From Deemed Measure to Codes and Standards: A timeless idea that deserves a fresh look

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ABSTRACT

To meet aggressive greenhouse gas (GHG) reduction targets, technologies such as electric heat pumps must quickly be moved across the adoption curve. Exciting new CPUC policies like the fuel substitution test, tools like the electronic technical reference manual (eTRM), and the new total systems benefit (TSB) metric (which explicitly rewards GHG emissions reductions) provide an opportunity to significantly broaden the GHG-centered measures offered by Program Administrators (PAs). If Codes and Standards (C&S) programs were to become more directly involved with deemed eTRM entry development, then GHG savings could be even further maximized by providing program implementers with more incentive offerings and a quicker progression from incentive programs to C&S. These eTRM entries would be developed with a potential C&S pathway in mind up front.

Although the adoption curve is a simplification of reality, it helpfully illustrates that measures tend to flow from emerging technology, to incentives, and eventually to codes and standards. In practice, the different programs can be siloed, which limits knowledge transfer between the market adoption bins.

This paper will explore the opportunity of creating a framework where when appropriate, new measures consider the eventual codes and standards fate during their development. Specific examples will be detailed (such as a commercial unitary incentive program that leads to an appliance standard, or an air-to-water heat pump that becomes a code compliance credit). C&S measures have major GHG savings potential and the faster that all-electric designs can make their way into codes and standards, the more quickly that buildings will fully decarbonize.

Introduction

For decades, the California Public Utilities Commission (CPUC) has authorized Investor-Owned Utilities (IOUs) to participate in and advocate for building code and appliance standards (i.e., codes and standards or C&S) enhancements by gathering data, performing analyses, and participating in public regulatory processes at the local, state, and federal levels. C&S programs also engage in code compliance improvement programs. These activities have resulted in beneficial enhancements to energy regulations over the years, causing lower energy bills for ratepayers in California, and reduced peak demand on the electric grid. They have also resulted in numerous other non-energy benefits such as improved comfort through widespread deployment of higher performance equipment.

This existing IOU codes and standards program infrastructure is well suited to drive the transition from a primary focus on energy efficiency to the more recent focus on energy efficient building decarbonization (EEBD), where success is measured in GHG reductions. Many of the activities that resulted in successful adoption for C&S that increase energy efficiency can also be applied to the adoption of C&S that drive EEBD.

Deemed measures are defined in the California Statewide Deemed Rulebook as: "a prescriptive energy efficiency measure. Energy efficiency measures with predefined savings calculations, cost, eligibility, and other measure attributes" (CA IOUs 2020). Deemed measures are typically understood in contrast to custom measures, which calculate energy performance and savings on a site-by-site basis. Deemed measures rely on a precalculated set of savings and cost values that seek to capture a statistical average performance for the efficient measure. Deemed measures have their shortcomings, surely, but also present the benefit of enabling much higher program throughput, which can assist with quickly moving incentive dollars to program participants. Regarding shortcomings, deemed measures can struggle with accurately capturing savings in systems with highly unique conditions, and also generally assume quality installation, which is not always the case and creates a gap between claimed and realized savings. However, the two main delivery methods other than deemed are custom and normalized metered energy consumption (commonly known as NMEC), which have shortcomings of their own. These delivery types typically involve much greater administrative overhead per project than deemed.

The theory is that although savings estimates for individual sites may overestimate or underestimate actual savings, if designed appropriately, on an aggregate program level, savings estimates are accurate.

The focus of this paper is to explore how, when appropriate, California IOU C&S programs can get more involved in the creation of deemed measures, coordinate with programs during the implementation period, and work with programs to identify when to sunset measures and migrate them over to C&S. Fostering this relationship and strengthening the pipeline from deemed measures to C&S can help accelerate the pathway for carbon free technologies to become more widely adopted and accepted in the market.

CPUC Support for Building Decarbonization

In recent years, CPUC has made a number of recent changes that significantly strengthened the viability of introducing building decarbonization measures into IOU portfolios. In addition, CPUC has modernized its deemed measure environment with its support of the California Technical Forum (Cal TF)-developed electronic technical reference manual (eTRM). These innovations are summarized below.

