red flag displayed whenever rebates exceed IMCs. All this, of course, depends on how reliably the IMC can be determined.[10]

On p.8 item 9, the Policy Manual acknowledges the limits of usefulness of TRC and the PAC in determining funding or evaluating program results, especially for programs which seek to demonstrate new technologies or to structurally change the marketplace. These are, in fact, characteristics of many new construction projects. This discussion, however, is more cautionary than directive. It does not say that the two tests should not be applied and their results reported.

Incremental Measure Cost (IMC)

The Policy Manual's *Appendix B - Common Energy Efficiency Terms and Definitions* provides the following definition[11]:

> **Incremental Measure Cost**
> The additional cost of purchasing and installing a more efficient measure. Calculated from the price differential between energy-efficient equipment and standard or baseline measures.

This definition is consistent with the SPM, as discussed in the preceding section of this White Paper. The definition assumes that the more efficient measure will be more costly than the standard measure. However, by extension, IMC could be a negative number if the efficient measure (or the efficient whole building) costs less than the standard design. If, however, this definition were extended or interpreted to include "soft costs", such as extra design effort or risk, then the IMC would be higher and not likely negative.

On p.9, item 11 directs that, when possible, program administrators should use DEER numbers for energy savings and measure cost estimates. As discussed below in section 3.3, however, this is problematic for new construction projects specifically, and for design-related measures in general.

Lost Opportunities

In the *Policy Objectives* section (II. beginning p.2), there is a discussion of lost opportunities, which are defined thusly (item 4, p.3):

"Lost opportunities" are those energy efficiency options which offer long-lived, cost-effective savings and which, if not exploited promptly or simultaneously with other low cost energy efficiency measures, or in tandem with other load-reduction technologies or distributed generation technologies being installed at the site (e.g., solar heating or photovoltaics), are lost irretrievably or rendered much more costly to achieve.

The following item 5 then directs that "…Program Administrators should actively develop strategies to minimize lost opportunities…"

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[10] If the measure includes "soft costs", such as extra design effort or risk, this may be less of a problem, but there is little precedent for doing so in IOU programs.

[11] Note: as we learned in the last round of the Policy Manual – not much attention gets paid to the definitions, and they are readily changed – e.g.,the first three drafts had free-ridership improperly defined.

A variation of this definition is found in Appendix B: Common Terms and Definitions:

> **Lost Opportunities**
> Energy efficiency measures that offer long-lived, cost-effective savings that are fleeting in nature. A lost opportunity occurs when a customer does not install an energy efficiency measure that is cost-effective at the time, but whose installation is unlikely to be cost-effective if the customer attempts to install the same measure later.

New construction programs are, in many ways, the ultimate lost opportunity programs, especially when directed at whole building design projects. Once a new building starts construction, it becomes highly unlikely that the owners are going to be willing to spend any time or money on additional energy efficiency upgrades for many years. Any energy efficiency opportunities that are not incorporated into the design at the outset will therefore represent lost energy savings.[12]

Integrated Design

It is well-recognized in the design and construction world that the least costly time to introduce advanced energy efficiency into a new building project is at the very beginning. This is also the time when integrated design strategies, which emphasize the interactions between design and efficiency features, are most likely to be implemented. As the design process progresses, it becomes increasingly more costly to add or modify design features, and designers/owners become increasingly reluctant to make design changes. By the time a building is ready for construction, any efficiency improvements are essentially treated by the design team as retrofits or one-for-one change outs of equipment in the existing design. Effective integrated design for energy efficiency must start early in the process in order to be most effective and least costly.

California's ambitious goals for new buildings (net zero energy designs for residential by 2020 and for nonresidential by 2030) will depend on integrated building and energy design strategies, not just simple equipment substitutions within conventional designs. Achieving these goals will require substantial adjustments to the ways we design and build in California, and those changes need to be starting with the current new construction programs if they are to become widely adopted throughout the state.

Treating new construction projects as if they are simple assemblages of retrofit-type measures will not prevent lost opportunities and will not stretch the design community toward the integrated design processes needed to meet the longer-term goals.

