Energy Savings Prediction Methods for Residential Energy Efficiency Upgrades

Robin LeBaron, Kara Saul-Rinaldi, Steve Cowell[1]

I. Introduction

The home performance industry is comprised of a diverse group of stakeholders. From utilities to implementers, contractors to program managers, there is a wide range of opinions on what "works" to best advance the success of home energy upgrades. The Department of Energy's Buildings Technology Office (BTO) has witnessed the range of programs, software, and models.

In response to a recent request for information[2] from the Department of Energy (DOE RFI) on "how to improve savings prediction methods for residential energy efficiency upgrades," the authors draw from decades of work in energy efficiency policy and from four decades of experience in creating and managing residential energy efficiency programs to propose a way to incorporate integrating modeled and metered savings into residential energy efficiency upgrades.[3] We comment not as statisticians or building engineers, but as policy and program experts with a deep understanding of contractor business models and program implementer experience. In fact, E4TheFuture's predecessor organization, Conservation Services Group (CSG), sponsored the first meter-based program to justify the creation of EE programs in 1986 and had 30 years of experience integrating metered and predicted savings. Our comments focus on the cost implications of different savings prediction approaches, and the extent to which these approaches affect market actors' confidence and willingness to invest in efficiency programs and upgrades. On the basis of these observations, E4TheFuture advances recommendations about how savings prediction methods could be deployed to drive greater investment and uptake of residential efficiency upgrades.

It should be noted that the following comments explicitly discuss utility programs, i.e. programs funded with specially allocated ratepayer dollars. However, most of these comments would be applicable to situations in which a utility paid for efficiency

[1] Contacts: Cowell, E4TheFuture (671.816.4826 / scowell@e4thefuture.org) LeBaron (646.416.2650 / robin@pearlcertification.com); Saul-Rinaldi (202.276.1773 / kara@anndyl.com)

[2] BTO RFI (DE-FOA-0001472/0001)

[3] E4TheFuture founder and President Steve Cowell was the Founder and prior CEO of Conservation Services Group.

resources from private market actors without sponsoring a program, or to private market initiatives operating entirely outside of the universe of utility programs.

II. Modeled and Meter-based Savings

The DOE RFI observes that there is a significant difference between savings predicted prior to the upgrade by engineering models ("deemed savings") and building energy simulations ("modeled savings") on the one hand, and savings quantified after the upgrade on the basis of metered data ("meter-based savings") on the other. Both methods are open to error, but the "meter-based" savings are, as the RFI notes, widely perceived as being more accurate. However, there has been very limited experience with using meter-based savings as the basis for payment to contractors, aggregators or customers through program implementation. There have been after-the-fact meter based savings analyses for the purpose of evaluating the impact and effectiveness of programs on a portfolio level and adjusting modeled savings. These metered savings analyses can and should be used as test cases for use of metered savings more broadly.

Our experience reflects BTO's observation: that exclusive use of deemed and modeled savings has created three significant obstacles for success of energy efficiency programs and the market for residential energy efficiency upgrades:

1. **Costs**. Deemed and modeled savings require detailed data collection and reporting for the purposes of rebate collection, and the modeled savings approach often requires detailed data collection for the purposes of creating the building simulation model. Profit margins are slim in the residential contracting industry, and the significance of these cost burdens to contractors is significant.

2. **Perverse Incentives.** Modeled savings create both opportunities and incentives for error. In most cases, these errors are unintentional: they result from data entry errors or from a contractor's decision (driven by the cost burdens discussed above) to cut corners through methods such as using a typical home as the baseline rather than recording actual existing conditions. In some cases, contractors may deliberately tweak model inputs, for example by recording lower levels of attic insulation or a poorer blower door reading, in order to inflate predicted energy savings. Deliberate errors can be particularly significant when incentives are sized in proportion to the amount of energy saved.