Total System Benefit

For decades, CPUC has tracked IOU incentive program performance based on traditional energy savings metrics: kWh to measure electrical energy, kW to measure peak demand, and therms to measure natural gas. However, in May 2021, with decision D.21-05-031, CPUC modified these metrics into a new metric called Total System Benefit (TSB) (CPUC 2021a). TSB is meant to not only capture these three traditional metrics but also captures additional aspects. TSB is derived from the CPUC Avoided Cost Calculator (ACC). Just like the ACC, TSB relies on six avoided cost categories: energy, generation capacity, ancillary services, transmission and distribution capacity, fluorinated gas emissions, and greenhouse gas emissions (CPUC 2021c). The three traditional "energy efficiency" metrics of kWh, kW, and therms now fall within the "energy" category. Programs will be measured by TSB starting in program year 2024 (CPUC 2021a). A benefit to this metric is that, aside from broadening the scope of program activities in which PAs can engage, the metric is now fuel neutral, making fuel substitution program comparisons with traditional EE programs more straightforward. From a building

decarbonization standpoint, however, the welcome change that TSB brings is the inclusion of greenhouse gas emissions as part of the calculation methodology. This change should work to the benefit of technologies and measures that are primarily focused on decarbonization.

The Fuel Substitution Test

Prior to 2019, CPUC placed a high bar on fuel substitution measures. In this era, fuel substitution measures had to clear the "three-prong test," which was developed in the 1990s at a time when the grid contained more coal-fired electricity and fewer renewables than it does today. Fuel substitution for fuel substitution's sake was not desirable and CPUC created this test to ensure that program budgets were allocated to measures that would generate a meaningful benefit to ratepayers.

The three-prong test contained, appropriately, three elements that needed to be satisfied:

1. The program must not increase source-British-Thermal-Unit (BTU) consumption.
2. The program must have Total Resource Cost (TRC) and Program Administrator Cost (PAC) benefit-cost ratio of 1.0 or greater.
3. The program must not adversely impact the environment.

Each of the three prongs contained aspects that forced fuel substitution measures to clear a higher bar than standard EE measures. For example, prong 1 required that the baseline system be the most efficient cost-effective option, which cut into the source Btu savings for the measure case. Regarding prong 2, no other EE measure was required to be cost-effective at the measure level, cost-effectiveness is generally applied at the portfolio level. Prong 3 was challenging to implement due to being vague and hard to quantify.

Since the 1990s, with the emissions intensity of the electrical grid steadily declining, fuel substitution became less of a zero-sum prospect. The three-prong test was officially replaced by the fuel substitution test with CPUC decision D.19-08-009 (CPUC 2019). The two new steps to the fuel substitution test are summarized as follows:

1. The measure must not increase total source energy consumption when compared with the baseline comparison measure available utilizing the original fuel.
2. The measure must not adversely impact the environment compared to the baseline measure utilizing the original fuel.

In contrast with the three-prong test, these two requirements were very clearly defined throughout the decision and subsequent guidance. The first step now specifies a minimally efficient original fuel base case, and the second step is clear that environmental impact refers to greenhouse gas emissions. The individual measure-level cost-effectiveness requirement is no longer in the test. CPUC, with Southern California Edison (SCE) assistance also created a fuel substitution calculator which allows fuel substitution measure developers to easily determine whether their measure passes the test based on source energy and greenhouse gas emissions comparisons (CPUC 2021d). This change has enabled a number of fuel substitution measures to be introduced into the deemed portfolio since 2019, with many more untapped opportunities that can be explored and developed. The updated Fuel Substitution Test is beneficial to the EEBD goals (in terms of market, technology, and program readiness) of the SCE C&S Planning and Coordination program.

The California Electronic Technical Reference Manual (eTRM)

Until recently, the CPUC's method of storing deemed savings values and measure packages (formerly known as workpapers) information was scattered across a few online resources and databases. This resulted in an environment that was opaque for those who did not regularly work with deemed measures. In the previous setup, the IOU measure packages would be stored at deeresources.net, other CPUC instructions and resources would be housed on deeresources.com, IOUs would interact and share files with CPUC staff through deeresources.info. CPUC-approved deemed savings values (known as the Database of Energy Efficient Resources, or DEER) and other deemed ex-ante values such as effective useful life and net-to-gross ratio would be housed in the Remote Ex-Ante Database Interface (READI), and other information about incentive programs would be stored on the California Energy Data and Reporting System (CEDARS). Frequently, information would be duplicated (and unfortunately, not always in alignment) across tools. Further compounding the issues with misalignment was the fact that each individual IOU would maintain their own version of a workpaper, e.g., the commercial unitary air conditioner workpaper would have a Pacific Gas & Electric, SCE, and San Diego Gas & Electric version. Each version would have to be separately maintained by the IOU, and this resulted in greater chances for misalignment and errors. Overall, this fragmented system of storing deemed information frequently resulted in confusion from stakeholders.

