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under Contract DE-AC05-76RL01830

Characteristics of the Department of Energy's Building Inventory FY2005- FY2010

SA Loper
WF Sandusky

February 2012



Pacific Northwest
NATIONAL LABORATORY

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Federal Energy Management Program
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Pacific Northwest National Laboratory
Richland, Washington 99352

Executive Summary

The Federal building inventory is a collection of more than 400,000 buildings. The government's property inventory is different than the private sector inventory, because of the diverse agency missions, real estate needs, lack of influence by local building codes as determined by land ownership jurisdiction, and uses. While the general inventory is summarized according to predominant use, the descriptive measure is total square footage within each building type. Missing in the descriptive information are the actual characteristics of the buildings according to use. The characteristics include number and square footage by building type and how these have changed over time. This is important information to agencies as they continue to drive toward the mandated energy and water intensity reduction goals. It is also key in how and where agencies implement efficiency and conservation programs in the most cost-effective manner.

The Pacific Northwest National Laboratory (PNNL), as part of their on-going support to the Department of Energy's Federal Energy Management Program (FEMP), was asked to analyze special building data for an agency to gain a better understanding of the inventory characteristics to help better shape implementation of its alternative financing activities. This report provides information for one agency, Department of Energy (DOE), and describes how individual building type characteristics have changed over time.

Results of this analysis revealed the following for building level data available for the years of FY2005 through FY2010:

- The DOE inventory is diverse in terms of location, predominate use, and changes over time.
- The building inventory is classified into 15 separate building types, with the predominate type being *Service* buildings, followed by *Warehouse*, *Office*, *Laboratory*, and *Industrial*. The number of buildings in each type, except for *Laboratory* and *Other*, show an increase from FY2005 to FY2010.
- The FY2010 data indicates individual building floor space ranged from 8 ft² to 2,850,216 ft².
- As of FY2010, DOE buildings were located at 531 individual sites with a combined total of 9,607 individual buildings with a total floor space of 108,049,567 ft². That is a 7% increase in number of sites, 5% increase in terms of buildings, and 6% increase in total floor space as reported in FY2005.
- On an individual building basis for the FY2010 data, a vast majority (72%) have floor space of less the 5,000 ft², while only 2% have floor space greater than 100,000 ft².
- While the overall DOE building inventory is comprised of relatively small size buildings, some sites have a large number of buildings and some have a large amount of floor space.

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1.0 Introduction

The Federal sector continues to seek ways to reduce both energy and water consumption in the Federal building inventory, as required by legislation (EISA 2007) and Executive Orders 13423 and 13514 (72 FR 3919-3923 and 74 FR 52117-52127). Both legislation and Executive Orders establish specific annual and cumulative energy and water intensity reduction goals. The U.S. Department of Energy's Federal Energy Management Program (FEMP) developed the Federal Site Building Characteristic Database (FSBCD) to provide information regarding building characteristics that can aid in locating energy and water efficiency opportunities. Loper and Sandusky (2010) have previously summarized several building characteristics of the FSBCD at the Federal sector level. Included in those characteristics were geographical distribution of sites, distribution of building count and floor space by Federal building type classified by agency, and many others. However, the FSBCD does not collect or report individual site building data on an annual basis for each agency. Building specific data for Federal sites is collected by the Federal Real Property Council (FRPC), who publishes annual real property reports on important aspects of the building inventory, such as disposition of real property, operating cost and various performance measures, such as use and condition at the total Federal level or key agency level (FRPC 2009). What is lacking between the FSBCD and the FRPC reports is a thorough analysis of each agency's building inventory and how it changes over time. Understanding these changes in building inventory can be useful to the agency in updating and implementing their respective Strategic Sustainability Plans, which are submitted annually, that also identify planned approach for continued reduction in both energy and water use. This would address the question - As building inventory changes, does the agency's water and energy consumption change?

Annual data used in the FRPC process for a specific agency is only available to that agency's Federal employees and their contractors. For that reason, this analysis is limited to annual data for the DOE building inventory for the period of FY2005 through FY2010, as provided from the FRPC. By having access to annual data, the scope of the analysis includes general characteristics of the DOE building inventory as well as changes in real property over time.

