# Evaluation Evolution: Leveraging Data Collection Standards for EM&V and Other Analysis

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## ABSTRACT

In the past decade, energy efficiency program evaluation and data collection efforts have increased to unprecedented levels, but in many cases the data were collected in different formats using different conventions. The disparate forms of data have led to incompatibility making it difficult to combine what should be similar data to produce meta-analyses with more comprehensive samples of real buildings and energy efficiency measures. National and regional groups have recently developed data collection protocols and transfer standards in an effort to develop robust datasets for further analyses beyond their original short term use by the organization which undertook the study. The effort of overlaying various standards to describe buildings for benchmarking and energy simulations as well as the associated end-use load shapes is the next frontier.

What will we, the evaluation community, develop as new approaches that leverage the data created using the new standards and protocols? This paper explores the use of data collection standards and looks to utilize different types of end-use metering data to develop a baseline for impact evaluations. Future evaluations and baseline studies can then collect additional data under traditional or new sample designs using the same data collection standard and possibly supplement past studies with small sample sizes. The ultimate benefit is the feedback loop this creates where data collected under various studies could feed into new load shape studies and deemed savings assumptions in updates of technical reference manuals around the country. Adopting standards for data collection potentially could save money in the future when the data can be combined to enable analysis across programs and utilities.

This paper explores a specific example of the potential benefits of using one regional data collection standard designed for compiling lighting load shape data. The first step was to establish a protocol and then implement it on some real data. Lighting data was compiled from past studies. Additional protocols for other end-uses were developed in addition to lighting. This paper describes how current evaluations will be able to utilize the load shape protocols to support future analysis across data sets. This paper also cites other national data standards and protocols that may be relevant to making some widely applicable load shapes including lighting more universal.

## Introduction

In the past decade, energy efficiency program evaluation and data collection efforts have increased to unprecedented levels. But in many cases the data were collected in different formats using different conventions to achieve different objectives. The disparate forms of data have led to incompatibilities that make it difficult to combine similar data to produce meta-analyses with comprehensive samples of real buildings and energy efficiency measures. There are several compelling uses of evaluation and program data that is gathered according to established standards and protocols. A primary use case for the combined data analysis is validation and calibration of existing load shape and savings estimates. The data may also be used to inform program design and used in new energy efficiency implementation strategies.

After giving a brief overview of these broad uses of consistently compiled data, we describe the development of a particular data protocol. We then review other protocols for data collection, analysis, and evaluation methods, and discuss the relationship of evaluation protocols to data standards. Finally, we consider what future evaluation might look like with adoption of consistency in data collection and analysis tools and methods.

### Validation and Calibration of Estimates

Energy efficiency program and evaluation information can be linked to interval meter data to develop a calibration, or "true-up", of savings estimates. Initial estimates of savings are often based on assumptions about the general population or eligible populations for a program. Historically have been static values that took large projects and stakeholder engagement processes to change. In the future, a more dynamic process can be achieved where the algorithms or benchmarks are vetted and the actual inputs from participant buildings and systems along with actual consumption and weather data are used to continuously estimate future savings and document achieved savings.

A clear benefit of this validation and calibration process is that of lending statistical merit to energy and demand savings that might be used in system planning. A typical prerequisite of being considered a full asset on par with generation is the assurance that the savings exist at a high level of confidence. Calendar year evaluations can instill confidence in savings estimates, but can elicit concerns that changes in participant or building demographics where measures are installed might cause them to be imprecise over time. The ability of standards to assist in the aggregation of longitudinal data helps allay much of these concerns and can offer highly reliable impact estimates that are better suited to withstand scrutiny.

Another value of developing calibrated estimates is to produce predictive results using recent weather and potentially predicted climate change. Normal weather based on the most current five to ten years may offer better predictions of the benefits of energy efficiency in changing climates.

### Additional Uses of Standards – Planning, Design and Implementation

A robust dataset of measure performance and impacts can provide a powerful tool for marketing efficiency and assisting in program implementation. Natural extensions of the data would include its use in case studies, refining ex ante savings estimates and in assessing cost effectiveness. In this manner, data standards might be expected to generate efficiencies in each of the primary phases of the program cycle: planning and design, implementation as well as evaluation.

