ASHRAE 1836-RP: Developing a Standardized Categorization System for Energy Efficiency Measures

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Project Advisory Board

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What is the goal of ASHRAE 1836-RP?

Background: EEMs are the basic unit of building energy improvement, and play a central role in energy auditing, energy modeling, and energy data collection and exchange (e.g., NYC Local Law 87).

Problem: However, there is no standardized implementation of EEMs across industry. This limits the ability to communicate the intent of an EEM clearly and consistently, and to perform "apples-to-apples" comparisons of measure savings.

Objective: The objective of 1836-RP is to develop a standardized system for the **categorization** and **characterization** of EEMs

Tasks:

Task 1: Conduct literature review
Task 2: Develop EEM categorization system
Task 3: Identify EEM characterization properties
Task 4: Draft final research report
Task 5: Finalize research report

We assembled a database of 3,480 EEEMs from 16 sources

Year	Title
2020	Building EQ
2020	Commercial Building Energy Saver
2020	Building Component Library
2020	BuildingSync
2020	National Residential Efficiency Measures Database
2020	Audit Template
2020	Illinois Statewide Technical Reference Manual for Energy Efficiency, Version 8.0
2020	New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Residential, Multi-Family, and Commercial/Industrial Measures, Version 7
2018	ASHRAE Standard 100-2018, Energy Efficiency in Existing Buildings
2015	ASHRAE 1651-RP, Development of Maximum Technically Achievable Energy Targets for Commercial Buildings: Ultra-Low Energy Use Building Set
2014	Energy Efficient Technologies and Measures for Building Renovation: Sourcebook
2010	Commercial Energy Auditing Reference Handbook
1999	Energy Efficiency Manual
2003	Energy Audit Workbook
1992	Energy Conservation in Existing Buildings Deskbook
1987	Source Book for Energy Auditors, Vol. 1

Findings

- All sources use a 1 or 2-level hierarchy
- All sources categorize EEMs according to building system/component
- Sources differ in characterization properties and navigational features
- Sources are not independent from one another

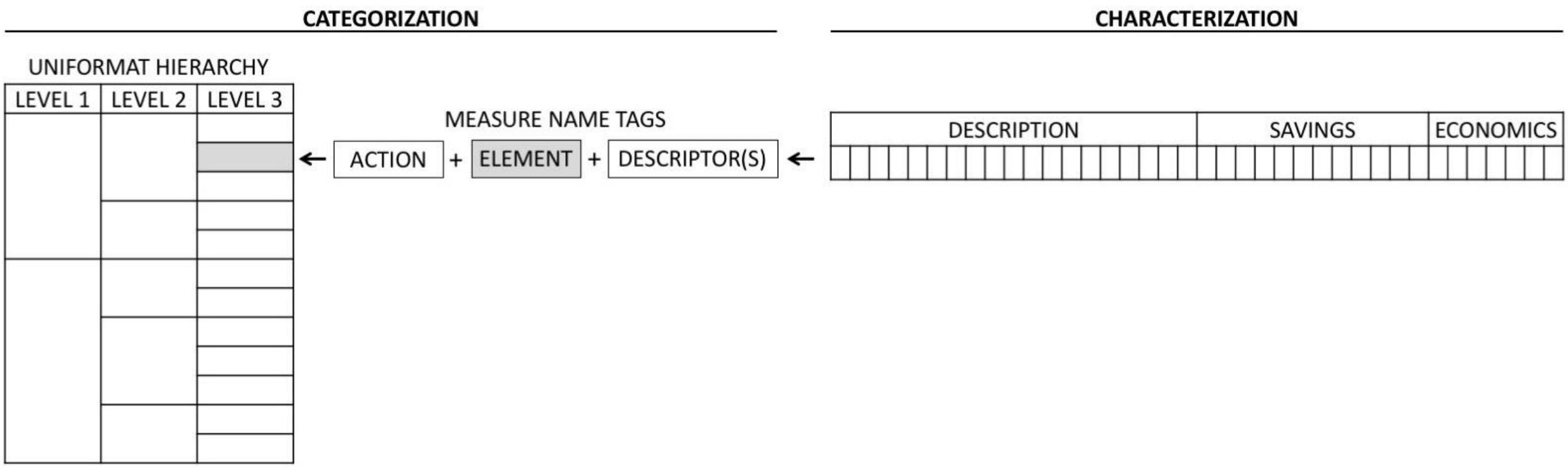
Source documents differ greatly in how EEMs are phrased

