Getting Real on M&V 2.0 Standards:
The Need For and Approach Necessary to Create Standards for M&V 2.0
Background

With the growing interest and focus on data driven, automated methods to measure energy efficiency, known as “M&V 2.0,” it’s time for the energy efficiency (EE) industry to get serious about developing standards. This document presents EnergySavvy’s vision for successful standards that can support advancing the energy efficiency industry and more broadly integrated DERs.

The purpose of this document is to explain our vision of success for standards around a common set of calculation methods for M&V 2.0. We begin by explaining the industry context for standards and why the status quo is insufficient. We then provide fundamental principles inherent to any successful industry standard and the stakeholders to be involved. We conclude with a tactical roadmap and raise caution on concepts that have zeal but are unproductive.

While EnergySavvy is a for-profit company, we see ourselves as part of an industry ecosystem and believe that open industry standards can promote societal success and market success as a whole. EnergySavvy believes in the transparency of our work, and enables clients and others to inspect its software source code and inspect its methods. We have worked on energy efficiency standards (e.g., HPXML, etc.) for over half a decade, have performed M&V 2.0 calculations on approximately 5 million meters for energy efficiency programs across the country and had our software reviewed and tested publicly and privately by numerous M&V firms. We have decades of experience in software standards, open source and proprietary software and data science. We serve more than 30 utilities across the country, including around 50% of the top energy efficiency utilities as ranked by ACEEE, and most of the major statewide energy efficiency providers. We offer our breadth of experience to support the development of an industry standard for M&V 2.0 that can help the industry scale and mature.

Overview and Industry Context

One of the great promises of M&V 2.0 is that it can bring a higher level of transparency, rigor, and manageability to energy efficiency. It may also enable market-based, pay-for-performance or procurement type delivery models for energy efficiency. M&V 2.0 is likely to modernize energy efficiency market segments or policies that include, but are not limited to, residential retrofits/remodeling and real estate, utility non-wires solutions, commercial energy services, and tracking utility/state emission reductions from energy efficiency programs. Clearly many of these sectors are performing well and have the data necessary to make decisions and drive energy efficiency investment. For example, more often than not, FICO scores work well for assessing consumer credit for retrofit financing. Similarly, ESCOs have leveraged performance contracting to sell more than an annual $6B in efficiency projects based on proprietary payback calculations that are trusted by public and private building owners.

While we acknowledge that there are a host of various M&V protocols and frameworks, interoperable and common standards to measure energy efficiency that can be used across the industry still do not exist. The creation of a suite of M&V 2.0 measurement standards for energy efficiency can unlock innovation, investment and new approaches to increase the scale of energy efficiency at more efficient costs. To achieve this goal, we need reliable and consistent accounting, i.e., “one set of books” with generally accepted, transparent and interoperable methods across applicable sectors, programs and technologies to ensure that the way we measure energy efficiency is accurate, reliable, auditable and replicable.

This paper proposes how we can achieve such a standard and what stakeholders can do to help move things forward.

The Keys to Scale: Innovation and Interoperability

How we reliably and accurately measure energy not used

To think intelligently about standards, it is helpful to agree on what a standard is. Because M&V 2.0 is likely to have software as its backbone, it’s useful to look at the goals for a standard espoused by leading internet, software and technology associations.4

• are chosen and defined based on technical merit, as judged by the contributed expertise of each participant;
• provide global interoperability, scalability, stability, and resiliency;
• enable global competition;
• serve as building blocks for further innovation; and
• contribute to the creation of global communities, benefiting humanity.

The goal of a software standard is to ensure that what one computer system says is an inch, is indeed an inch—no matter what the system. This is known as interoperability, which is the heart of what standards are all about. To be a bonafide standard the approach needs to be used by different programs by different developers. This is the magic that enables countless systems the reader uses every day to interoperate e.g. HTTP5, LTE6, SMS7 and bluetooth8.

Good standards foster innovation, they don’t restrict it

Innovation means making things possible that once seemed impossible. Successful standards foster innovation. For example, because everyone agrees what an inch is, we have cheap tape measures and we have advanced laser measurement technologies that enable self-driving vehicles9—the each of these tools are great for different jobs. Neither tool would venture a half-baked argument to claim to have a better or more correct inch and neither would be out of compliance with what an inch means—because an inch is standard, like the Watt, Joule or second.