Today, nearly all information has transitioned to two primary resources: the Cal TF eTRM and CEDARS. Deemed measure packages and other ex-ante data is stored at the eTRM, and supporting documentation, software resources (such as MASControl), the cost effectiveness tool (CET), and program performance is stored in CEDARS. The eTRM has been built from the ground up to store deemed information in a clear and user-friendly manner. As of January 1, 2022, the eTRM officially became the database of record for deemed measure packages in California. Furthermore, over the last few years, Cal TF staff undertook the significant task of consolidating all existing IOU-specific measure packages into singular statewide versions, which is how the deemed measures are presented on the eTRM today.

The eTRM does not signify a major shift in how deemed measures are developed, but instead represents an innovation in accessibility and clarity of how deemed information is presented. This is a subtle change to the deemed environment in California but its helpfulness needs to be appreciated. Program administrators and third parties can now very easily access all active measures with certain characteristics using the eTRM's search and filtering tools. Within an individual measure package, users can easily access earlier editions of the measure to learn what has changed over time. The measure's cost-effectiveness input files are now tied to the measure package, which helps users quickly understand the measure's cost effectiveness. In the past, this information could be rather time-consuming to assemble, especially for users unfamiliar with the details of the measure. The eTRM presents many other subtle improvements in how data are laid out and organized. The energy and demand impacts can be displayed as a table of static values (typical for measures that were developed using building energy modeling tools) or calculated within the eTRM itself.

The improvements that the eTRM has brought about in how deemed information is stored makes measures more widely accessible and usable by the general public. This enables stakeholders and other types of programs, such as C&S programs, to more actively engage with existing data and potentially find ways to create deemed entries that are more tailored to their program needs and goals.

Deemed Engineering's Role Within the Market Transformation Framework

The concept of the "market adoption curve" is an imperfect but useful framework to consider how technologies move from limited to universal deployment, i.e., commercial introduction through targeted demonstration to eventual mandatory codes and standards requirements. Of course, the reality is that the process is much less linear and straightforward than the market adoption curve implies, but in general, the concept helps us understand the relative ordering of prototypical program intervention types that a given energy efficiency or building decarbonization measure could experience relative to its market penetration and customer acceptance level.

Figure 1 shows a schematic of the market adoption curve with a number of significant milestones labeled as the given measure moves from research and development (i.e., conceptualization) to updated codes and standards (i.e., normalization). Note that some activities in the same boxes do not necessarily relate to one another (e.g., pure R&D and code compliance) but instead are shown together since they occur at similar stages of the adoption curve. To be clear, potential prescriptive and mandatory C&S measures can be found at stages before "normalization" on the graphic. Furthermore, as the figure shows, C&S programs have a role to play all throughout the technology's progression from conceptualization to normalization. In parallel, voluntary incentive offerings are available for technologies that have not been adopted into mandatory or prescriptive codes and standards regulations.