The connection of robust data to analysis tools on web-accessible servers allows for powerful simulations based on measured data. Tools developed by DOE, LBNL, and Stanford are allowing simulations to be coupled with actual control algorithms. This allows controls programmers to simulate the impact of controls changes and then implement them rapidly in real buildings. With sensor data feeding back to the new controls the simulations can also be updated allowing a constant iterative optimization process of estimating potential savings from changes and then measuring to determine the realized impacts.

In addition, programs can be designed around linked data and web or mobile messaging. Similar to the concepts of residential behavioral programs, inter office networks can send energy efficiency data and feedback. The lowering costs of simple measurement devices and open-source developed programs open new possibilities to connect the information and produce simple and effective results (Curry 2013).

## Data Protocol Development

This story begins with a regional group's struggle with pooling past evaluation data from lighting loggers to develop load shapes that can be used across utilities and electrical grid operators in the Northeast.

Based on the challenges faced in that study, the regional group recently developed data collection protocols and transfer standards. The goal of the effort was to develop robust datasets for further analyses beyond their original short term use by the organization which undertook the program evaluation. The effort of overlaying various standards to describe buildings for benchmarking and energy simulations as well as the associated end-use load shapes is the next frontier. The figure below illustrates the incompatibility issue as well as a vision of how various standards can improve the framework and provide a more dynamic feedback loop.

