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De Minimis Thresholds for Federal Building Metering Appropriateness

March 2015

JW Henderson



Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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Pacific Northwest National Laboratory
Richland, Washington 99352

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1.0 Introduction

The U.S. Department of Energy (DOE) is required by statute and Presidential Memorandum¹ to establish guidelines for agencies to meter their Federal buildings for specific energy forms (electricity, natural gas, and steam) and water. See 42 U.S.C. § 8253(e). DOE issued guidance in February 2006 on the installation of electric meters in Federal buildings. A recent update to the 2006 guidance² accounts for more current metering practices within the Federal Government. The updated metering guidance specifies that all Federal buildings shall be considered “appropriate” for energy or water metering unless identified for potential exclusion.

2.0 Purpose

In developing the updated guidance to carry out the statute, Congress also directed DOE to (among other things) establish exclusions from the metering requirements based on the *de minimis* quantity of energy use of a Federal building, industrial process, or structure. This paper discusses the method used to identify *de minimis* values.

Meters are installed on buildings to measure energy and water use. Metered data are useful only when analyzed for opportunities to optimize building performance and reduce energy and water consumption. Some buildings are expected to use such a small amount of energy or water that metering may not offer significant opportunities to reduce resource use. It is recognized that every building is different and thus setting a *de minimis* standard of operations will not address every conceivable situation.

The method used to identify the required *de minimis* standard involved three parts:

1. *Examine building energy use by building type as it applies to the Federal sector.*
2. *Align existing, related, regulatory requirements.*
3. *Incorporate industry standards.*

3.0 Federal Sector Building Energy Use

To determine the appropriateness of metering Federal building requires an understanding of the Federal portfolio. The Federal Real Property Profile (FRPP) is the Federal government’s inventory system that contains data on all real property assets within and outside the United States. The FRPP summary charts provide a detailed breakdown of the square footage of all real property assets (by building type).

What is not included within the FRPP data are associated energy and water consumption data. The Commercial Building Energy Consumption Survey (CBECS) is a sample survey that collects information (e.g. energy consumption) on the stock of commercial buildings nationally. The survey is conducted periodically by the Energy Information Administration (EIA) with the 2003 survey being the latest available. Using square footage summary data from the FRPP, combined with estimated energy use developed from EIA’s 2003 CBECS metadata, Table 1 was developed to provide an estimated breakdown of energy use and square footage of predominate building functions across the Federal portfolio. The estimated energy (orange) is calculated by multiplying the actual square footage from FRPP (blue) by average energy use intensities (EUI) calculated with CBECS metadata of each building function. EUI is defined as thousand British thermal units (kBtu) per square foot.

Table 1 depicts the **top thirteen energy consuming building functions** along with the FRPP building use classifications. This conglomerate accounts for **97%** of the federal floor place (both owned and leased) and is estimated to account for around **96%** of the total federal building energy consumption. The remaining 3% of the Federal building type floor space not shown represents only 4% of the total Federal building energy consumption.

¹ See Presidential Memorandum, Federal Leadership on Energy Management (December 5, 2013) [hereinafter “Presidential Memorandum”], <http://www.whitehouse.gov/the-press-office/2013/12/05/presidential-memorandum-federal-leadership-energy-management>.

² See Federal Building Metering Guidance (per 42 U.S.C. § 8253(e), Metering of Energy Use), Federal Leadership on Energy Management (November, 2014), http://energy.gov/sites/prod/files/2014/11/f19/metering_guidance.pdf.