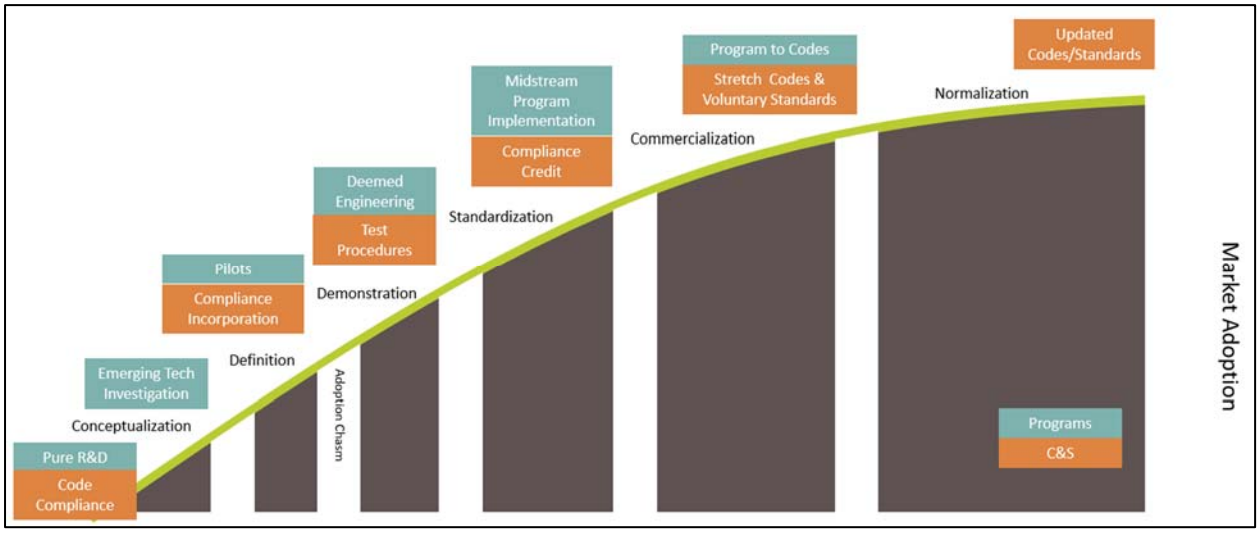

Figure 1: The Market Adoption Curve showing parallel program and C&S activities from conceptualization to normalization
Source: Energy Solutions

To illustrate deemed measure development's potential central role in the process of market transformation, we have reformatted the market adoption curve into a number of categories, as shown in Figure 2.

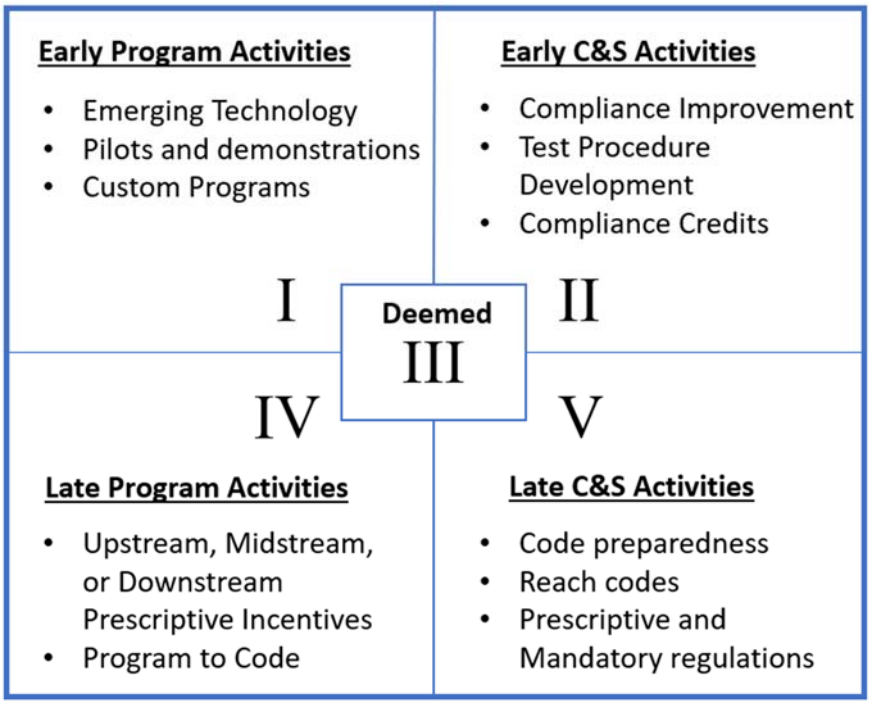

Figure 2: A framework for viewing how deemed measure development fits in with other program and C&S activities throughout the market transformation process
Source: Energy Solutions

While the layout in Figure 2 may place deemed at a slightly unrealistically prominent position in the graphic, it is also valuable to consider how many ways that going through the process of performing deemed measure analysis can serve to assist a measure's subsequent path through incentive programs and C&S measures. Fundamentally, deemed engineering is about organizing and structuring information about a measure so that it can be easily applied to a wide range of site-specific conditions (e.g., building types and climate zones). The resulting database of energy, demand, and cost information is traditionally applied to incentive programs. However, this information could also be applied to C&S analysis and activities. Furthermore, if C&S programs take a more active role in deemed measure development, specific topics and items of interest to the C&S program could be introduced into the deemed measure package, which will better facilitate a measure's journey to becoming a prescriptive or mandatory C&S measure.

Each of the five labeled sections of the graphic in Figure 2 have their own unique attributes and challenges. The purpose of organizing market interventions in this manner is to draw attention to the specific challenges and opportunities of each area, and then highlight how deemed engineering can assist or overcome those barriers. Some of these barriers are summarized in Figure 3.