3.3 DEER Cost Studies

The DEER (Database for Energy Efficiency Resources)[13] is the CPUC's reference source for typical energy efficiency measures. It describes both the energy savings and

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[12] Note: when the original design has been established, the remaining efficiency opportunities typically revert to simple lighting and HVAC changes, and take on the character of retrofit measures, as discussed in the following section.

[13] *2004-2005 Database for Energy Efficiency Resources (DEER) Study, Final Report*, December, 2005. Prepared for Southern California Edison by Itron Inc., with assistance from JJ Hirsch & Associates, Synergy Consulting, and Quantum, Inc. CALMAC Study ID: SCE0214.01

the measure costs for a wide range of equipment. These provide the default values used by program administrators, evaluators and others in estimating the cost effectiveness of measures and programs. CPUC & utility procedures direct that the DEER values be used whenever possible, and that workpapers and supporting documentation be developed to support savings and cost estimates that differ from the DEER defaults. The following excerpt from a recent utility third party RFP demonstrates an instance of this policy:

> *If the program measure is included in DEER the Bidder can propose an alternate energy and/or demand savings estimate **ONLY** if the Work Paper savings is 20% or greater, on a per unit basis, than the DEER energy and/or demand savings and the differences in assumptions leading to this increase are clearly stated. Bidder must supply the relevant study and/or document(s) upon which the revised savings are based. Utility will determine if the documentation is adequate to override the DEER energy and/or demand savings figures.*

Determination of Incremental Measure Cost

Because its importance in CPUC/utility procedures, it is important to understand the limitations of the DEER numbers in the context of new construction projects and programs.

The first thing to understand is how the cost estimates in the DEER Database are estimated. They are limited to incremental *equipment* cost (or sometimes full equipment cost if a measure is assumed to be a stand-alone measure that does not represent an upgrade from an existing measure), and they only include *labor* costs when a measure entails extra labor beyond what the base measure would require, or when there are extra costs associated with replacing existing equipment (such as demolition costs). The DEER costs do not include other costs, such extra design, risk mitigation or transaction costs.[14] It may not require that DEER change, but that the total cost of the measure – new construction programs be added around the simple equipment (whole building costs).

This is briefly explained in the Measure Cost Study[15] that accompanies the DEER report cited above:

> *p.24: new construction (NEW) applications typically have a cost basis of incremental cost (INCR). In these applications, a customer is choosing between a standard or less efficient technology and more efficient option. Incremental cost usually means incremental equipment cost with no labor cost; that is, there is no labor cost or it is the same in both cases thus a zero sum. Examples include installing a higher SEER AC unit at the end of its useful life, installing a premium efficiency motor as opposed to a rewind at the time of burnout, and installing a higher efficiency chiller in a new construction application.*
>
> *These are not hard and fast rules and there are exceptions. For example, occupancy sensors have been designated as retrofit and new construction*

[14] This is a DEER definitional failure. When the utility pays the extra design costs, the hand-holding, and design training these are included in the TRC and the PAC, but they seem to be limiting the DEER definition to only the equipment part of the equation.

[15] *2005 Measure Cost Study - Final Report*, December 2005. Prepared for Pacific Gas and Electric Co. by Summit Blue Consulting and the Heschong Mahone Group, Inc., CALMAC Study ID: PGE0235.01

applications, yet their cost bases are considered to be FULL or installed in both cases since there is a cost to the installation beyond that of normal on/off switching in both applications. Similarly, installing a heat recovery system is considered to be a retrofit and new construction application, yet the cost basis is defined as FULL or installed in both cases because it is an addition or option to a conventional system. Therefore, each measure needs to be examined individually with respect to application and cost basis.