In fact, measurement standards have already enabled innovation in the smart grid. Advanced metering infrastructure (aka, smart meters) all count kW and kWh, yet companies like Siemens, Itron and Landis + Gyr all sell different smart meters based on proprietary software and compete based on the value-added services they provide with their smart meters.

This is how a standard works: it provides a common definition and/or method that serves as a foundation for innovation and fosters competition according to variations on features.

At EnergySavvy, for example, we have taken our basic M&V 2.0 engine and built additional features onto the product to add value for our clients. This has included predictive energy savings analytics, contractor performance monitoring and a quality assurance/quality control identification module, etc. A standard for M&V 2.0 would help foster trust in the core M&V 2.0 engine we have built and allow EnergySavvy and other vendors to continue innovating and selling software based on new features.

5. https://en.wikipedia.org/wiki/Hypertext_Transfer_Protocol: Hypertext Transfer Protocol (HTTP) is an application protocol for distributed, collaborative, and hyper media information systems. HTTP is the foundation of data communication for the world wide web.
6 https://en.wikipedia.org/wiki/LTE_(telecommunication): In telecommunication, Long-Term Evolution (LTE) is a standard for high-speed wireless communication for mobile phones and data terminals
7. https://en.wikipedia.org/wiki/SMS: Short Message Service (SMS) is a text messaging service component of most telephone, World Wide Web, and mobile telephony systems. It uses standardized communication protocols to enable mobile phone devices to exchange short text messages
So the question is how do we enable standardization and interoperability that will work for energy efficiency so that numerous market actors and software vendors can enable innovation and transformation? To begin answering this question we first turn to the status quo and then look at key elements of what is needed for standards.

**Status Quo Efforts**

As the techie phrase sarcastically goes, "The nice thing about standards is that you have so many to choose from." There are many efforts, both mature and emerging, that provide protocols, frameworks and emergent attempts at standards. Yet, none of these are prescriptive or mature enough to enable accuracy, replicability and interoperability. These are:

<table>
<thead>
<tr>
<th>Area</th>
<th>Focus / Scope</th>
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<tr>
<td>IPMVP</td>
<td>General guidelines for international program evaluation practices</td>
<td>Primary: evaluators, ESCO’s and M&amp;V providers  Secondary: utilities and regulators</td>
<td>Originated in 1996. General guidelines that can be applied in a variety of ways. Created as four main options for different purposes and use cases. Options A, B, C and D.</td>
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<tr>
<td>Uniform Methods Project (UMP)</td>
<td>Multi-chapter set of guidelines for sector specific evaluation practices</td>
<td>Primary: evaluators  Secondary: utilities and regulators</td>
<td>A set of protocols intended to provide consistency and transparency for EM&amp;V. Are sector and program/technology specific. Chapter 8 was released in 2013 and covers whole house consumption data analysis.</td>
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<tr>
<td>ISO-NE Forward Capacity Market (FCM) Manual M-MVDR 11</td>
<td>Guidance and required criteria for the measurement and verification of performance of Demand Resources participating in the wholesale electric markets administered by the ISO-New England.</td>
<td>Qualified 'Project Sponsors' may include utilities or other businesses or aggregators of demand reductions.</td>
<td>The guidance accepts all IPMVP options and alternative methodologies that can demonstrate equivalence, subject to approval by the ISO. These guidelines are typically employed by utilities in applicable service territories to bid qualifying resources into the capacity market. Established in 2007 and updated in 2014.</td>
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<tr>
<td>BPI/ACCA</td>
<td>Creation of an ANSI standard for residential M&amp;V</td>
<td>Implementers and analytics vendors</td>
<td>ANSI process led by BPI and ACCA. Stated scope is to provide replicable calculation procedures for quantifying energy savings in existing homes utilizing weather adjusted metered data, and for aggregating impacts to increase confidence in savings that result from energy interventions or programs. Methods based on CalTRACK—see below. Initiated in 2015 and ongoing at time of publication.</td>
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<tr>
<td>CalTRACK</td>
<td>PG&amp;E pay-for-performance</td>
<td>Utilities and software vendors with guidance, but not sign-off, from regulators</td>
<td>CalTRACK is a set of methods for calculating site-based, weather-normalized, metered energy savings from an existing conditions baseline and applied to single family residential retrofits using data from utility meters. These methods focus specifically on calculating site-based, weather-normalized metered energy savings for determining payments under a Pay-for-Performance program, rather than the more evaluation oriented guidance that is found in ASHRAE Guideline 14 or the Uniform Methods Project (UMP). CalTRACK methods do not require energy consumption data from a population of energy users beyond the treatment group. Completed in 2017.</td>
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Nine Key Attributes for an M&V 2.0 Standard