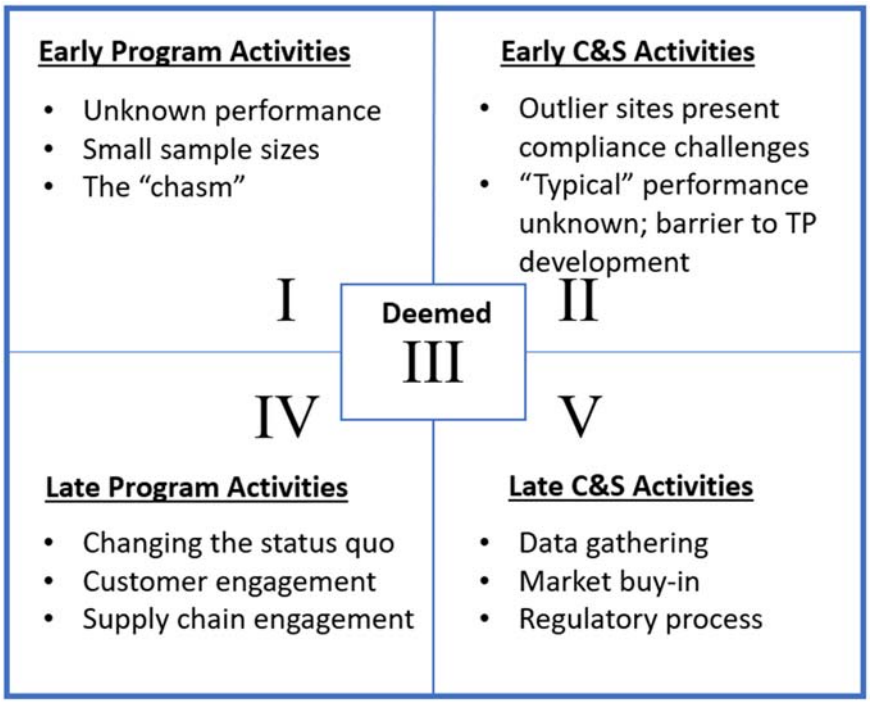

Figure 3: Issues and challenges that are commonly associated with types of interventions
Source: Energy Solutions

Again, the advantage of viewing market transformation through a deemed lens is that it can serve as both an end point and starting point for various other program types. A deemed measure is a logical endpoint for emerging technology program activities, which also serves as the starting point for "late program activities" such as midstream incentive programs. Each of the "pathways" is discussed briefly in the section that follows. As noted earlier, we understand that this framework is a simplification of reality.

Pathway 1: I – III – IV, "ET to deemed to programs"

This is a familiar way of understanding deemed measure development's place in the market adoption curve. In this pathway, the "input" to a deemed measure can be the result or outcome of an emerging technology study or pilot program. Each study can be dedicated to gathering a limited amount of data that can be used for the deemed measure development process, and then the outcome is an incentive program intended to further achieve penetration of the energy-efficient measure or equipment.

Pathway 2: II – III – IV, "Early-stage C&S to deemed to programs"

In this pathway, an early C&S intervention could lead to a deemed measure, which then subsequently supports an incentive program. The C&S program could assist with developing a new test procedure for a product (through engagement with industry and an independent test procedure committee), which can generate data that can be used to develop a deemed measure and qualified product list based on the test procedure. This would then support incentives that can further transform the supply chain and make the new technology more commonplace.

Pathway 3: I – III – V, "ET to deemed to late-stage C&S"

In this pathway, measures could be "fast tracked" from ET to C&S by using deemed as a stepping stone. The "deemed" stage could be used to support a brief incentive program period. This would not be appropriate for many technologies, but it should be examined as a possibility. The traditional path of ET to incentive programs to C&S is not necessary for every technology or measure.

Pathway 4: II – III – V, "Early-stage C&S to deemed to late-stage C&S"

Like Pathway 3 outlined above, this pathway envisions incentive programs generally being skipped in favor of a direct line from deemed to C&S. One could imagine the outputs of a test procedure for a new technology being housed in a (modified) eTRM entry so that subsequent C&S analyses have a starting point. A brief data-collection oriented incentive program could be run as a precursor to a prescriptive or mandatory C&S measure.