Measure Cost Limitations

Although DEER does provide IMCs, it is severely limited in its applicability to new construction projects, especially those using an integrated design approach. These limitations are discussed at length in the DEER report:

> ***Difficulty of estimating measure costs*** *p. 14-24: Historically, estimation of measure costs has taken a back seat to estimation of energy savings, both in California and, even more so, nationally. Whereas tens of millions of dollars have been invested over the past fifteen years in impact evaluations, very few resources have been allocated toward estimation of measure costs. The imbalance in resource allocation is problematic given the fact that measure costs are as important to estimation of total resource cost ratios as are measure savings. Perhaps this reflects an assumption that costs can be estimated much less expensively than energy savings. Although this may be true in some cases it is certainly not true in all. In fact, in some areas, such as custom and SPC-type projects in the non-residential sector, there have been extensive impact evaluations but literally no published studies on measure costs. Even in cases where one might expect the effort needed to develop reliable measure cost estimates to be minimal, there are usually a number of technical issues that must be addressed to make sense of the data collected.*

This problem has been recognized in connection with nonresidential new construction (NRNC) programs, almost since the beginning. Utility NRNC programs in the mid-90's tried to impose a requirement on participants that they provide receipts to demonstrate that the the rebate amount paid on the project did not exceet the costs of installed equipment. Similar requirements are still nominally in place. Likewise the residential new construction programs seek to document IMCs for each project. The quality of this data has been mixed, but is often the best that can be obtained.

Other Costs and Measures

The formal definition of IMC allows for the inclusion of other costs besides *incremental* equipment and installation labor (see definition discussion in section 3.1 above, which includes "*the value of the customer's time in arranging for the installation of the measure, if significant.*") This could include extra design time and effort, as well as time spent by the customer researching new technologies or design strategies in order to mitigate the risk of problems or non-performance. In the new construction arena, these are real costs, often cited by customers in focus groups and in conversations with utility program reps. However, these costs are typically not recognized in program cost calculations. The CPUC's cost effectiveness method (E3 calculator) will accept such soft costs as part of the IMC for custom measures, although this likely would be subject to special scrutiny before being accepted by the CPUC.

In addition to this IMC problem, DEER is also limited in its ability even to address integrated design and/or whole building system measures. Examples of these are lighting system design (resulting in an overall Lighting Power Density value), advanced HVAC systems with their associated controls, and daylighting strategies.

These are likely among the reasons that DEER has not addressed costs associated with new construction programs, as noted in the report:

> *p. ES-4: "Future DEER cost studies should also address design-related new construction measures or bundles."*
>
> *p.14-38: The current DEER does not include cost estimates associated with design improvements that result in savings relative to current standards nor do the savings estimates in DEER explicitly identify the design strategies assumed to result in savings relative to code. For example, Title 24 standards for lighting are generally set on the basis of Lighting Power Density (LPD) in watts per square foot. To achieve savings beyond current standards generally requires design-driven changes in the mix and layout of lighting sources rather than simply substitution of more efficient for less efficient technologies. The current DEER does not provide cost estimates or descriptions of these strategies and how they vary by building type.*
>
> *Future DEER efforts should include a task to address whether and how costs and savings should be developed and consistently integrated for design strategies and packages of measures in new construction.*

Improved DEER Methods for Cost Data

The DEER report acknowledges the lack of good cost data, and makes the following recommendation:

> *p.14-53: **Integrate cost data collection and reporting into program delivery if possible.** There is potentially a wealth of data available through the program delivery process. For example, in the current cost update the cost team was able to get actual contractor equipment and installed cost data for some HVAC measure through one of the local efficiency program implementation contractors. This is among the best quality data because it reflects what a customer actually paid a contractor for the equipment/installation. Program data collection systems could be put in place specifically to collect cost data as part of an integrated data collection process. We recognize that this is easier said than done particularly for existing programs where data and fulfillment processes are already in place. However, for future programs, this integrated approach could be adopted. It may be most useful for specific types of applications such as HVAC system installations or new construction applications where pricing is relative to and dependent on other aspects of the project.*

The report goes on to further discuss these problems as they relate to custom measures and design-related measures (both common in new construction projects):