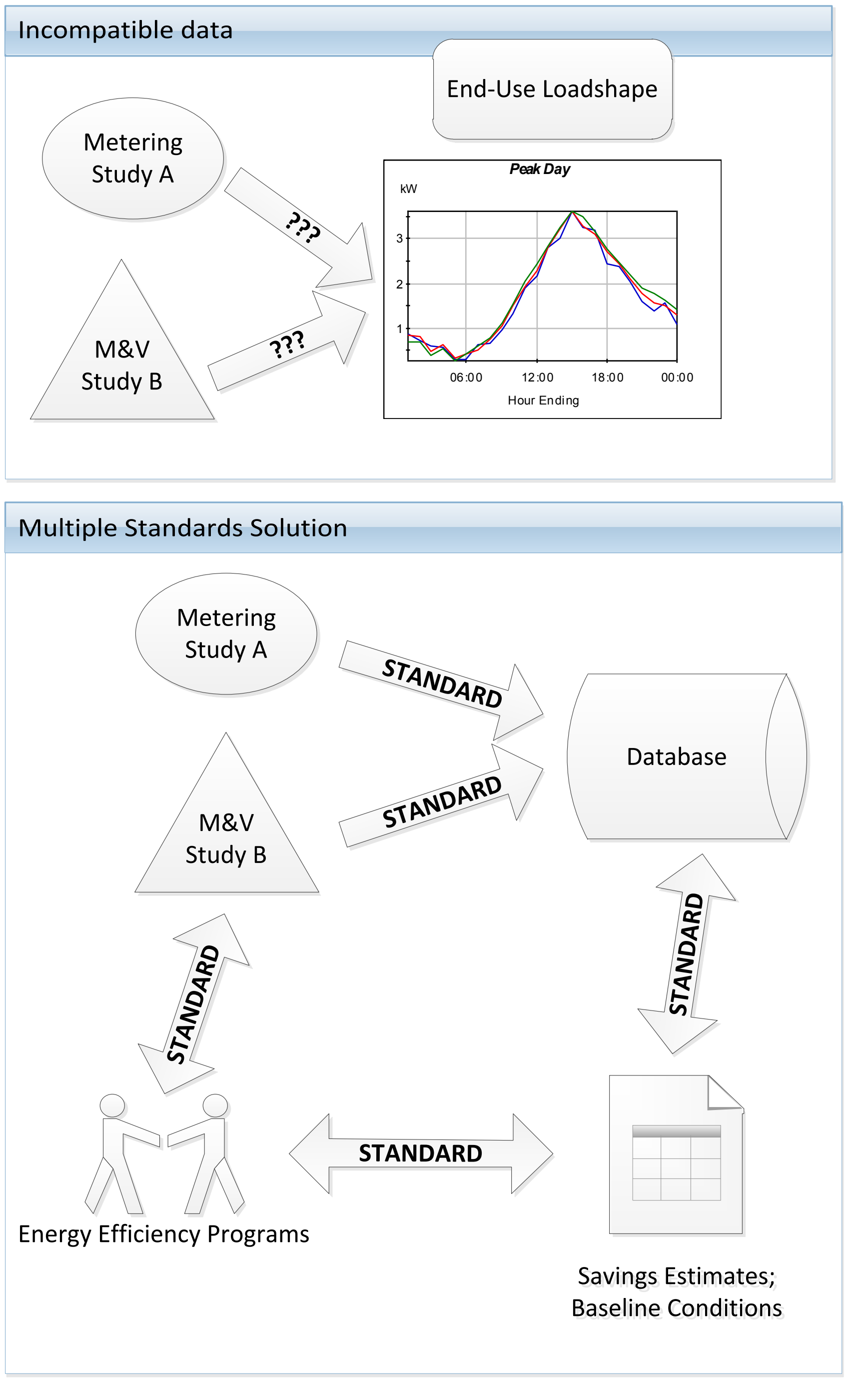


**Figure 1.** Illustration of Data Standards Role in Energy Efficiency and Load Shape Studies

## Current Load Shape Protocols

Nationwide, energy and energy efficiency investments are based – at least in-part - on estimates of consumption and potential savings for end-uses such as lighting, appliances, or HVAC equipment. In the past, annual or seasonal energy end-use estimates were sufficient for making these investment decisions. However, these annual and seasonal load shapes lack the granularity to make some investment decisions in today's market. Today, hourly profiles are required to calculate, among other items:

- Dollar savings of energy conservation based on time-variable avoided costs
  - Typically the avoided costs are used in energy efficiency cost-effectiveness tests
  - More and more the customer's electric rates are also time variable
- Capacity savings
  - In today's energy market, capacity savings can be a large component of cost-effectiveness of energy efficiency programs.
  - To the extent that a utility builds / buys peaking resources by a defined hourly (or daily) peak value, hourly load profiles assist in more accurately assigning avoided capacity costs to utility programs and for Forward Capacity Market bids to Independent System Operators
- Peak coincidence of power draw and demand reductions through energy efficiency and demand response programs, and
- Greenhouse gas emission reductions based on time-variable mix of electricity generation.

To meet this need for load shapes, the energy and energy efficiency industry often relies on existing load shapes, some of which are either old, not seasonally variable, or are simulated with no to little data supporting the simulations. Obtaining updated, empirically-based hourly load shapes is paramount to better informed investment decisions. A clear way to develop such updated load shapes is through the performance of an independent metering study to gather end-use usage data for desired load-shapes. However, this is often deemed cost prohibitive due to the expense of metering equipment and necessary field time. An alternative, equally empirical method of determining load shapes is to develop them through the compilation of end-use meter data from past program evaluation studies. The challenge of this compilation approach is that the evaluations with meter data were not likely to have collected data in consistent formats with consistent methods. The compilation approach may also be problematic when used to represent new or changing populations. For example, if the data becomes out of date for its original purpose it would also be likely be out of date for a compilation study.

## Lighting Load Shape

In 2010, a regional study in the Northeast was commissioned to develop Commercial and Industrial (C&I) lighting load shapes based upon the compilation of logger data previously collected from across the region. The long history of evaluations in the Northeast provided a particularly deep and rich resource from which to mine for lighting metered data. The data sources gathered consisted entirely of interval lighting meter data collected for evaluating energy efficiency impacts. All of the data were mined from existing data that consisted of short-term (typically 3-4 weeks) metered data of interior C&I lighting equipment that was installed through an energy efficiency program. A total of 3,780 loggers were compiled in this effort. A load shape tool was the primary study outcome.