Deemed Engineering Enhancing Codes and Standards

Barriers to Successful C&S Measure Adoption

In order for a C&S measure to be successfully adopted by a regulatory body, a measure needs to be cost-effective, not be overly burdensome to a subset of the population, and align with the given regulatory agency's legislative mandates or goals. The lack of data can greatly limit a C&S program's ability to succeed at energy code enhancements. There are all types of data that can be of service to a potential C&S measure. A few examples include:

- The difference between an equipment's efficiency rating and its field performance. A test procedure or rating is inherently limited by having to capture the average use of a piece of equipment. This issue is especially relevant for HVAC equipment, which encounters significantly different climate conditions around the country. This topic can be further subdivided into two subtopics: 1) determine the difference between the equipment's rating (taken to represent the national average conditions) and the local climate or usage patterns, and 2) investigate or confirm whether the equipment's rating is representative of the average conditions for which it purports to measure.
- How equipment performs in unique conditions that may not be captured by the average conditions described in a given test procedure. For example, a given site may operate at significantly more or less runtime hours than the equipment test procedure assumes. Getting a better understanding of how equipment performs in the field could help C&S savings analysis. A program with a heavy focus on ongoing data collection could address this issue. Note that the deemed program delivery may not be best suited for addressing this question, but some type of hybrid program that contains elements of deemed could work.
- How users comply with building codes. For example, is the performance or prescriptive approach more frequent for a given building type or situation? Within the performance approach, what are the common trade-offs pursued?
- Within compliance software, equipment performance is revisited infrequently due to bandwidth and competing priorities. Therefore, what tends to happen is that while

equipment performance (and building energy modeling objects and techniques) steadily improve over time, the compliance software tends to remain mostly static, with only the highest priority items receiving attention (such as the need to capture new federal appliance standard levels, or mandatory/prescriptive code requirements in the standard design as each code edition is finalized)

- Cost information. This can apply to equipment costs, permitting costs, panel upgrade costs, installation costs, etc.
- Information about the subset of the population that may have additional challenges with complying with a potential C&S measure.
- Finally, as regulatory agencies begin to more explicitly focus on building decarbonization and electrification, since this type of regulatory change is less well understood and has a much smaller track record, data regarding the unique benefits and challenges that fuel substitution presents is lacking.

Many of these data gaps can be mitigated by thoughtful deemed measures developed with C&S needs in mind.

Ways that Deemed Measures can help overcome C&S Barriers

Deemed measures are not a cure-all, of course. However, the deemed measure development process can contain powerful tools and can be used to support different program goals than what they have traditionally been used for. The methods by which deemed measures can help facilitate C&S is discussed in the paragraphs that follow.

An obvious source of improvement is to more explicitly coordinate between the incentive and C&S programs. This could be realized by increasing C&S program involvement in deemed measure development. Incentive program implementers could then regularly coordinate data and knowledge sharing while the program is being implemented. If a measure is a viable candidate for eventual adoption as a C&S measure, then the type of incentive program intervention can be tailored in a way that can maximize the market effects and level of preparedness for the C&S version of the measure. For example, a strategy that combines regular downstream with a direct install element specifically targeted at hard-to-reach customers or others that are flagged as being likely to have challenges with complying with the eventual C&S measure could help both soften that segment of the market and generate crucial data on their habits and challenges.

Along similar lines, measure creation with a C&S lens could manifest in writing in a number of “triggers” or elements that the program implementer/evaluator should monitor over the measure lifetime as evidence that the measure is becoming ready for C&S. For example, if the net-to-gross (NTG) ratio begins to decline, then that could mean that the market is no longer in need of the incentive offering and C&S could be the next logical program intervention. Another element to monitor would be incremental measure cost (IMC). If the IMC declines over time, the measure may be ready for C&S.

Many deemed measures undergo rigorous performance data collection efforts in support of the energy impact development. This can take the form of collecting detailed performance mapping of several representative examples of equipment at a wide range of the operation envelope, leveraging (and enhancing) other studies and work on the technology or measure, or collecting primary data on field performance of the equipment. These data can be expensive and time-consuming to collect. Therefore, the more uses that can be derived from these data, the more beneficial that it can be. There are many potential uses for performance data gathered for

deemed measure development in the C&S context. For example, code compliance software can be simultaneously enhanced along with the deemed measure. Deemed performance data need to be gathered in support of a so-called "base case" efficiency level as well as higher efficiency "measure cases." The "base case" performance can be applied to the compliance software's "standard design" and the deemed "measure case" can be applied to optional higher efficiency "compliance credits." In some cases, the prescriptive code minimum base case efficiency is different than what is assumed as the industry standard practice (ISP) efficiency for the deemed measure's base case, but this issue can be dealt with by modeling additional efficiency levels as needed. In this instance, measures where ISP is greater than code could be good candidates for C&S enhancements, resetting ISP efficiency levels to the prescriptive/mandatory baseline.