> *p.14-53: Two large classes of measures that have been excluded from DEER in the past are custom and design-related measures, principally for non-residential applications. Although these measures are difficult to assess, we recommend that future DEER projects try to incorporate at least some of them given their large contribution to the overall portfolio. It may be possible to estimate costs and savings for some measures directly through prototypical analyses, e.g., by costing out design strategies for exceeding Title 24 lighting requirements by 10 or 20 percent by building type. In other cases, it may be useful to simply verify and analyze tracking data or evaluation results to develop average savings levels for certain types of measures (e.g., injection molding machines) based on previous program experiences. Treatment of custom measures should be investigated in more detail in the next DEER project through a task that includes a scoping analysis of approaches and tradeoffs for key custom measures. In addition, program tracking should be improved to include better and more complete documentation of custom project costs and characteristics. Similarly, reporting in future evaluations of programs with primarily custom measures should be structured as much as possible to support characterization of these measures in DEER.*

While these recommendations may solve part of the problem, they will not resolve the problems discussed above in the *Measure Cost Limitations* section. Furthermore, the recommendation points to estimating costs through analysis of prototypes, which will necessarily be approximations for real buildings, and which will not likely be appropriate for innovative and cutting edge design solutions.

In conclusion:

- DEER does not adequately address the IMC question for new construction projects, especially those employing integrated systems design strategies
- In practice, IMCs for whole buildings and integrated designs are frequently impossible to determine
- Future DEER research would be needed to estimate IMCs for new construction, and even then the recommended approaches revolve around prototypes and simulations, and so are not likely to produce realistic answers. Clearly such prototype work would be the basis of any DEER deemed values such as custom design costs per square foot.

3.4 Utility Precedents and Practices

Because of increased importance of program performance under the new shareholder earnings mechanism, IMC, and other cost effectiveness assumptions, have come under increased scrutiny. The problems with IMC, discussed in the preceding sections, have long been understood by utility program planners and administrators. The methods that have been used by them, in dealing with this problem in the past, provide useful precedents for the present discussion.

Deemed IMC Values

The Workpapers for so-called calculated savings programs provide some documentation on the current approach to IMC for new construction programs. This example describes the workpapers filed by PG&E for their 2006-08 programs, but the method is essentially the same with the other utilities. An excerpt from these workpapers is shown in the Table below.

Measure/End Use	Incentive Rate	Maximum Incentive per Project	Incremental Costs	
New Construction (Non-Residential) (NRNC) (4)				notes
Whole Building-Owner-Electric	$.10-$.25/KWH (6)	(7)	$.19/kwh	8
Whole Building-Owner-Gas	$.34-$1.00/THM (6)	(7)	$3.03/thm	9
Whole Building-Design Team-Electric	$.05-$.083/KWH (6)	(7)	0	N/A
Whole Building-Design Team-Gas	$.186-$.33/THM (6)	(7)	0	N/A
Day Lighting	$0.04/KWH	(7)	$.16/kwh	8
Lighting Systems	$0.05/KWH	(7)	$.16/kwh	8
HVAC & Refrig-Electric	$0.14/KWH	(7)	$.21/kwh	8
HVAC-Gas	$0.80/THM	(7)	$3.03/thm	9
Service Hot Water	$0.80/THM	(7)	$3.03/thm	9
Process System-Electric	0.08/KWH	(7)	$.22/kwh	8
Process System-Gas	$0.80/THM	(7)	$2.53/thm	8&10

(6) Incentive rate varies with the percent of savings compared to code.
(7) Project incentive is limited by program budget and must be less than 50% of the incremental measure costs.
(8) From PG&E Savings By Design Program Workpapers for 2004-2005 Program Years, the incremental cost is based on the 2001 DEER study and the 1996 Measure Cost Study using weighted averages derived from historical program data.
(9) From PG&E Savings By Design Program Workpapers for 2004-2005 Program Years, the incremental cost is based on Equipoise's summary, Exhibit 8 average, which is associated with the "Southern California Gas Company's Commercial Gas Water Heaters in the Savings By Design Program-Whole Building and Systems Approach", Equipoise Consulting Incorporated, October 10, 2000.
(10) From PG&E Savings By Design Program Workpapers for 2004-2005 Program Years, the incremental cost is based on Equipoise's summary, Exhibit 8 Large Boiler-Steam, which is associated with the "Southern California Gas Company's Commercial Gas Water Heaters in the Savings By Design Program-Whole Building and Systems Approach", Equipoise Consulting Incorporated, October 10, 2000.