3. **Confidence**. Homeowners and policymakers alike have difficulty trusting predictions. Deemed savings are often old, out of date or inconsistent with actual conditions in the home, causing multiple barriers. And utilities and public utility commissions have expressed doubts about the validity of modeled savings.

Meter-based savings methods can theoretically play a role in addressing each of these limitations of deemed and modeled methods. The introduction of AMI and real time metered data can introduce a dramatic change in the turnaround time for use of metered data.

1. Quantification of savings based on metered data, adjusted for factors such as weather, macro-economic conditions, etc., reduces need for a high level of pre-upgrade modeling precision, allowing contractors to use simpler, less data-intensive prediction methods. These methods could be standardized using existing tools, such as BEDES/HPXML, further decreasing transactional costs for contractors and program administrators.

2. Use of metered savings provides contractors with a strong incentive to generate "real" savings. Conversely, it reduces the potential for gaming the system by making adjustments to a model.

3. Meter-based savings could generate a significantly greater level of public confidence in the outcomes of energy efficiency programs, with the result that commissions and utilities would approach energy efficiency in a new way: as a reliable resource that can be depended upon to meet energy and capacity needs. This in turn could result in quantitatively and qualitatively different levels of investment in energy efficiency, as utilities actively seek to procure it to meet market and regulatory requirements.

Integration of Meter Based-Savings into Energy Efficiency Programs

The foregoing discussion notes the limitations of deemed and modeled savings methods, and describes ways that meter-based savings methods can address these limitations. However, it is important to note that meter-based savings methods are not a replacement for modeling. <u>Energy efficiency programs are most likely to be successful by combining modeled and meter-based approaches into a larger framework that allows both to play a role in driving market adoption of energy efficiency upgrades</u>. This is particularly true in markets where smart meters have not been widely deployed.

1. Predictions of energy savings are needed for programs that provide payments based on energy savings or where energy savings are a critical part of public policy for providing incentives so that any contractor, homeowner, or aggregator along with the utility or program sponsor can make reasonable investment decisions about the home retrofit based on predictions of the payments they can expect or long term funding decisions that need to be made.
2. Meter-based savings analyses are necessary to ensure that financial payments on a portfolio basis are made for energy efficiency actually delivered, and to

generate the public confidence in the program that allows it to be seen as a key energy resource, and funded accordingly.

3. Meter-based savings analyses can generate the data that will allow more accurate determination of the drivers of energy savings, including both specific measures and “soft” considerations such as contractor training and experience. New technologies such as smart devices that provide more granular information about a home’s energy performance will further support these analyses.

Important Policy Considerations for Metered-Savings Programs

The discussion above focuses on the way that meter-based savings methods resolve some of the problems of traditional modeled and deemed savings. However, it is important to note that meter-based savings methods must address many of the obstacles that faced the predictive models, and a few new ones as well. It is crucial that these problems be addressed before a program based on a combination of modeled and meter-based savings is launched.

Risk: A program that makes payments on the basis of meter-based savings will push the risk of realizing those savings to the contractor and/or aggregator[4] unless specific steps are taken to allocate the risk among all parties. This risk lies primarily in the fact that, even if a contractor implements energy efficiency measures perfectly, in any given project the occupant behaviors, composition or occupancy may partially or entirely negate the energy savings.

- ➔ It is assumed that if projects are aggregated in sufficient quantities, the risk will be reduced as outlier occupant behaviors will become statistically irrelevant although few contractors may have the volume needed for adequate levels of aggregation.[5]

Upfront costs: A program that makes payments on the basis of meter-based savings also runs the risk of creating a significant interval between the time that a contractor implements a home upgrade and the time that the savings are established through analysis of post-upgrade meter data. This requires the contractor and/or aggregator to cover the upfront costs of the upgrade for a significant period of time, effectively imposing on the contractor/aggregator the burden and risk of financing cash flow costs.