Performance data collected for deemed measures can also be used to support test procedure development for new technologies. For new technologies that don't yet have a standard test procedure, some initial assumptions can be assembled into an initial version of a deemed measure, and then the resulting program can collect a larger dataset that can be used to create the product's test procedure. The second iteration of the incentive program could then rely on that test procedure and resulting qualified products list (QPL). Since a widget-based incentive program needs a standardized method of comparing inefficient and efficient versions of the widget, a test procedure and resulting QPL is desirable. The exception would be prescriptive incentive programs or specific measure application types such as "add-on equipment" which are more binary in their application. But many programs require a test procedure. For brand new technologies (a relevant example for building decarbonization is hydronic, combination space and domestic water heating, or cold climate heat pump systems that do not have a robust test procedure framework), C&S programs can help bring a technology into incentive programs more quickly by focusing on test procedure development. Working with standards bodies and manufacturers to develop a test procedure is an expensive and time-consuming endeavor, so having the knowledge that these efforts will yield dividends in the incentive programs may make the investments more worthwhile.

At some point after an incentive program has existed, and the measure is ready for C&S, then that same performance data that once represented the cutting edge of the technology can be applied to the mandatory or prescriptive analysis to support the code change. This "handoff" would need to be treated very gingerly, since developing and accessing performance data can be a sensitive process whereby strict limits on what is done with the data are conveyed along with the data. Manufacturers may be comfortable sharing data for a voluntary incentive program may have a much different posture if they knew that the data would also support a code change. However, certain forward-looking manufacturers may be comfortable with this arrangement if the parameters are made clear up front.

In addition to setting efficiency requirements, a measure package can also establish other program or eligibility requirements. Measure packages can also include customer surveys to help establish program influence or preponderance of evidence to satisfy regulators. We propose adding additional optional elements to measure packages that can help inform both deemed measure developers (who need to periodically update/modify the measure) and C&S programs about aspects of the given measure. Customers can be offered an additional incentive if they want to voluntarily disclose more information about their specific circumstances or motivation behind pursuing the high efficiency measure. Customers could also be offered the opportunity, for an additional incentive, to volunteer their site for more detailed data monitoring to study the effects of the high efficiency measure. Surely, a small percentage of customers would take

program implementers up on this offer, but for a midstream program with a very large pool of incentive recipients, even a small number of volunteers could produce a very valuable source of data. Again, as mentioned above, this would have to be done in a transparent way that acknowledges that this information is being used for potential C&S enhancements. Furthermore, customer personally identifiable information must not be abused or disclosed in ways that goes against customer wishes. This field data collection effort would be able to inform potential test procedure enhancements, future iterations of deemed measures, compliance software enhancements, reach codes, and eventually, prescriptive and mandatory C&S measures.

Customers who participate in incentive programs can be engaged in more qualitative ways. Optional interviews and surveys (where participation is rewarded with another incentive or possibly a gift card) could generate information that is of use to both deemed measure enhancements and C&S programs. For example, a survey could include questions about the site's operating schedule, and if a statistically valid amount of data is collected, this could be used to supplement or enhance ex-post evaluation of the measure or inform how the Codes and Standards Enhancement (CASE) analysis would be handled. In another example, for a fuel substitution measure, data could be collected on the frequency and size of panel upgrades needed to accompany the shift from a natural gas fired to electric heat pump water heater, which would be able to inform future C&S activities and incentives. In another building decarbonization example, surveys could be designed to gather data on common HVAC system configurations or site-specific characteristics, which would help develop C&S interventions to support all-electric space heating requirements.

Putting 'Deemed to Code' into Practice for Heat Pumps

Depending on the market segment, space heating heat pump offerings range from robust (e.g., residential ductless and central ducted systems) to very limited (e.g., residential room and window heat pumps). In other cases, such as large commercial buildings, there are heat pump products on the market, but the system complexity and overall novelty of an all-electric system design have kept all-electric saturation lower than it could be.