The process of compiling this data was arduous. The data was located in disparate locations, among different companies and in different structures and formats. To be useful, the logger data itself had to be pulled together along with all of the critical information needed to properly use it in the aggregate analysis. This often required reviewing original analysis sheets to capture the information necessary. Fields that needed to be gleaned and assembled for the load shape work aside from the logger data itself included:

| Logger Level Data | Site Level Data |
|---|---|
| • Connected kW associated with the data | • Building type where logger installed |
| • The start and end dates in the data | • HVAC type |
| • Logged Fixture Control type | |
| • Logging Method and unit | |
| • Room where installed | |

Although cheaper and more efficient than performing a primary metering study, gathering the information needed to create the generic C&I lighting load shapes and the load shape tool was intensive and time consuming. It was clear that a protocol would be useful that would maximize the usability of data collected in future meter-based measurement and evaluation studies, or metering studies to develop end-use load shapes. Usability implied the need for the protocols to address data availability, accessibility, standardization and documentation of the vintage of the data and the population studied. In 2011, an effort to develop such protocols was commissioned in the Northeast. Load shape data collection protocols were developed to accomplish the following:

- To specify recommended primary and secondary data items that may be collected for a range of residential and commercial/industrial end-use categories, with a focus on defining and organizing data in a manner that would be familiar to energy efficiency EM&V practitioners in order to minimize inconsistencies and enhance accessibility.
- To specify a user-friendly data structure able to be used in multiple file formats that will facilitate electronic data transfer.
- To develop comprehensive, detailed and user-friendly documentation of the protocols available for inclusion with requests for proposals.

**Protocol Development**

The protocols were designed to facilitate the integration of data that are collected during different time periods or within different sampling frameworks, including instances where metered data might be combined from different seasons. In developing the protocols it was also important to consider how to handle actual metered versus modeled or extrapolated/normalized data as well as how to treat sampled data or data collected within multiple locations at the same site and extrapolated to the entire site. The protocols were intended to recognize that the benefit of compiling data is most useful when it is done in a way that facilitates its statistical analysis among the compiled data. This means that added information necessary beyond the primary data collected should be gathered including the objectives of the study performed, the population sampled[1], the characteristics of the buildings where the data was gathered and caveats on the accuracy of the data itself.

The protocol was developed in the form of a dedicated spreadsheet for each measure type along with accompanying documentation. Having a separate spreadsheet for each measure type relieved the protocol from having to conform to a single format and allowed it to maximize data collection resolution when needed. The protocols were designed to gather information at each level of data collection aggregation from logged component, to circuit or system, to the building, and to the study or project. Figure 2 below presents a diagram that illustrates the concept behind the protocol, using C&I lighting as an example.

[1] The information about the sampled population includes the stratification variables and the sample weight associated with an individual meter file. The protocol focuses on documentation and allows for any sampling and stratification option.

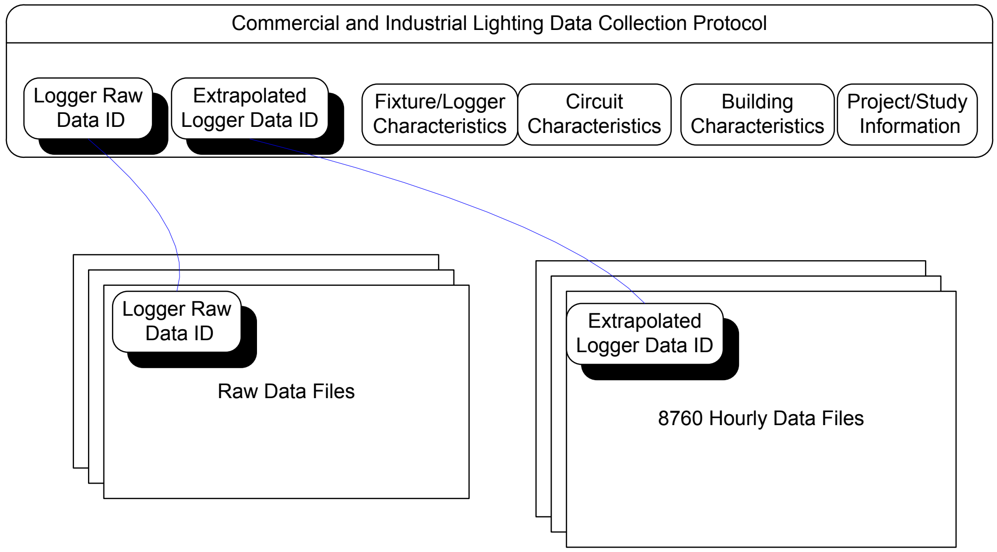


**Figure 2.** Diagram of C&I Lighting Protocol

In this diagram we show the micro-to-macro type progression starting on the logger level, and progressing to higher levels of the circuit level, building/site level, and project/study level. Each row in the spreadsheet may include a link to a load shape dataset or to a collection of standard files. This is further described below:

- **Metered data level** (logger raw data and/or extrapolated logger data) – contains a unique meter identifier (ID) that maps to the actual metered dataset along with information on the logger make, model, calibration date, logging method (interval, event, etc.) and end and start times of logger data.
- **Fixture and circuit characteristics** – contains information on the location and kW of the logged circuit and how the circuit is controlled.
- **Building/Site level** – contains type and location of building, HVAC system information applicable to logger location, and other demographic information such as size, age, etc.
- **Study/project level** – contains information on the nature of the study that produced the data, including study sponsors, firms conducting the study, year of study, and contact information.

### Additional Protocols and Issues

As part of the same effort to develop the lighting load shape protocol, additional protocols were developed for other end uses including HVAC and commercial refrigeration. The additional protocols presented new issues specific to the end-uses and the associated differences in end-use metering approaches. For example, the load shapes for weather dependent end-uses such as HVAC are less transferable than measured data on lighting. For HVAC, there are many options for data collection and analysis to develop load shapes. Some studies have produced load shapes using building simulations calibrated to monthly billing data, while others performed various forms of end use metering. There are also a number of contextual variables that affect the load shape including several building characteristics.

The load shape protocols provide a format for documentation of study or project results and do not fully specify all variables at all levels nor the methods to collect the primary data. To date, we do not believe the load shape protocols have been fully exercised although they are available for use and inclusion in RFPs.

Fortunately, key national standards emerged in 2011 and 2012 to address the issue of methodology and standard building information. These efforts include the Uniform Methods Project (Jayaweera et al. 2013) and Building Performance Database (US DOE 2013), described below, both funded by the US Department of Energy (DOE). For the load shape protocols, these efforts provide complimentary standards necessary to specify contextual building information and the minimum methodologies for evaluation studies across the country.

## National Standards for Evaluation Methods, Data Compilation, and Data Analysis

In the past two years, the US DOE has supported specific standards for energy efficiency evaluation as well as broader standards on collecting energy use and building characteristics data. Over the years, there have been a number of efforts to provide guidelines and specific protocols on how to evaluate particular types of energy efficiency projects and programs such as the International Performance Measurement and Verification Protocols (IPMVP) and the California Evaluation Protocols. The open exchange of ideas, the development of state-level evaluation protocols, and the publication of national guidance documents all have helped to improve evaluation practices and to make demand-side resources more credible to system planners.

### DOE Uniform Methods

Load shape development requires a basic understanding of the methodologies used in the current and past studies to determine if the meter data can be combined for analysis. Some state and regional guidance documents existed, but there was no national standard. In 2012, the DOE began developing a national guidance document on best practices for particular energy efficiency program types (Jayaweera et al. 2013) in response to a confluence of developments. A key motivation was the introduction of legislation requiring DOE to establish measurement methods for energy efficiency savings. While the legislation was *not* passed, the DOE wanted the development process to progress forward in the event that a similar requirement may be imposed in the future. Thus, a set of national methodologies emerged that can provide more consistent meter data for load shape studies. Also, in recent years, many states that had previously seen very little energy efficiency program activity have begun running programs.. The DOE wanted to help these states use evaluation methods that meet some basic, minimal standards.

The DOE, through the National Renewable Energy Laboratory, commissioned the Uniform Methods Project for Determining Energy Efficiency Program Savings (UMP). UMP is a basic set of evaluation methods consistent with the perspectives of a broad spectrum of energy program evaluation experts. The UMP methods do not all include end use metering. The most notable protocols that include metering are the lighting and unitary HVAC protocols. Developing standards for M&V has always meant balancing a need to ensure appropriate methods are used with a need to allow evaluators to develop new methods that advance the field. One gap in the UMP lighting and unitary HVAC protocols is specification of collected and contextual data and analysis results. The load shape protocols and building performance database help fill these gaps for UMP methods that include meter data.

