Scoping of Intelligent Efficiency Measurement

Paper by the Connected Devices Alliance, July 2016

Objectives

The purpose of this paper is to communicate the results of a scoping exercise undertaken by the Intelligent Efficiency Measurement Working Group of the Connected Devices Alliance (CDA). The objectives of the scoping exercise were to:

- Scope measurement methodologies for quantifying the energy savings from real-world intelligent efficiency projects and products.
- Undertake a gap analysis to determine where new or improved measurement methodologies might be required.

The technical scope of the paper is intelligent efficiency projects and products in the residential and commercial building sectors (not including dematerialization[1]).

Background

CDA participants have recognized the need to take globally coordinated action to: *realize a world where devices and networks optimize energy management, while delivering increased energy productivity across all sectors; and, maximize network-enabled energy savings and minimize the energy consumption from all networks and networked devices*.

This recognition has occurred in the context of G20 governments making significant national pledges for carbon emission reductions at COP 21. Experts believe that intelligent efficiency will necessarily be a key contributor to achieving these goals. However it has been noted within the CDA that the difficulty in assessing quantified and verifiable energy savings from intelligent efficiency may unfortunately inhibit its advancement. Thus the CDA has recognized the need to study measurement methodologies for intelligent efficiency in order to help overcome this barrier.

As a first step, the CDA's Intelligent Efficiency Measurement Working Group agreed to undertake this scoping exercise. It is designed to complement the IEA-4E/EDNA study of *Policy Opportunities to Encourage Intelligent Efficiency*[2] as well as the Voluntary Labeling Initiative being undertaken in the US by the ACEEE. While the working group recognizes that intelligent efficiency projects and products will be found across industrial sectors and in important areas such as transportation and manufacturing, we believe an initial focus on buildings is appropriate for this scoping exercise.

Matrix of Methodologies

The working group developed a matrix (see table below) which attempts to list known measurement and verification (M&V) methodologies for energy efficient products, projects, and programs in the residential and commercial sectors.

Requirements for (M&V) expand and change as one progresses along a continuum of device/system "intelligence". For example, a connected device without internal logic will not require an M&V protocol because it communicates only data. If the device has internal logic, it may be able to report gross energy savings according to a protocol that compares historical energy use information with current energy use data. Alternatively, if a device without internal logic is connected to a network that has access to logic that can determine savings, a similar M&V protocol can be used to quantify energy savings. If the device is part of a financial assistance program, accurate measurement and evaluation of program savings may be required and this precipitates the need for another level of M&V protocols.

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[1] Dematerialization of a product means using less (or no) physical materials to deliver the same level of functionality, for example downloading music rather than purchasing physical CDs

[2] http://edna.iea-4e.org/tasks/task3

The type of M&V analysis often depends upon the needs of the end user of the analysis. A building owner may only be concerned with the difference between pre- and post-project energy consumption, while a program evaluator may be concerned with attribution issues such as the motivation for an efficiency investment. For the purpose of this paper, attribution issues are not be considered - they are difficult to determine with consistency, and are beyond the scope of the CDA's interests. Nevertheless, they do factor into many of protocols that are reflected in the matrix below.

Table 1: Matrix of M&V Methodologies

Sector	Intelligent Device / Project	Examples of Proprietary Methodologies	Examples of Ongoing Efforts to Develop New, Specific Methodologies	Examples of Public Methodologies
Residential	Smart lighting	Proprietary algorithms		IPMVP protocols[3] US utility technical resource manuals (TRMs)[4] US DoE Uniform Methods Project (UMP)[5] ASHRAE Performance Measurement Protocols for Commercial Buildings[6]
	Smart appliances			
	Connected thermostats	Proprietary algorithms	Energy Star efforts to develop specifications and measure savings[7]	
	Residential products generally		ACEEE protocol initiative for connected devices[8] (promote creation of M&V protocols for 10-20 IE applications)	
	Home Energy Management System (HEMS)	Proprietary algorithms	Northeast Energy Efficiency Partnerships[9]	
	Digital engagement and behavior modification programs	Quazi-experimental methods (QEM)		
Commercial	Smart Lighting	Proprietary algorithms Quazi-experimental methods (QEM) Remote Building Analytics (RBA)	ANSI C137 Lighting Systems Committee[10]	
	Smart elevators and escalators			
	Building management system (BMS)			
	Software as a service (SaaS) for BMS			

[3] http://evo-world.org/en/
[4] http://database.aceee.org/state/evaluation-measurement-verification
[5] http://energy.gov/eere/about-us/ump-protocols
[6] http://www.techstreet.com/ashrae/standards/performance-measurement-protocols-for-commercial-buildings?product_id=1703581
[7] https://www.energystar.gov/products/spec/connected_thermostats_metrics_discussions_pd
[8] http://www.iea-4e.org/files/otherfiles/0000/0362/Presentation_08_-_Chris_Hankin.pdf (refer slide 17)
[9] http://www.neep.org/opportunities-home-energy-management-systems-hems-advancing-residential-energy-efficiency-programs (refer chapter 5)
[10] https://www.nema.org/Technical/Pages/ANSI-C137-Lighting-Systems-Committee.aspx

Discussion

The gaps in measurement methodologies that exist tend to be in the form of standardization across the industry. For example, the methods for determining energy savings from Home Energy Management Systems (HEMS) and connected thermostats vary by vendor. In the words of one stakeholder, "it's a wild west for savings assumptions" for these products.

Other gaps involve the treatment of (large quantities of) data. For example, the current Energy Star connected thermostats exercise is attempting to quantify the effectiveness of connected thermostats, which involves analysing large amount data from the field - multiple data streams in multiple homes is being sent to cloud every 5 or 15 minutes.

Programs evaluators have found that a significant amount of the information collected from meters and devices should not be used for one reason or another. Thus data cleaning and filtering can become more of an art than a science, without established rules. The same issue applies to the use of remote building analysis (RBA) of commercial buildings and the ability to develop a benchmark for a set of buildings and a baseline for an individual one.

IPMVP protocols may not be particularly relevant to intelligent efficiency projects and products, as these often do not have ready access to baseline data, or even to energy consumption data (e.g. in some cases the key data are simply the run times of the HVAC system). The IPMVP protocols are also not detailed enough to deal with the "big data" which is inherent to intelligent efficiency.

In summary, the CDA working group concluded that the measurement of intelligent efficiency projects and products in the residential and commercial building sectors would benefit from development of M&V protocols specific to intelligent efficiency, which:

- Standardize assumptions
- Standardize treatment of (big) data
- Can cope with lack of a baseline
- Can cope with lack of measured energy consumption.

There are however several ongoing efforts to develop specific measurement protocols for intelligent efficiency (refer examples in column 4 of the table above) and these initiatives should be encouraged and promoted.