Commercial Large Building Heat Pump Systems (Pathway 3)

Commercial hydronic heat pump systems are a technology that have major potential to decarbonize buildings. At the same time, they face a number of barriers to adoption. Because many larger commercial buildings are currently heated with fossil fuel fired hydronic boilers, the general direction toward a combination of air-to-water heat pumps, heat recovery chillers, and thermal energy storage is a promising group of technologies to replace boilers (since they can meet the building's space heating needs cost-effectively and with a reasonable footprint). This potential has been noted by individuals such as Brandon Gill and Mark MacCracken in recent ASHRAE Journal articles. Specifically, Brandon Gill outlined the Time-Independent Energy Recovery (TIER) system configuration that would serve as a standard chiller-boiler system replacement option. However, there are significant barriers and questions that need to be answered before efficient all-electric space heating systems for large buildings can be brought into code.

The current prototypical system for a large, space constrained building is a hydronic system consisting of a boiler, chiller, and cooling tower. This is a commonly designed system. The issue is that replacing it with a fossil boiler-free replacement system is not a straightforward

1:1 swap-out. Instead, Gill demonstrates how a 5-piece system, consisting of a water-cooled chiller (WCC), heat recovery (HR) chiller, thermal energy storage (TES) tank, air-to-water heat pump (ATWHP), and cooling tower is a viable replacement strategy. The system type is particularly attractive in the mild CA climate but is viable throughout the country. The main barriers today are total number of system installs, workforce education and up-front cost-parity with fossil fuel options.

Incentives could help with up-front costs. And a suite of deemed measures would underpin that program. At the same time, a contractor workforce education initiative could be undertaken. The combination could transform the market and pave the way for a variety of code and standard interventions.

The goal would be to create a deemed program that captures TIER system performance. Sites that install a TIER system (and followed some type of best practice/design guide for quality installation) would become eligible for incentives.

The goal of this program would be to provide large incentives to the early adopter crowd and build up interest in the system configuration.

The basic measure could be layered with a "kicker" program that can provide incentives that require aspects like installed equipment data monitoring, follow up interviews, detailed customer address information, ongoing smart meter monitoring, these results would be directly applicable to upcoming C&S performance, prescriptive, and mandatory measures.

When initiating a data gathering effort to create a deemed measure for a hydronic technology such as an air-to-water heat pump, it's highly likely that detailed performance maps will need to be gathered from manufacturers. This information would specify the equipment's capacity and power consumption at an array of indoor and outdoor conditions, both in heating and cooling modes. These detailed data are sometimes but not usually publicly accessible in engineering documentation. This necessitates time-consuming and expensive interactions with the manufacturer to gather enough data to enable building energy modeling.

In addition to possessing this performance data for equipment, typical field conditions must also be known in order to appropriately estimate savings for a deemed measure or design a compliance credit (or prescriptive code requirement). Either as part of the initial development of a deemed measure, or through customer data generated as part of the measure implementation, site information such as temperature setpoints, typical space constraints on existing boiler equipment, and existing system configurations can be gathered.

All of these quantitative data are extremely informative but also expensive to gather. The range of use cases should be maximized beyond incentives and applied to compliance credits in parallel. Performance information and site data could also be applied to equipment test procedures. Eventually, the lessons learned from this program would be applied to building code measures.

Although enacting a C&S measure mainly involves quantitative aspects such as an energy savings and cost-effectiveness analysis, there are also a number of qualitative factors that must be considered as well, such as feasibility of complying with the new measure, equity considerations, and the potential for backlash of a vocal minority of consumers. In addition, mechanical designers could be identified through the program implementation process. The design community can be contacted and interviewed to learn about site-specific considerations.

Conclusion

The purpose of this paper is to revisit deemed as an option to bring measures into the C&S development pipeline. Although the connection between programs and code has been acknowledged for many years, in practice, this connection is not leveraged as actively as it could. Building decarbonization is a relatively new priority compared to energy efficiency. This paper explores this topic with a California-specific lens. CPUC has substantially reformed its policies and tools in a way that now provide major support to decarbonization-related efforts. We are claiming that deemed measures and programs can be developed more proactively in a way that includes C&S specific considerations, since C&S measures can have widespread positive impacts. Prescriptive programs are a potentially powerful tool to collect quantitative and qualitative data for use in future C&S initiatives. Deemed is certainly not always the appropriate type of intervention, since it can sacrifice nuance for program volume, but if designed thoughtfully, deemed programs can be a powerful vehicle to collect data and help transform markets. Given the urgent need to decarbonize buildings and reduce greenhouse gas emissions, all potential program avenues should be examined and leveraged to the maximum extent possible.

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