The preceding status quo efforts demonstrate that there are a variety of guidelines and protocols concerning the measurement of energy efficiency, but there are no comprehensive standards, particularly with respect to measurement of energy savings based on changes in energy consumption. Recognizing that the status quo is not suitable to bring energy efficiency to scale, we believe the industry must work quickly to create a suite of standards for M&V 2.0 tools. To begin this process, we have identified nine key attributes that are valuable for the creation of an M&V 2.0 standard. These attributes are intended to guide a standard creations body.

**ACCUACY**
An M&V 2.0 tool must be accurate, repeatedly, on different data sets.

**SECTOR DEPENDENT**
M&V varies for different building types. Energy efficiency measurement conducted for residential premises is not the same as the practices used for commercial office buildings. Standards must respect and recognize those differences. A common set of standards and testing procedures must be developed for different building types and different use cases such as residential vs. multi-family vs. commercial and industrial.

**DATA DRIVEN**
Calculations must be based on the data from energy consumption meters located at the premises being measured. The standard must specify allowable meters (e.g., utility meters, installed sub-meters, etc.)

**NORMALIZE FOR KEY EFFECTS**
A standard must identify the factors that may confound the measurement of energy savings, and specify the requirements for normalization of such factors. These normalization practices vary for different premises and should be included in the standard according to the sector to which they are assigned and the use case for the savings, as deemed applicable.

**REPLICABLE**
Consistent measurement, within acceptable accuracy bounds, is a core function for M&V 2.0. Any M&V 2.0 standard must provide specifications and methods that can be run by multiple tools on similar data sets and provide similar results, more than once.

**FAST AND CHEAP TO TEST**
Demonstrating compliance with a standard requires testing. The standard must create compliance testing and should strive to create validation tests that are fast and cheap to complete. This is the case with many software systems today such as web accessibility testing.

**INTEROPERABLE WITH DISTRIBUTED ENERGY RESOURCES**
Energy efficiency is no longer a stand-alone energy activity. Demand-side management is occurring in homes and buildings with solar, EV’s, storage, controls, or connected to microgrids. A standard must account for other DERs and create a standard that fits the evolving clean energy environment.

**NON-LIMITING**
As the standard evolves it should not restrict M&V 2.0 technologies from applications involving grid awareness (e.g. circuit data for constrained systems and non-wires applications), temporality (capacity vs. energy), delivered fuels (for emissions considerations) and other key use cases.

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12. The stakeholders supporting a standards process will determine the extent to which the testing measures a tool’s ability to model and predict energy consumption or a tool’s ability to measure against “known” energy savings.

As noted above, EnergySavvy has already completed validation tests on various occasions, with different utilities and different evaluation firms. Those test cases have not provided certainty for all industry actors in different jurisdictions or with different data sets. Therefore, we believe the effort involved in creating a true standard is worth the time, effort and resources necessary to complete the process.

13. [https://www.w3.org/WAI/ER/tools/](https://www.w3.org/WAI/ER/tools/)
We acknowledge that some of these attributes will be more difficult than others to meet when creating standards. For example, defining energy savings calculations that are also non-limiting and interoperable with DERs will challenge industry experts to think beyond their specialties and historical experience. This is why we are calling for a broad group of stakeholders to come together and agree on these fundamental attributes that need to be a part of any suite of standards.

**Bringing the Industry Together**

As we stated at the outset, for energy efficiency to truly scale, the industry has to arrive at a suite of standards that creates 'one set of books' for measuring savings. That means creating a common approach to measurement that is trusted, used across the country, enables energy efficiency to scale and integrates with distributed energy resources. To achieve that end, the right assemblage of experts must all be at the table. That means the standards development body must include representatives from the evaluation community, leading regulatory agencies, utilities, program implementers, M&V 2.0 vendors, and energy service companies (ESCOs). Getting all of these parties to the table will foster trust and allow for the creation of a standard that achieves the goal of 'one set of books' for energy efficiency measurement.