### DOE Building Performance Database

The load shape protocols have little detail specifying the building characteristics where end use metering data was collected. In a separate effort through Lawrence Berkeley National Laboratory (LBNL), the DOE commissioned the Building Performance Database (BPD). The development began by defining a common taxonomy of building characteristics and an associated data transfer protocol. The overall vision for this effort had multiple goals including providing more accessible data on real building characteristics and energy consumption for future benchmarking. Another goal was to establish the database as the central hub for other efforts such as energy analysis and building simulation tools that can be developed separately and access the database to perform analysis. In that framework, experts and developers can leverage the characteristic data that were previously in many forms and difficult to access. The data transfer protocols are designed in XML, a schema for defining database records that is open source and being used by other standardization efforts. Prior to the building performance XML, a schema called Green Building XML (gbXML) was developed for new construction projects to transfer data between architects, engineers, and consultants working on energy efficiency and LEED performance calculations.

The BPD relies on the Building Energy Data Exchange Specification (BEDES), a data format designed to support energy savings analysis for commercial and residential buildings. The data specifications cover energy consumption, building characteristics an, and energy efficiency measures. The BEDES was designed for the BPD and other DOE tools, however the DOE has now begun to work with energy efficiency experts and stakeholders to determine use cases for BEDES.

The BPD is the data repository and the BEDES is the data exchange protocol and both are part of the DOE's Standard Energy Efficiency Data (SEED) platform. SEED is a software tool for analyzing potential energy efficiency benefits a large portfolio of buildings for building portfolio owners including state and local governments. The tool integrates with EPA's Portfolio Manager and the DOE Asset Rating tool. SEED also allows linkages to external datasets such as property records, ASHRAE energy audits, and other site specific data. Selected data can be published or shared via an open Application Programming Interface (API) and data can be directly exported to BPD. The data and analysis results can be used to track internal energy efficiency efforts and share data with third parties or investors.

### Universal Translator M&V Tool

Many energy efficiency portfolios include custom programs for non-residential projects. The projects often include end use metering that may be useful in load shape development if collected consistently. The UMP does not address custom energy efficiency programs. LBNL is developing an interface and new features for Pacific Gas and Electric's Universal Translator (UT)[2]. The UT is a publicly-available tool for managing, analyzing, and visualizing field performance data, such as building plug and lighting loads, equipment run times, economizer operation, and set-point control. The tool has the potential to be useful in other applications, such as Fault Detection Diagnostics (FDD) and Measurement and Verification (M&V).

### Data Transfer Standards

Data transfer standards have also been evolving in parallel to data collection and evaluation standards. These efforts specify a structure for data be transferred to and from standard databases such as BPD or a database built using the load shape protocols. Relevant examples of data transfer standards include residential standards developed by Building Performance Institute (BPI) and non-residential standards developed by a group of industry experts. For residential whole house projects the BPI began development of a Home Performance Data Collection Standard and a transfer protocol, HPXML. The standards were aligned with the DOE Building Performance Taxonomy and the Homer Performance standards further address non-energy issues such as combustion safety and financial information related to retrofits. Additional efforts at NREL are also developing a database in HPXML format of homes from across the country as well as the billing data associated with each home for further calibration and analysis.

A standard model has also been developed for combined energy efficiency and renewable projects or Integrated Energy Projects (IEP). A 2012 paper at the ACEEE Summer Study details the development (Johnson and Kelsey 2012). For retrofit projects information must be passed among multiple stakeholders.

[2] The version of the Universal Translator (UT) prior to the addition of features by LBNL is available at www.utonline.org.

The authors proposed a new open-source platform for information exchange to avoid projects being slowed due to the exchange process. In their own words the authors summarized:

*The concept is analogous to the development of HTML as the primary enabler of the Internet economy. HTML became the common platform that allowed for quick and effortless data exchange that then led to the emergence of the e-commerce industry. Similarly, quick, reliable and secure exchange of data for energy efficiency (EE) and renewable energy (RE) projects can minimize green clutter and enable the delivery of significantly more efficient and profitable EE and RE projects.*

*The authors developed the IEP Model under funding from the California Solar Initiative (CSI) Research, Development, and Deployment (RD&D) Program: a new open data model based on an XML framework to share IEP information. The model focuses on the common data shared among stakeholders during the lifetime of a project including historical energy use, affected building and energy systems, customer data, proposed upgrades, energy costs and related products. The IEP XML schema documentation is publicly available for energy software developers to implement interoperability with other tools (kW 2012b). The intended users of tools implementing IEP are utility programs, rating programs (e.g. LEED), ESCOs, contractors, customers, and financing entities. Each of these stakeholders can use the model as a means for faster and more effective sharing and storing of relevant IEP data.*