#	Document Name	EEMs per document		Words per EEM			
		Total	Duplicates*	Min	Median	Avg	Max
1	ASHRAE Building EQ	295	1	2	12	12	41
2	Commercial Building Energy Saver	102	0	2	7	7.5	19
3	Building Component Library	302	0	1	3	3.9	14
4	BuildingSync	222	81	1	4	4.2	14
5	REMDB	129	3	1	3	4.3	14
6	Audit Template	223	81	1	4	4.2	14
7	Illinois Statewide TRM	195	5	2	4	4.5	12
8	New York Statewide TRM	110	20	1	4	4.1	13
9	ASHRAE Standard 100	236	1	2	15	17.7	103
10	ASHRAE 1651-RP	398	0	1	5	5.2	17
11	IEA 46	419	4	1	12	16.7	109
12	Doty	69	0	1	4	4.8	11
13	Wulfinghoff	366	13	2	11	12.7	41
14	WSU	130	0	2	6	6.5	17
15	Thumann	52	0	2	6	5.7	15
16	IEA 11	232	0	2	5	5.3	13
	TOTAL	3480		1	5	7.5	109

Literature review and PAB meetings highlighted key challenges and desirable features

Key Challenges	Desirable Features
• There is currently no industry-standard method of categorizing energy-related building components.	• Measure categorization should be based on building component.
• Measure names have different levels of specificity.	• Measure categorization should be hierarchical and limited to only a few levels.
• Measures may fit in more than one category.	• Measure categorization criteria should be clearly defined.
• Measures may not fit well in any category.	• Measure categorization should be based on existing industry-standard tools.
• Measures may sit on different levels of the hierarchy. • Measure names may use vague terminology.	• Measure categorization should include navigational features. • Measure names should follow a clear, consistent, and semi-structured format.
• Measure names may use synonymous terminology or abbreviations.	• Measure names should be distinct from measure descriptions.
	• Measure names should be built from a preset list of verbs and nouns.
	• Keyword extraction should be used to sort EEMs into the appropriate categories.

New standardized system consists of hierarchy, measure tags, and characterization properties



Six ACTION tags were developed based on frequency analysis of EEMs and PAB discussion

#	Action Tag	Definition	Synonymous Verbs
1	Install	Add new component or system to existing premises.	install (563), use (228), add (114), insulate (76), implement (61), provide (48), seal (31), select (24), create (22), apply (14), make (13)
2	Replace	Put something new in place of existing component or system	replace (278), convert (39)
3	Retrofit	Modify existing component or system	upgrade (128), improve (54), retrofit (26), change (21), modify (18)
4	Adjust	Change the operation of an existing component or system	reduce (184), control (129), set (73), turn (68), minimize (53), increase (47), lower (45), adjust (37), optimize (37), reset (36), supply (35), avoid (27), correct (12)
5	Remove	Get rid of an existing component or system	eliminate (35), remove (32), separate (25)
6	Repair	Restore an existing component or system to its desired operation	clean (73), repair (44), check (33), maintain (39)

Initial list of 70 ELEMENT and 96 DESCRIPTOR tags were developed through review of EEMs and BEDES terms