It is important that no standards body take shape without this full spectrum of representatives involved. For example, if evaluators are not included in the creation of a standard, the industry trusted experts for measuring energy efficiency will not have faith or utilize the standard. Similarly, regulators must also be included in this process. Regulators are the final arbiter of judging energy efficiency savings achieved by utilities. If regulators do not support and agree with the standard, they may require another layer of EM&V that is different than the standardized M&V 2.0 method. That will result in the industry continuing to have multiple sets of books and hindering growth.

EnergySavvy offers a roadmap further below in this paper on what this process could look like.

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14 As discussed in preceding sections, 'one set of books' refers to generally accepted, transparent and interoperable methods across applicable sectors, programs and technologies.
Alternative Approaches to a Standard?

Getting this right is important. The emergence of M&V 2.0 provides the industry with an opportunity to create clear and consistent M&V process that can be understood and replicated around the country. But creating a standard requires significant effort, time and will take resources. We recognize that there are several suggested paths towards the creation of an M&V 2.0 standard, and some of these proposals are based around the concept of open source software. Due to the issues we raise in the following section, some of these proposals may risk the efficacy of the effort to move towards energy efficiency that is measured at the meter. We outline below the reasons why developing a standard for all M&V software platforms, regardless of source code status, is a more effective approach to spurring innovation and building a more robust M&V industry over time.\(^{15}\)

What about just creating validation tests?

An argument can be made for fast-tracking a standard process with the development of validation tests—without creating specific directions on how to perform computations. We see merit in this approach if creating normative direction on how to calculate measurement of energy efficiency will be too costly or time consuming to develop. However, we believe a true suite of industry M&V 2.0 standards that provides guidance on computations is superior to merely settling for validation tests.

Can we just say that open source is the standard?

There is a difference between a standard and a software product. A piece of software code is not a standard, nor can it be accepted as the standard. Software code can adhere to a standard, but it cannot be the standard. This same rule applies for any common standard. A ruler can measure an inch, but it’s incorrect to say that only one ruler, or only the rulers manufactured by one company, can be the tool to measure an inch.

Furthermore, without a standard, countless open source companies could develop different products, based on different methodologies, that arrive at different answers for a similar data set and all claim to be compliant by being open source. Under this scenario, requiring open source code, without creating a standard, would erode M&V 2.0 and hinder the creation of a common weights and measure.

What about picking one open source software code as the standard?

This sounds like a simple solution. Unfortunately, it is contradictory to how open source software works. The definition of open source software requires that derived works (e.g., new software packages) are allowed to be created from the code.\(^{16}\) This means that anyone can modify the open source package into anything else. And thus, there can be many derivations of any given software system derived from any open source Library as is the case with Android and Linux. Conversely, if a software system does not allow such derivations, it is not considered open source. Or if one company controls what gets changed in the code it is also not an open source project – rather, it’s just a proprietary software project that may be free and offer source control access.

As a result, attempting to create a default M&V 2.0 standard around an open source software product, without an actual standard, is likely impossible. The logic follows, that if a piece of code is open source, without an industry standard, there is no way to verify that derivations of the code, or different configurations, will calculate energy savings in the same manner as the original code. That means an open source M&V 2.0 product,

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15. Per the ANSI Guidelines on Software in Standards (2008) “As a general rule, standards should provide a description of features from which competing and interoperable implementations can be developed and not serve as endorsements for a particular solution or implementation.”
16. The Open Source Initiative, Open source definition; https://opensource.org/osd
without an actual industry standard, by definition and simple logic cannot rightly claim to create a common measurement of savings.

Can source code access ensure compliance with a standard without validation?

At EnergySavvy we believe in transparency and enable clients and others to inspect our source code. However, seeing source code doesn’t necessarily allow someone to validate a software product is compliant with a measurement standard. Code can be written in a variety of different ways to achieve the same objective. Consider these three lines of pseudocode:

1. \( a = a + 1 \)
2. \( a++ \)
3. \( b = a, a = b + 1 \)

All three lines are the same underlying algorithm and compute the same result. They literally mean exactly the same thing to computers and programmers.\(^{17}\) However, they don’t serve as the basis for determining whether a certain standard was met.