## Using the Standards in Future Evaluation

The various standards for load shape and building data collection and data transfer alone will not dramatically shift energy efficiency program evaluation. It will still take the combination of experienced evaluators and innovative programmers to realize the potential of the data standards. One benefit of the open source standards is that they do not limit possibilities. The standards are building blocks and a platform for incremental innovations in the way evaluations are conducted and the opportunity for more productive leaps in innovation. There will be a period of adoption and a longer period of translating existing data into the standard formats, but we can plan for the areas of incremental improvements and to a lesser extent we can present possibilities beyond anything we are currently anticipating. In this section we explore how the standards will begin to gain traction, how the results may begin to show up in actual energy savings estimates, and finally, discuss some ways in which the standards may begin to weave into actual program design and implementation.

### Incorporating Standards in Evaluations

The load shape and other data collection protocols are not intended to dictate or specify what data will be collected in future projects, but rather to shape the manner in which common data from different studies is gathered and stored such that it becomes more usable for meta-studies and load shape development studies, when the data being collected is applicable.

The incorporation of standards has already begun with the voluntary adoption by the evaluation community. For example, New York home performance programs are piloting HPXML and the CPUC is reviewing multiple standards including IEP XML for data warehousing of energy efficiency evaluation data. In some specific current projects the authors are leveraging various draft standards to define data collection and also specify the analysis using initial data from the field. Currently, the early users are the same individuals who are working on the draft standard working groups and development committees. Wider adoption of the load shape protocols, UMP, and data transfer standards is just beginning to be undertaken by utilities and regulators who are not as experienced in energy efficiency.

A primary use of the data standards would be as an attachment to evaluation RFPs to specify a format for final delivery of data in addition to a report deliverable. The data protocols also do not prescribe a required level of disaggregation for data collected in M&V projects, nor do they require specifications for

M&V project approaches or sample designs. The data protocol is intended to aid in developing consistent data that is collected as part of M&V studies so it can easily be organized and used in appropriate savings and end-use load shape development.

As utilities and regulators start asking for standard data in RFPs then a more direct method of populating open-source databases such as the DOE BPD will be realized. This will mean there are enough data to begin developing new algorithms to analyze those data and linked data, such as real weather and other user inputs. The authors envision one key area of utilizing the data would be developing baselines for early replacement of equipment. Another area of development of baselines would be for energy efficiency measures such as system maintenance, retro-commissioning, and other cases where an energy code or appliance standard does not define the baseline conditions used to estimate baseline energy usage.

**Building a Better Baseline**

An obvious use of the standards is incorporation in baseline and potential studies that will be collecting new data that will inform updates of deemed savings and technical resource manuals (TRMs). A clear advantage of the standards would also be that energy efficiency programs and program evaluations could collect similar data that can be compiled to form a baseline from past and current participants. We acknowledge that there are some issues with developing baselines from even standardized approaches that take continued effort to overcome, including potential data collection biases that are inherited into subsequent analyses and regional variations that might get diluted among a larger data set. However, we contend that these issues can be better mitigated and handled when standard protocols are able to provide the necessary data to do so. While we also note that the definition of the baseline(s) developed will continue to be driven by the various data sources compiled regardless of whether the data was gathered via a standard protocol or a project specific one, a standardized approach will greatly assist in exploring, examining and understanding what programs, customers or technologies the baseline represents. The DOE BPD can be leveraged in baselines for savings estimates if more data can be fed in. There are a number of other reasons for continuously collecting and compiling data other than impact estimate baselines, including market share tracking and estimating market effects and spillover over time.

Many datasets underlying current baselines and deemed estimates will take significant time to translate into the new formats and new projects will also take significant time to compile data in the standard formats. In the next year, there will not likely be many energy consumption baselines adjusted based on standard data. The effort is likely to take shape for whole building residential and non-residential retrofits where there is no deemed savings estimates.