- ➔ There are key financing models that address these upfront costs at little burden to the homeowner or contractor: Property Assessed Clean Energy (PACE)[6] and On-Bill Financing are two clear methods to support home upgrades.

[4] An aggregator could facilitate this model by working with multiple contractors to bundle the energy savings into a form that can financed and/or sold. Aggregator models do not currently exist in the residential energy efficiency industry.

[5] As a practical problem, the number of projects for behavioral factors to have minimal impacts may be larger than most home performance programs currently generate on an annual basis.

[6] PACE for residential only exists in its most robust, non-subordinate-lien form in CA. There is a national effort underway to advance a successful PACE residential model nationally with the support of HUD.

- ➔ Theoretically, upgrades with a proven track record for reliably creating energy savings could be financed in aggregation with payments made, at interest to the contractor/aggregator, for partial rebate incentives upfront.

Access to utility data: Access to pre and post utility data is required to ensure that contractors and aggregators can correctly model homes and gain the data for the energy savings.

- ➔ California has a new data access law that will allow third-party access to interval meter data. This does not exist in other states though is under consideration by PUCs.
- ➔ Utility operated programs acquire and store data and can make it available.

Value of Data: The energy savings only have value if there is a buyer who will pay enough for the energy savings to make the aggregation, contractor participation, and homeowner incentives worth the effort.

- ➔ Programs could distribute existing ratepayer funds through a "pay-for-performance" mechanism. However, if a capacity and/or carbon market[7] were to exist alongside an energy efficiency registry to bank the energy savings, additional funds could be made available to support residential energy efficiency upgrades.

Potential for gaming the system: As noted above, perverse incentives can lead to gaming in the predicted model. In the meter-based model, savings could be gamed by contractors if a contractor identifies a way to report savings that result from changes in occupancy or other factors, rather than installation of energy efficiency measures. Some early "pay for performance" programs experienced gaming of this nature, where contractors merely chose clients who, for example, had recent high school graduates (thus reducing occupancy).

- ➔ The energy efficiency industry has the tools to prevent such gaming: these include requirements for data standards-enabled reporting on measures installed, combined with robust, and possibly device-enabled EM&V. The real costs of this QA/EM&V should not be ignored or dismissed to ensure legitimacy in payments.

Customer equity: If the prime driver of the program is energy savings, then larger homes will be the target customer and smaller homes will be overlooked.

- ➔ Public policy initiatives can address the failures and limitations of the market by providing additional support to low-income or other underserved communities.

The policies to drive financing (PACE and On-Bill Financing), as well as data access and data standards-based EM&V, are explained in DOE's SEE Action September 2015 report: "A Policymaker's Guide to Scaling Home Energy Upgrades"[8] and should be considered with this submission.

[7] This may also be predicated on the creation of a national energy efficiency registry. One is already being developed by E4TheFuture and The Carbon Registry for use with the Clean Power Plan.

[8] https://www4.eere.energy.gov/seeaction/system/files/documents/residential

Conclusion
Predicted/modeled savings and metered savings are inextricably linked for successful programs. Using this linkage and best-practices for program design are crucial to the success of either pathway to home performance. It will be important that states and utilities which move forward with programs that rely on customer/contractor/aggregator meter-based savings to ensure the policy and program conditions outlined in this submission have been sufficiently tested before they are deployed on a large scale. Failure to plan, test, and implement solutions to these problems could result in the destruction of existing program infrastructure, as contractors are forced out of business by failure to manage the risks and cash flow challenges inherent in the new programmatic model. The ideal model will emerge from the marketplace. However, as these models are developed, we recommend that they include the modeled energy savings (with a base incentive) while combining it with an additional financial reward for metered savings. This would ensure data is gathered for further analysis, assist in realization-rates by aligning contractor incentives with savings, and ensure contractors are not penalized for homeowner-behavior performance out of their control. In all cases, public investment in energy efficiency needs to incorporate standards and quality assurance protocols that ensure consumers receive quality work but do not impede the market.