For this reason, it is impossible to ensure standard compliance by just reading software code or requiring a specific software code. Code is written in rich and varied programming languages and techniques. Many technologists would say that computer programming is an act of writing subject to the creativity of the authors. This is part of why a best practice in software development is to write tests in conjunction with writing source code because it is easier to measure and observe the output of a computer program than it is to read and understand a computer program.\(^{18}\)

Is open source testing more cost effective than validating an industry standard?

Open source products allow one to inspect source code to ensure compliance with a standard. This is known as a “code inspection” testing approach, where the internals can be inspected. The converse is “validation” testing, where the source code cannot be inspected but the outputs can.

Both “code inspection” and “validation” testing seek to achieve the same outcome—demonstrating compliance with a standard or the ability to achieve a certain outcome. But validation testing is much faster and cheaper than code inspection. In fact, the industry has embraced validation testing to certify other standards in the past.\(^ {19}\) This is because it is relatively straightforward to require passing an empirical validation test. But relying on code inspection to perform validation testing is much more expensive, due to required expertise and time considerations—adding a hindrance to adoption.\(^ {20}\)

Roadmap—The Path Forward

The creation of a suite of M&V 2.0 standards will require that an entity with convening authority needs to create a standard setting body that has sufficient resources to commit the time and effort and coordinate the expertise necessary for the industry to set standards. This authority needs to have a budget to hire expert consultants with data science and

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17. A programmer might argue that at the assembly language level these programs may be structured differently but the essential truth stands.
18. The famous article where "Joel on Software" explains that it’s harder to read code than to write it. https://www.joelonsoftware.com/2000/04/06/things-you-should-never-do-part-i/
19. There are several examples where the industry has already embraced validation with great success. These include the RESNET Certification for home energy audit software tools – provided by RESNET (http://www.resnet.us/professional/); HPXML (BPI-2100) compliance testing to ensure data interoperability between home energy audit tools and program data systems (provided by NREL - https://pxxml-stage.nrel.gov/validator/); and EnergySavvy has created a free validation tool for HPXML (http://blog.energysavvy.com/2016/02/09/new-tool-takes-the-pain-out-of-hpxml-testing/)
evaluation expertise. It also needs to be able to solicit and handle utility data in accordance with the strict privacy standards. This entity also needs to be prepared to assemble test validation data sets that can be released publicly for the industry to access and use.

We see at least five concrete steps that must be taken:

1. Establish a standards creation body that includes all the stakeholders mentioned above and is capable of following a transparent, open and consensus-driven process to create a standard.
2. Establish the goals and scope of a standards effort including what key attributes are necessary for which key sub-segments.
3. Establish test data to foster empirical standards. The data sources must be various and diverse enough to support the creation of a standard that has been tested in different weather zones and with different treatment activities.
4. Establish an accuracy framework. This will govern acceptable error and accuracy ranges across the sample empirical data. E.g. If a tool is able to measure 90% of the sample projects or an aggregated set of projects within 10% of the expected values then it might be deemed compliant on the accuracy attribute.
5. Establish a governance framework to evolve, update and certify compliance with the standards framework.

Following these steps, abiding by these principles and working together, the industry can create a standard for energy savings. The effort involved in this process will be significant but the reward will be far greater—an energy efficiency industry that can scale, modernize and support the efforts of distribution planning, grid optimization, targeted load reductions and reducing emissions. At EnergySavvy we believe in hard work, true collaboration and transparency; it is our privilege to try to help convene, lead and collaborate with all industry stakeholders, including competitors, to realize this vision.

About EnergySavvy

EnergySavvy provides cloud solutions to power modern utility transformation. Through data-driven insights, innovative customer engagement, and automated program delivery, EnergySavvy delivers the industry’s only cloud-based utility transformation platform—purpose-built to enhance the customer experience and increase operational efficiency. More than 30 utilities and state programs rely on EnergySavvy to enable customer experience transformation in the modern, digital customer era.

Contact us:
research@energysavvy.com
www.energysavvy.com