Figure 1: Excerpt from PG&E Workpapers (with notes)

Footnotes 8 & 9 cite the previously filed workpapers for PY 2004-05, 2001 DEER IMC data, and "weighted averages derived from historical program data". For the reasons discussed in the preceding sections, none of these sources are definitive. The IMCs are, in effect, deemed values based on the amount of energy saved. As deemed values, they have been accepted as reasonable in past filings. Anecdotal evidence suggests that these values were based primarily on the professional judgment of the program planners. Sounds like it could benefit from some prototype work. But more importantly these are very out-dated (1996 --2001??), especially if the industry and market actors have become more proficient at these type of design issues.

IMC Values from Program Experience

New construction program implementers can ask participants for IMC information for projects receiving IOU incentives, and can seek to limit those incentives so as not to exceed the documented incremental costs.These kinds of requirements make two dubious assumptions:

- ***Dubious assumption #1:*** *It is possible to identify all measures and their base (standard) measure equivalents.* This is retrofit thinking. In an integrated whole building design process, there are both explicit and implicit measures. Explicit measures include such items as air conditioners with specific SEER/EER ratings. Implicit measures include such design features as building orientation, window areas, mechanical system choice, etc. Taken together, they make for an efficient building. But to develop a base case for cost comparison purposes would require the design of an entire base case building, which is never done. Accordingly, many of the measures, and the basis for their incremental measure costing, cannot accurately be identified.
- ***Dubious assumption #2:*** *Contractors are able and willing to produce receipts for equipment purchased.* In most new construction projects, the general contractor assembles a bid for the entire building, incorporating multiple subcontractor bids. Each of these bids is typically a fixed price amount, made up of assumed materials, equipment and labor costs. Theoretically, it would be possible to break out the costs of individual measures. In practice, contractors are reluctant, and in some cases unable, to provide these breakouts. This is especially true if the general contractor or owner asks their competitive subcontractors to provide breakouts. To make their bids competitive, contractors and subs often make bulk purchases and stockpile materials for multiple projects, so there are not individual project receipts to produce (even if they were willing to disclose their business dealings). They also negotiate special pricing with subs or suppliers, which they do not disclose. They frequently adjust their final bids up or down for competitive reasons unrelated to actual costs. Not explicit in the bidding process is the fact that but real costs include profit (and sometimes loss leaders) – these are buried in final bid which is their final cost to the owner. Furthermore, the construction budget for a new building is often firmly fixed by the project owner (or its financiers) even before design begins, so the ultimate IMC of the more efficient building design is deeply embedded in the budget, and not readily broken out. In this situation, the designers have to accommodate any changes in individual measure costs with other design adjustments, so that the building can still be built for the budget. One could argue, in this case, that IMC is zero by definition.

All of this together makes it very difficult to determine IMCs for individual elements in a construction contract. (There may be exceptions in publicly funded construction projects, wherein the contract may impose such cost disclosure requirements, but this is not common in private construction contracting.)

Derived IMC Values

One other approach to deriving IMC values was used in the development of the economics for the California Energy Efficiency Potential Study[16], specifically in the development of the commercial new construction potential. In this study, IMC played a central role, because one of the key scenarios was defined such that incentives would be equal to the full incremental measure cost. This scenario nearly doubled the savings potential, compared to the program current practice scenario.