Tag Type	Terms
Element	foundation wall, slab, basement wall, building envelope, floor, exterior wall, exterior shading, curtain wall, window, exterior door, roof, skylight, interior wall, interior door, interior wall finish, ceiling finish, elevator, escalator, sink, shower, toilet, water heater, domestic hot water, energy supply, boiler, burner, chiller, cooling tower, condenser, evaporative cooler, thermal energy storage, air handling unit, damper, duct, economizer, fan, steam trap, terminal unit, air distribution system, furnace, packaged RTU, packaged terminal unit, Building Automation System, Energy Management and Controls System, thermostat, thermostatic radiator valve, HVAC controls, meter, transformer, ballast, lamp, luminaire, reflector, lighting controls, exterior building lighting, interior lighting, power factor correction, equipment, plug loads, computer, data center, server, vending machine, clothes dryer, clothes washer, refrigerator, refrigerated case interior shading, ceiling fan
Descriptors	insulation, air leakage, air barrier, radiant barrier, argon, low e, reflective, tinted, operable, weatherstrip, cool roof, green roof, tubular skylight, low-flow, tankless, pipe, anaerobic biodigester, combined heat and power, fuel cell, microturbine, photovoltaic, solar thermal, wind, heat recovery, energy recovery, pump, compressor, absorption chiller, vapor compression chiller, air cooled, water cooled, screw, scroll, centrifugal, reciprocating, motor, diffuser, ECM, filter, variable speed drive, variable air volume, heat pump, variable refrigerant flow, exhaust. return, supply, fancoil unit, radiator, chilled water, glycol, hot water, steam, refrigerant, axial, centrifugal, Energy recovery ventilator, Heat recovery ventilator, heat pump, packaged terminal air conditioner, packaged terminal heat pump, unit ventilator, unit heater, DDC, demand control ventilation, pneumatic, reset, setback, static pressure, supply air temperature, condensing temperature, outside air temperature, room air temperature, supply chilled water temperature, supply hot water temperature, scheduled, compact fluorescent, fluorescent, halogen, high intensity discharge, incandescent, LED, low pressure sodium, metal halide, mercury vapor, neon, T-5, T-8, T-12, electronic, electromagnetic, pulse start, manual control, occupancy control, daylight control, timeclock control, ENERGY STAR-rated, advanced power strip, anti-sweat heater

EEMs are categorized on the UNIFORMAT hierarchy using each EEM's ELEMENT tag

UNIFORMAT (excerpt)

Level 1	Level 2	Level 3
D SERVICES	D10 Conveying	D1010 Elevators & Lifts
		D1020 Escalators & Moving Walks
		D1090 Other Conveying Systems
	D20 Plumbing	D2010 Plumbing Fixtures
		D2020 Domestic Water Distributions
		D2030 Sanitary Waste
		D2040 Rain Water Drainage
		D2090 Other Plumbing Systems
	D30 HVAC	D3010 Energy Supply
		D3020 Heat Generating Systems
		D3030 Cooling Generating Systems
		D3040 Distributions Systems
		D3050 Terminal & Package Units
		D3060 Controls and Instrumentation
		D3070 Systems Testing & Balancing
		D3090 Other HVAC Systems & Equipment
	D40 Fire Protection	D4010 Sprinklers
		D4020 Standpipes
		D4030 Fire Protection Specialties
		D4090 Other Fire Protection Systems
	D50 Electrical	D5010 Electrical Service & Distribution
		D5020 Lighting and Branch Wiring
		D5030 Communications & Security
		D5090 Other Electrical Systems

UNIFORMAT Section 6 with ELEMENT and DESCRIPTOR tags

Level 3	Includes	Excludes	Element Tags	Descriptor Tags
D3020 Heat Generating Systems	(1) Boilers, including electric; (2) Piping and fittings adjacent to boilers; (3) Primary pumps; (4) Auxiliary equipment; and (5) Equipment and piping insulation.	(1) Electric space unit heaters and baseboard, fuel fired unit heaters, and furnaces (see D3050, Terminal and Package Units), and (2) Controls and instrumentation	boiler, burner	heat recovery, energy recovery, insulation, pipe, pump