Table 1 – Federal Real Property Profile and Estimated Energy Use

Building Functions (FRPP)	Building Predominant Use Classifications (FRPP)	General Building Type (CBECS/RECS)	Percent of Total Estimated Energy (Based on CBECS/RECS)	Percent of Total Gross Square Feet (Based on FRPP Charts)
Office	Buildings primarily used for office space or military headquarters.	Office	20.5%	24.2%
Laboratories	Buildings used directly in basic or applied research in the sciences (including medicine) and in engineering, such as medical laboratories; meteorological research laboratories; and buildings used in designing, developing, and testing of prototypes and processes for chemistry and physics . This category excludes medical or industrial laboratories used for routine testing.	Laboratory	13.8%	5.4%
Other Institutional Uses	Buildings used for institutional purposes other than schools, hospitals, and prisons, such as libraries , and chapels . This category also includes food preparation and dining facilities , buildings housing entertainment and recreational activities , and visitor's centers .	Food Sales Food Service Public Assembly	13.6%	6.9%
Service	Buildings used for service activities, such as maintenance and repair shops , dry cleaning plants, post exchange stores , airport hangars , and buildings primarily used for vehicle maintenance and repair.	Service	10.7%	13.7%
Hospital	Buildings used primarily for furnishing in-patient diagnosis and treatment under physician supervision and having 24-hour-a-day registered graduate nursing services. This category also includes medical laboratories used for routine testing. This category excludes buildings used directly in basic or applied medical research.	Inpatient Health Care	9.1%	3.9%
All Other****	Buildings that cannot be classified elsewhere.	Other	7.4%	8.9%
Dormitories/Barracks	Buildings primarily used as dwellings for housing individuals (without families/dependents).	Lodging	7.4%	8.6%
School	Buildings used primarily for formally organized instruction , such as schools for dependent children of Federal employees, Indian schools, and military training buildings including specialized training facilities.	Education	6.3%	8.2%
Industrial	Buildings specifically designed and primarily used for production or manufacturing , such as the production or manufacture of ammunition, aircraft, ships, vehicles, electronic equipment, fish production, chemicals, aluminum, and magnesium. Included are buildings that house utility plants or utility system components such as pump stations or valves.	Other	3.1%	3.7%
Family Housing	Buildings primarily used as dwellings for families/dependents. Includes apartment houses , single houses , row houses, public housing, military personnel housing, Federal employee housing, and housing for institutional personnel.	Single Family (Attached and Detached)	2.6%	7.7%
Warehouses	Buildings used for storage , such as ammunition storage , covered sheds , and buildings primarily used for storage of vehicles or materials . Also included are underground or earth covered ammunition storage bunkers and magazines. This category excludes water reservoirs and POL storage tanks which are storage structures.	Nonrefrigerated Warehouse	1.7%	5.6%
Percentage of Total			96%	97%

The building functions are also ranked from the highest percent of estimated energy consumption to the lowest. For example, office space accounts for 24.2% of the federal portfolio by square footage but is estimated to consume only 20.5% of the total energy. The next highest consuming building function is estimated to be laboratories at 13.8%, but only represent 5.4% of the federal floor space (because of the high EUI of laboratories).

4.0 Determinants of Energy Use

As previously stated, there are buildings using such a small amount of energy or water that metering may not offer opportunities to reduce resource use. While setting a *de minimis* standard of operations will not address every conceivable situation, it is both needed and required for setting a standard for metering requirement determination.

Within the metadata of the EIA 2003 CBECS are building characteristics such as size, location, building function, etc. Using this information, energy use for various building types was examined. Table 2 is an example of square footage categories analyzed against average Office building EUIs and their corresponding ranking. The average EUI of each building type for each square footage criteria were ranked; 1 (red) representing the highest EUI in the group and 9 (green) representing the lowest. For example, Office buildings with square footage between 500,001 and 1,000,000 square feet have the highest average EUI of the group at approximately 123 (kBtu per square foot).

Table 2 – CBECS EUI Analysis Examples

Square Footage Category	Office Average EUI	Rank
1,001 to 5,000 sq. ft.	84	8
5,001 to 10,000 sq. ft.	72	9
10,001 to 25,000 sq. ft.	90	7
25,001 to 50,000 sq. ft.	91	5
50,001 to 100,000 sq. ft.	96	3
100,001 to 200,000 sq. ft.	96	4
200,001 to 500,000 sq. ft.	121	2
500,001 to 1,000,000 sq. ft.	123	1
over 1,000,000 sq. ft.	90	6

When looking for determinants of energy use, the following criteria were evaluated within the CBECS metadata:

- Operating Hours
- Number of Computers
- Wall Material
- Main Roof Construction Material
- Window Type
- Number of Floors / Building Shape
- Main Heating Equipment
- Main Cooling Equipment
- Climate Zone / Census Division
- Building Type
- Building Size

Table 3 is the same information (square footage categories analyzed against average EUIs) for all building types. The average EUI of each building type for each square footage category was ranked; red representing the highest EUI in the group and green representing the lowest.

Table 3 – EUI Analysis – By Square Footage Category

Square Footage Category	ALL	Office	Education	Non- Refrigerated Warehouse	Other	Public Assembly	Service	Outpatient Health Care	Inpatient Health Care	Public Order and Safety	Lodging	Laboratory	Food Service	Food Sales
1,001 to 5,000 sq. ft.	124	84	71	26	98	76	92	68		84	85	271	407	259
5,001 to 10,000 sq. ft.	90	72	88	28	46	78	71	71		104	138	120	269	129
10,001 to 25,000 sq. ft.	83	90	78	31	56	73	93	101	93	84	71	427	215	199
25,001 to 50,000 sq. ft.	89	91	87	39	124	126	63	126	142	116	95	255	143	239
50,001 to 100,000 sq. ft.	98	96	83	39	104	115	84	132	236	106	80	256	167	188
100,001 to 200,000 sq. ft.	109	96	94	44	122	139	71	132	278	139	114	307		177
200,001 to 500,000 sq. ft.	144	121	103	35	142	141	105	221	271	95	103	249	100	
500,001 to 1,000,000 sq. ft.	181	123		81	61	192	164		255	128	132	372		
over 1,000,000 sq. ft.	146	90	139	50		247			257					
N	5,215	976	649	473	64	279	370	144	217	85	260	43	242	125

Tables 4 through 7 are summaries of some of these EUI analyses performed using EIA's 2003 CBECS metadata.