The methodology section for the commercial new construction potential describes the procedure that was used to develop the IMC values used in the study. It starts with DEER data for specific hardware or equipment measures, when they exist in DEER. This worked for relatively standard measures, such as insulation, glazing, packaged air conditioners, etc. For measures which were not found in DEER, the contractor (Architectural Energy Corp.) estimated IMCs from other available data sources. In some cases, this exercise required considerable professional judgment. For example, one of the principal measures entailed reductions in lighting power densities (LPDs). LPDs are determined by the entire lighting system design, starting with lamp and ballast efficiency, but also influenced by luminaire optics, numbers and quality of luminaires needed, required illuminance levels, etc. In an integrated design situation, the reduced LPD lighting system may be substantially different than the baseline LPD lighting system, and determining the IMC for the LPD reduction would require estimating the system costs for detailed lighting system specifications for both the base and efficient designs. A similar situation obtained for HVAC systems, which include primary equipment (chillers, boilers, etc.), secondary systems (fans, pumps, etc.), distribution systems (ductwork, piping, etc.), and control systems. For simple designs, such as packaged systems, determining the IMC can be straightforward, but integrated HVAC designs present the same problems just described for LPD reductions.

When it was not possible to obtain or work with detailed system specifications for the numerous building simulation models used to estimate the technical potential, general estimates of the IMC on a per square foot basis were developed. Again, these relied heavily on professional judgment, rather than on known details and characteristics of real designs.

The IMC situation was further complicated when the new construction potential study attempted to estimate IMCs for buildings with bundles of measures and integrated design. The building models applied measures that clearly increased the costs of the building, such as more insulation or more costly glazing systems, but these measures often resulted in substantial reductions to the cooling (and heating) loads. Consequently, the size and cost of the HVAC system could be reduced.[17] The potential study's *modeling* system calculated these reductions and applied them to the whole building IMC. The modeling system even added an additional cost for extra HVAC design effort (determined from limited data and professional judgment). The problems arose when the HVAC system

[16] *California Energy Efficiency Potential Study, May, 2006.* Prepared by Itron, Inc. and subcontractors. Main study, CALMAC ID PGE0211.01. Appendix P Commercial New Construction Methodology, CALMAC ID PGE0211.03.

[17] Note: It will not always be the case that systems will be downsized or quantities reduced, given higher efficiencies and the tendency to over-design, but progressive designers frequently claim this as a benefit to the owner and as an argument for integrated energy systems design..

downsizing cost savings were greater than measure cost increases for other measures, resulting in a negative IMC on a whole building basis. A review of the results shows that this is not an uncommon occurrence. An excerpt from the cost tables, shown in Figure 2 demonstrates this situation for "25% Above 2001 Standards – Climate Zones 8-10." Note the IMCs shown in the "Cost ($/SF) column. The Appendix P report provides many similar tables, showing wide variability in cost by building type, climate zone and levels of efficiency.

Building Type	Base Compliance	Package Compliance	Cost ($/SF)	Electricity Savings (kWh/SF)	Gas Savings (therm/SF)
College	8.6%	23.2%	-$0.43	2.09	0.0173
Schools	7.5%	25.9%	-$1.71	1.84	0.0037
Grocery Stores	1.0%	32.3%	$3.81	17.70	-0.0007
Health Care	-2.9%	27.2%	$0.07	3.89	0.0080
Lodging	-7.4%	11.8%	$0.77	5.39	0.0061
Large Office	8.7%	22.6%	-$1.64	1.62	0.0111
Misc.	6.0%	18.4%	$0.58	1.93	0.0465
Restaurants	-1.9%	14.1%	$13.85	9.48	0.9356
Retail	11.6%	23.5%	-$0.38	2.60	0.0041
Small Office	-0.4%	19.1%	$0.28	2.94	0.0061
Warehouse	9.7%	17.8%	$0.07	0.30	0.0030
All	**6.5%**	**20.6%**	**-$0.23**	**1.82**	**0.0203**

Figure 2 - Excerpt from CNC Potential Study Showing Negative IMCs

There are several pertinent lessons to be gleaned from the exercise that the analysts went through in this study:

- Whole building IMCs can be quite different than individual measure IMCs, often having very small or even negative values when integrated design is applied, because of system economies such as HVAC downsizing.
- New construction IMCs are not consistent, showing substantial variability between building types, climate zones and efficiency levels; sometimes IMCs are high, sometimes low.
- This method for estimating IMC, while rational and consistent for the purposes of the potential study, is based on the characteristics of a sample of buildings, which may not reflect the characteristics of other new buildings, or the choice of measure bundles that other designers would make. So the method results may not be generalizable. It could vary so much among building types as to be hard to come up with a rule of thumb.
- In cases with small or negative IMCs, the general recommendation would be to offer very small or non-existent incentives. Program experience, however,

suggests that participation rates would be much lower without substantial incentives, and there would be substantial lost opportunities.[18]

- The potential study acknowledges that it does not deal well with integrated design, and recommends further research.