EEMs (re-)categorized automatically using R script and manually

Sample: Building Sync EEMs

				Standardized Categorization System				
id	**level_1**	**level_2**	**EEM**	**Element Tag(s)**	**uni_code**	**uni_level_1**	**uni_level_2**	**uni_level_3**
28	BuildingSync	Building Envelope Modifications	Increase roof insulation	Roof	B3010	SHELL	Roofing	Roof Coverings
31	BuildingSync	Building Envelope Modifications	Install cool/green roof	Roof	B3010	SHELL	Roofing	Roof Coverings
34	BuildingSync	Building Envelope Modifications	Install or replace solar screens	Screen	B2010	SHELL	Exterior Enclosure	Exterior Walls
27	BuildingSync	Building Envelope Modifications	Increase ceiling insulation	Ceiling	C3030	INTERIORS	Interior Finishes	Ceiling Finishes
69	BuildingSync	Conveyance Systems (e.g., Elevators)	Add elevator regenerative drives	Elevator	D1010	SERVICES	Conveying	Elevators & Lifts
200	BuildingSync	Service hot water (SHW) and domestic hot water (DHW) systems	Install solar thermal SHW	SHW	D2020	SERVICES	Plumbing	Domestic Water Distribution
6	BuildingSync	Boiler Plant Improvements	Replace boiler	Boiler	D3020	SERVICES	HVAC	Heat Generating Systems
7	BuildingSync	Boiler Plant Improvements	Replace burner	Burner	D3020	SERVICES	HVAC	Heat Generating Systems
157	BuildingSync	Heating, Ventilating, and Air Conditioning	Add or replace cooling tower	Cooling tower	D3030	SERVICES	HVAC	Cooling Generating Systems
43	BuildingSync	Chilled Water, Hot Water, and Steam Distribution Systems	Retrofit and replace chiller plant pumping, piping, and controls	Chiller	D3030	SERVICES	HVAC	Cooling Generating Systems

The demonstration revealed that element-based tagging works well, but with some caveats

Caveats

- EEMs are unevenly distributed across the UNIFORMAT categories.
- Some types of EEMs do not have a well-defined home within UNIFORMAT (e.g., refrigeration equipment, appliances and plug loads, and IT equipment, behavioral)
- Not all terms in an EEM are equally useful (or necessary) for categorization.
- EEM terminology is diverse and includes many synonyms and abbreviations that must be accounted for.

38 standardized characterization properties were developed based on literature review and PAB discussion

Type	Characterization Properties
Description	**Measure Name, Measure Description, Energy Source Impacts, End Use Impacts, Scope of Application, Baseline Condition, Proposed Condition, Recommendation Status, Implementation Status**, Market Sector, Principal Building Type, Detailed Building Type, Gross Floor Area, Year of Construction, Climate Zone, City, State, Postal Code, Assessment Date
Savings	**Calculation Approach, Annual Energy Savings (By Energy Source Type), Peak Electricity Demand Savings, Annual Energy Cost Savings (By Energy Source Type), Annual Carbon Emissions Avoided**, Baseline Annual Energy Use, Baseline Peak Demand, Baseline Annual Energy Cost, Baseline Annual Carbon Emissions, Baseline Annual Site Energy Use Intensity (EUI); Baseline Annual Energy Cost Index (ECI); Baseline Annual Carbon Emissions Intensity
Economics	**Level of Investment, Measure Cost, Incentive Funding Amount, Net Measure Cost, Measure Life, Simple ROI (with incentives), Simple Payback (with incentives)**

***EEM-level characterization property**

Future works is needed to implement and further demonstrate the value of the 1836-RP system

1. Incorporate the results of 1836-RP into an ASHRAE standard or guideline.
2. Conduct user testing and additional industry vetting of the 1836-RP standardized system.
3. Implement the 1836-RP standardized system into building energy data exchange tools and/or Technical Reference Manuals.
4. Assemble a coalition of industry stakeholders to drive 1836-RP system adoption.
5. Develop a standardized list of common EEMs, categorized according to the 1836-RP system.
6. Expand the list of EEM tags used as part of the standardized categorization system.
7. Expand the list of standardized characterization properties to include properties related to packages of measures.
8. Apply the standardized system to analyze aggregate measure data.

Details on 1836-RP will be available in several publications and data will be available on data.ashrae.org

Publications	data.ashrae.org
• 1836-RP Final Report	• Complete list of 3,480 EEMs
• STBE text mining article	• List of element and descriptor tags
• STBE categorization system performance article	• R script used to re-categorize measures, along with a demo vignette
• ASHRAE Journal article	• Two subsamples of EEMs: 5% random sample and BuildingSync
	• Complete list of measure characterization properties in each source document

Questions?

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