Table 4 – EUI Ranking – Main Heating Equipment – For All Buildings

Main Heating Equipment	All Buildings Average EUI	Rank
District Steam or Hot Water	216	1
Boilers Inside the Building	132	2
Packaged Heating Units	117	3
Furnaces that Heat Air Directly	94	4
Heat Pumps for Heating	81	5
Other Heating Equipment	67	6
Individual Space Heaters	60	7

Table 5 – EUI Ranking – Main Cooling Equipment – For All Buildings

Main Cooling Equipment	All Buildings Average EUI	Rank
District Chilled Water Piped In	217	1
Central Chillers Inside the Building	152	2
Packaged A/C Unit	114	3
Swamp Coolers or Evaporative Coolers	100	4
Residential-Type Central A/C	95	5
Other Cooling Equipment	92	6
Individual Room A/C	83	7
Heat Pumps for Cooling	82	8

Table 6 – EUI Analysis – By Climate Zone

Climate Zone (30 Year Average)	ALL	Office	Education	Non-Refrigerated Warehouse	Other	Public Assembly	Service	Outpatient Health Care	Inpatient Health Care	Public Order and Safety	Lodging	Laboratory	Food Service	Food Sales
Zone 1 (<2000 CDD, >7000 HDD)	114	96	95	48	71	114	99	144	256	112	88	218	313	195
Zone 2 (<2000 CDD, 5500-7000 HDD)	115	107	90	47	99	97	94	102	284	109	88	351	306	227
Zone 3 (<2000 CDD, 4000 HDD)	115	103	102	38	197	102	92	103	257	94	112	345	337	288
Zone 4 (<2000 CDD, <4000 HDD)	93	77	76	22	58	85	67	88	229	89	80	185	372	192
Zone 5 (>= 2000 CDD, <4000 HDD)	97	79	68	18	41	78	84	105	271	79	108	222	325	251
N	5,129	945	648	469	64	275	370	144	190	85	260	43	242	125

Table 7 – EUI Analysis – By Hours of Operation

Hours per Week Open	ALL	Office	Education	Non-Refrigerated Warehouse	Other	Public Assembly	Service	Outpatient Health Care	Inpatient Health Care	Public Order and Safety	Lodging	Laboratory	Food Service	Food Sales
1 to 39	20	88	53	7	42	27	15	58		27	26	402	123	74
40 to 48	50	88	62	19	45	51	34	97		119	18	250	193	88
49 to 60	71	87	69	30	82	63	51	87		99		191	315	224
61 to 84	84	95	77	41	115	119	66	143			25	302	267	179
85 to 167	119	96	103	32	68	95	156	101			80	307	418	220
Always Open	177	142	120	50	111	131	234	137	259	110	95		586	298
N	4,653	976	647	447	62	275	360	144	217	81	260	43	242	125

Table 3 (on page 3) illustrates a general trend with most of the typical building types; the larger the facility, the more energy being consumed at a higher rate (EUI). There are however, observed exceptions to the general trend. Laboratories are known to have unique operations depending on the type of research/work being done within the facility. The fluctuation throughout the square footage categories can be seen in Table 3. **Laboratories**, regardless of size and specific function, **should always be metered** because of their apparent high EUIs.

The Food Service/Sales building function (as included in the ‘**Other Institutional Uses**’ group in Table 1) account for 6.9% of the federal floor space and are estimated to consume 13.6% of the total energy. Food Service/Sales facilities

are shown to be generally opposite of the other building types as a whole. Small facilities between 1,000 and 10,000 square feet exhibit higher EUIs (as shown in Table 8). For that reason, the ***de minimis threshold of 1,000 square feet*** was developed for ***Food Service/Sales***.

Table 8 – EUI Analysis – Food Service/Sales

Square Footage Category	Food Service		Food Sales	
	Average EUI	Rank	Average EUI	Rank
1,001 to 5,000 sq. ft.	407	1	259	1
5,001 to 10,000 sq. ft.	269	2	129	6
10,001 to 25,000 sq. ft.	215	3	199	3
25,001 to 50,000 sq. ft.	143	5	239	2
50,001 to 100,000 sq. ft.	167	4	188	4
100,001 to 200,000 sq. ft.			177	5
200,001 to 500,000 sq. ft.	100	6		
500,001 to 1,000,000 sq. ft.				
over 1,000,000 sq. ft.				

For Non-refrigerated Warehouses there is a noticeable drop in the average EUIs below 25,000 square feet. A ***de minimis threshold of 25,000 square feet*** was decided for ***Warehouses*** because of the ranking and generally low EUIs.