[18] Note: This gets into the tricky problem of setting incentives at the appropriate level. Program administrators want to keep incentives as low as possible, while still encouraging broad participation. Program information can show building decisionmakers that energy efficiency is highly cost-effective, but this is often insufficient to get them to invest. The CPUC cost effectiveness calculations encourage minimizing incentives, but this may not always be the best way to achieve large savings and participation. Incentive levels are beyond the scope of this White Paper, except as they are skewed by inaccurate IMC numbers.

4. APPROACHES TO ESTIMATING IMC

This section builds upon the preceding sections, and presents alternative approaches that could be considered for treating IMCs in California new construction programs (with emphasis on commercial whole building new construction in particular)

4.1 Primary IMC Considerations

Before discussing alternative approaches, however, we provide a brief review of the key considerations in using IMC for program design, implementation and evaluation.

Avoiding Overpaying Participant Incentives

One of the key uses of IMC values is to set an upper limit on incentives paid to customers. For a simple equipment change-out, this is straightforward. One determines how much more it costs to purchase and install the energy efficient equipment, compared to a baseline piece of equipment. As we have explained, however, it is difficult-to-impossible to determine the whole building IMC for an integrated building design project. Analysis suggests that the IMC may actually be very small or negative in many such cases. Logic would suggest that incentives should be very small in such cases, provided IMC captures all of the economic barriers to energy efficiency. This assumption may not be true in all such cases.

Avoiding Lost Opportunities by Encouraging Program Participation

Because new construction projects become substantial lost opportunities if they are not energy efficient from the outset, it is important to encourage as much participation as time, money and manpower can enlist. It is clear that incentives are a primary motivator to program participation, and that setting them low will produce lower participation rates than setting them high. Since it is true that a highly efficient integrated building design can cost the same or less than a less efficient design, one would expect that rational building owners and designers would be designing highly efficient buildings without the need for new construction programs and their incentive payments. This, however, is the exception rather than the norm. Clearly, there are other market, technical or economic barriers that are getting in the way besides the first cost (and design time and cost?).

Cost Effectiveness - Passing the TRC and PAC Tests

Program administrators (and program designers and implementers) have been highly sensitized to the TRC and PAC tests due to CPUC policies and directives which require that these benefit/cost metrics be calculated and used in setting budgets and in meeting program efficacy targets. Programs with low or negative IMCs are quite likely to be valued less highly because of strange TRC and PAC values. Likewise they may come under extra scrutiny for paying excessive incentives. (If the CPUC accepts the reasons why the TRC should be lower than the PAC, this may not be a problem,)

Determining Defensible IMC Values

The CPUC's evaluators understand that IMC values play an important role in calculating the TRC and PAC tests, and so are expecting justification of all IMC values used in the calculations. Program administrators seek clarity as to how best to determine IMCs, and to demonstrate their reasonableness. As the preceding discussions indicate, the new construction program administrators have not been given sufficient guidance on how to determine IMCs, because all of the existing guidance seems targeted to simple retrofit measures and misses the practical problems of determining IMCs for integrated whole building designs.

4.2 Advantages and Disadvantages of IMC Approaches

The following discussion presents five possible approaches that could be used to determine IMC for new construction program participant projects and the advantages and disadvantages of each:

1. Ask Customers for IMC Values

One approach, is to ask the customer to document the IMC as part of their program application and verification process.