There are some current efforts by program administrators and planners to compile residential data in an effort to move customized residential retrofits into a deemed approach. In addition there are some initial efforts to benchmark residential savings estimates from new and untested software against utility billing data in order to validate the estimates or provide a way for multiple software options to be used in programs as opposed to deemed estimates. As the databases become populated, these efforts may be the first use cases for the data in informing either savings algorithms or average baseline conditions. Clearly while the data from common project level data collection can be compiled after the fact, standardized data approaches have the ability to more efficiently and effectively facilitate the ability to move away from prescribed or deemed savings estimates.

Over many years the database will develop and evaluators and software companies can utilize the data sets for rapid development of evaluation products. There could be standard algorithms from the UMP applied to data as they are collected by programs. UMP is a minimum set of standards. The evaluation role would continue to evolve in developing enhanced algorithms that go beyond and eventually improve upon the UMP. Evaluations will also continue to fulfill the need to collect data that was not collected during program implementation.

Having repositories of thousands of buildings and systems data will be even more beneficial by providing the raw data needed to establish the uncertainties around inputs and effect on savings estimates. Currently, evaluations report on the precision of gross savings estimates based on statistical sampling principles and in some jurisdictions also require details on measurement equipment accuracy to be reported. This often leads to a situation that does not take into account that the reported uncertainties are usually better than the unknown uncertainty of deemed estimates or baseline assumptions. Performing statistical tests on the databases not only allows for the baseline assumption to be grounded in real data, but also provides an estimate of the uncertainty and a distribution of the known range of values. This also allows evaluators to design targeted studies to collect data on the most uncertain parameters. Knowing the relationships of the inputs and distributions of values for the inputs a propagation of error analysis and Monte Carlo simulations can be used to translate input uncertainties into usage and savings estimates and uncertainties. In all of these applications, it will be necessary to address the representativeness of the available data.

## Conclusions

The ultimate benefit of the various data standards described in this paper is the feedback loop created where data collected under various studies could be used to develop new standardized load shape studies, provide the basis for updates to baselines, and inform deemed savings assumptions in technical reference manuals around the country. Adopting standards for data collection potentially saves future dollars spent to combine and analyze data if the future data is collected in a way that can be combined with other relevant data for a robust analysis. One can envision that the higher the scale at which the standards are developed and adhered to, the greater the opportunity to leverage those efforts for subsequent needs[3]. Conceptually, at whatever level they are employed, data standards will enable a better defined exchange of data that will ensure integrity when analyzed by secondary users. In addition, broader benefits of standards are likely to include an easier ability to examine, explore and resolve conflicts in M&V data among different jurisdictions, possible reductions in duplicative metering efforts, and development of a framework for the sharing of other data among participating entities (such as simulation data and/or load shape tools).

More specific benefits include:

- Continuously updates savings potentials- Meta load shape data can be incorporated in baseline and potential studies that will inform updates of deemed savings and technical resource manuals (TRMs). Having repositories of thousands of buildings and systems data will be even more beneficial by establishing uncertainties of inputs and estimates.
- More rapid development of evaluations- Over many years the database will develop and evaluators and software companies can utilize the data sets for rapid development of evaluation methods and products. The connection of robust data to analysis tools on web-accessible servers allows for powerful simulations based on measured data. Tools developed by DOE, LBNL, and Stanford are allowing simulations to be coupled with control

[3] Imagine you are at IEPEC 2021. Data collection standards and uniform transfer protocols have been adopted by most of the energy efficiency evaluation community. Many of the conversations question whether the futurist speaker at lunch of IEPEC 2011 was correct in his initial predictions. Long time attendees are excited to hear from new panels that have attracted speakers from the high tech industry. Since the development of standards, programmers have developed novel program designs and evaluation techniques.

algorithms. Similarly new calculations and algorithms can be tested on the existing data set before they are implemented in new evaluations.

- Calibration of savings estimates- Energy efficiency program and evaluation information can be linked to interval meter data to develop a calibration, or "true-up", of savings estimates. A clear benefit of validation and calibration process is that of lending statistical merit to energy and demand savings that might be used in system planning.
- More robust efficiency services marketing- A robust dataset of measure performance and impacts can provide a powerful tool for marketing efficiency and assisting in program implementation. Such a tool would provide particularly robust datasets to small utilities and parties that might not otherwise have access to such rich data to inform program designs and operations.

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