Table 9 – EUI Analysis – Non-refrigerated Warehouse

Square Footage Category	Warehouse	
	Average EUI	Rank
1,001 to 5,000 sq. ft.	26	9
5,001 to 10,000 sq. ft.	28	8
10,001 to 25,000 sq. ft.	31	7
25,001 to 50,000 sq. ft.	39	5
50,001 to 100,000 sq. ft.	39	4
100,001 to 200,000 sq. ft.	44	3
200,001 to 500,000 sq. ft.	35	6
500,001 to 1,000,000 sq. ft.	81	1
over 1,000,000 sq. ft.	50	2

As illustrated below in Table 10, the remaining typical building functions (including Office, Education, Other, Public Assemble, Service, Outpatient & Inpatient Health Care, and Public Order & Safety) follow the general trend specified previously (EUIs have a tendency to increase with square footage). Based on Table 10, one could argue for the ***de minimis threshold*** for ***All Other Building Functions*** to be set at 10,000 square feet.

Table 10 – EUI Analysis – All Other

Square Footage Category	All Other Average EUI	Rank
1,001 to 5,000 sq. ft.	83	8
5,001 to 10,000 sq. ft.	76	9
10,001 to 25,000 sq. ft.	85	7
25,001 to 50,000 sq. ft.	94	6
50,001 to 100,000 sq. ft.	101	5
100,001 to 200,000 sq. ft.	114	4
200,001 to 500,000 sq. ft.	165	3
500,001 to 1,000,000 sq. ft.	201	1
over 1,000,000 sq. ft.	172	2

5.0 Related Regulatory Requirements

Part of the methodology used to identify the required *de minimis* values also involved aligning existing regulatory requirements. Executive Order (E.O.) 13514³ aims to establish an integrated strategy towards sustainability in the Federal Government and to make reduction of greenhouse gas emissions (GHG) a priority for Federal agencies. Within the text of E.O. 13514 (Section g,iii) it states that at least 15 percent of the agency's existing buildings (**above 5,000 gross square feet**) and building leases (**above 5,000 gross square feet**) must meet the Guiding Principles by fiscal year 2015 and that agencies must make annual progress toward 100-percent conformance with the Guiding Principles for its building inventory.

A requirement of the Guiding Principles is to install building level meters to track resource use and continuously optimize performance. For that reason the ***de minimis threshold*** for ***All Other Buildings*** was lowered to ***5,000 square feet*** to align with the High Performance and Sustainable Building (HPSB) Guiding Principles.

6.0 Industry Standards

Water metering exclusions were derived from the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 189.1 – Standard for the Design of High-Performance Green Buildings, Table 6.3.3A. This table lists minimum thresholds for when measuring water consumption should be considered.

The “less than 5,000 square foot” category was included to provide a *de minimis* size consistent with energy metering.

³ See Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance (October 5, 2009). http://www.whitehouse.gov/assets/documents/2009fedleader_eo_rel.pdf

7.0 De Minimis Threshold Summary

Table 11 is a summary of the *de minimis* thresholds developed for Federal buildings energy metering appropriateness. It was also determined that Laboratories, regardless of size and specific function, should always be metered because of their apparent high EUIs. Laboratories, and all other known energy-intensive facilities, should be prioritized accordingly.

Table 11 – Energy Metering Exclusions

Federal Building	Threshold
Food Service / Sales	< 1,000 square feet
Warehouses	< 25,000 square feet
All Other Building Functions	< 5,000 square feet

Table 12 is a summary of the *de minimis* thresholds developed for Federal buildings water metering appropriateness.

Table 12 – Water Metering Exclusions

Federal Building	Threshold
Large Water Using Process	Consumption < 1,000 gal/day
Irrigated Landscape Area	< 25,000 square feet
All Building Functions	Consumption < 1,000 gal/day
All Building Functions	< 5,000 square feet

As shown in Table 13 below, 73% of Federal buildings (by number of buildings) according to FRPP data would be excluded based on the metering exclusions from Tables 11 and 12 (i.e. < 5,000 square feet).

Table 13 – FRPP Building Breakdown

Building Size	Square Footage	# of Buildings	Percent by Square Footage	Percent by # of Buildings
Any	2,867,095,836	295,209	100%	100%
Buildings > 5K GSF	2,556,011,533	79,772	89%	27%
Buildings ≤ 5K GSF	311,084,303	215,437	11%	73%

For more information on metering appropriateness and prioritization processes see the updated *Federal Building Metering Guidance*.⁴

⁴ See Federal Building Metering Guidance (per 42 U.S.C. § 8253(e), Metering of Energy Use), Federal Leadership on Energy Management (November, 2014), http://energy.gov/sites/prod/files/2014/11/f19/metering_guidance.pdf.



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