Advantages

- Places the burden of determining IMC on the participant
- Customers may know best what their IMCs are

Disadvantages

- Dubious accuracy - This approach assumes that the customer is able to accurately determine the whole building IMC, and further assumes that s/he is able to produce plausible documentation. As discussed in the previous section, these are dubious assumptions. If the customer is able to produce documentation, it is not unreasonable to question its validity.
- Incentive to exaggerate IMC - If the customer understands that s/he is being offered a whole building incentive that is a function of how energy efficient their design is (relative to code), and that the incentive will be capped at some percentage of the IMC. In such a circumstance, there is an incentive for the customer to calculate a large IMC.
- Large IMCs may discourage high efficiency - If the customer believes there are high IMCs on their projects, they may be less inclined to accept the financial burden or they may believe the incentive paid is insufficient. If the IMC is inflated, this may have the effect of discouraging participation
- Keeps the customer focused on costs rather than benefits - focus group findings have consistently shown that many customers value the non-energy benefits of energy efficiency more highly than the economic benefits. Increasing their awareness of costs may backfire on program participation levels.

2. Use DEER to Calculate IMC Values

Another approach is to emulate the retrofit programs and use DEER values to estimate IMCs for projects.

Advantages

- Standardized, simplified approach that could produce plausible IMC values for individual measures
- Takes the burden off the customer and the program staff, which could reduce participation "hassle costs"

Disadvantages

- Not all new construction "measures", such as efficient lighting systems or complex HVAC systems, are listed in DEER
- Negative measure costs, such as downsized HVAC system, may not be captured
- DEER methods were not designed to deal with integrated designs (per DEER reports and discussions with report authors)
- Whole building IMCs may not be accurate

3. Adapt Potential Study IMC Estimates

Another approach could be to summarize and standardize the estimated IMCs per square foot for the whole building designs that were used in the new construction potential study

Advantages

- Methodology was developed for integrated whole building designs, and may be the most rigorous available
- Covers a wide range of climates, building types and efficiency levels
- May be outdated soon (based on 2005 data)

Disadvantages

- Based on optimized measure bundles, which may not reflect many new construction projects in the programs
- System design measure costs determined using professional judgment, using limited data
- Wide variability in the findings may be difficult to generalize
- Makes an assumption that reduced costs for HVAC systems, etc., are actually going to be experienced; this may not be true if designers do not actually downsize in response to reduced loads,

4. Derive Deemed IMC Values

Another approach would be to apply a similar approach to that of the utilities' program filing workpapers, which is to develop a deemed value that is a function of the energy savings.

Advantages

- Provides a simple metric that assumes increasing IMC with increasing energy savings
- IMC values can be related directly to the value of the savings, and can implicitly include other costs, such as measure risk or information barriers
- Does not pretend that actual IMCs can be determined for whole building projects, which costs estimates are dubious at best
- Method has precedent and has served its purpose for several years

Disadvantages

- Approach not often used for simpler programs or measures, so may not be as understandable or acceptable to all stakeholders
- Could potentially make the TRC calculation less reliable, because IMC values could be back-calculated to produce favorable TRCs. This may not be acceptable to some stakeholders.
- Unless multiple deemed values are developed for various building types, climate zones, levels of efficiency, etc., may not be accurate enough to be accepted by all stakeholders.
- Deemed values may become outdated, and they may not accurately reflected integrated building design (rather are likely to be derived fromsub-systems.)

5. Monetize Lost Opportunity Costs

A final option could be to develop a method to quantify lost opportunity costs, either as a negative cost, or as a positive benefit (see lost opportunity discussion above in section (3.2). This idea is that the savings lost from not making a new building energy efficient could be recognized in the TRC calculations.[19] Advantages

- Provides a way to recognize and value a feature inherent in new construction program activities
- Improves the cost effectiveness of new construction programs

Disadvantages

- New approach not used in other program cost effectiveness calculations
- Method would be highly dependent on assumptions that would be hard to validate.

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[19] Note: This approach could actually apply to any lost opportunity situation, not just new construction, but to our knowledge is has not been used outside of theoretical discussions.