This report is divided into seven sections. The sections are organized in a manner of decreasing disaggregation data to better portray the analysis results. Section 2.0 provides an overview of the total DOE building inventory in terms of number of sites, total number of buildings, and total floor space on an annual basis. The characterization of the buildings into unique building types is provided in Section 3.0. That section also provides information regarding the number of buildings in each building type over time, to provide an overview of predominate building types in the DOE inventory. Section 4.0 summarizes individual building floor spaces into groups from both a total agency overview and by building type. This provides a better feeling for the distribution of building size for a specific building type. Section 5.0 provides characteristic information for those sites that have the largest total number of buildings and total floor space. This section also covers the distribution of the sites. These sites should represent the largest opportunity for energy efficiency and water conservation projects as viewed at the DOE level. The conclusions of the analysis are summarized in Section 6.0, with cited references listed in Section 7.0.

2.0 DOE Building Inventory Overview

Data for the DOE's real property building inventory was downloaded from the General Services Administration's (GSA) Federal Real Property Profile (FRPP) (GSA 2011). The FRPP is a database listing all Federal agencies real property building information, and specific data is available for download by Federal employees and contractors. The available information includes specific building information for each site. Federal employees and their contractors may only download data for their agency; data for other agencies is not available to them. For this study, all available DOE data was downloaded and included the years FY2005 through FY2010.

When downloading data from the FRPP website, the following search criteria was used:

Fiscal Year: (Each individual year from FY2005-FY2010)

Reporting Agency: Energy

Search Area: Uploaded

Display: Description

Reporting Bureau: All

Real Property Type: Building

Building: All

Legal Interest Indicator: All

Status: Active

Geographic Location: United States

Once the data was downloaded, it was summarized to gain insight on how overall characteristics of the building inventory have changed over time, if any, and how that information may be used in applying specific implementation programs.

The total number of DOE sites has been increasing since FY2005 (Table 1). A site does not necessarily mean one building; a site can have one building or many buildings and building types. In FY2005, there were 495 sites and the number increased 7% by FY2010. Total building counts rose from FY2005 to FY2006 but declined slightly in FY2007 (Table 1). In FY2008, building counts were still above FY2005 values and continued to increase in FY2009 and FY2010 (Table 1). Overall, the total number of buildings increased by 491, or 5%, from FY2005 to FY2010. Total floor space (ft²) increased dramatically from FY2005 to FY2006. This increase was so large even a FY2007 to FY2010 decline still resulted in FY2010 total floor space being larger than FY2005 (Table 1). Overall, total floor space increased by over 6 million ft² or 6% from FY2005 to FY2010.

Table 1. DOE's Number of Sites, Number of Buildings and Total Floor Space

FY Year	Total Number of Sites	Number of Buildings	Square Feet
2005	495	9,116	101,915,187
2006	512	9,614	115,788,485
2007	513	8,731	113,960,851
2008	525	9,335	110,342,740
2009	528	9,377	108,112,840
2010	531	9,607	108,049,567

Individual sites may change from year to year in regards to the number of buildings and total square feet. Table 2 shows an example of one site and how number of buildings and total square feet fluctuated from year to year. Some sites, however, have either been dropped or added to the database from year to year. Many of the sites dropped or added include substations or communication sites. Other sites are dropped because their mission is completed.

Table 2. Example of One Site's Fluctuation in Number of Buildings and Total Floor Space

FY Year	Number of Buildings	Square Feet
2005	77	1,334,815
2006	76	1,322,360
2007	75	1,246,591
2008	75	1,181,943
2009	75	1,181,813
2010	74	1,224,710

3.0 Building Types

There are 15 different building types within the DOE’s building inventory (Table 3). These building types follow GSA’s real property database definitions of building categories (FRPC 2010). Comparing total building counts between years does not give enough information to thoroughly understand the characteristics of the building inventory. By understanding the type of buildings in an agency’s inventory, it can provide insight regarding the potential for energy and water savings because different building categories have distinct usage patterns. For example, hospitals tend to have high potential for water efficiency improvements, while storage facilities typically have little potential for large energy efficiency enhancements. Hospitals are water intensive facilities because they operate 24 hours per day, 7 days per week.

Table 3. DOE Building Types

Building Type	Characteristics
All Other	Not fitting into another category
Communications Systems (Comm Systems)	Communication facilities (e.g., radio towers, telephone, data transmissions)
Dormitories/Barracks	Housing for individuals without families
Family Housing	Family dwellings
Hospital	In-patient healthcare facilities
Industrial	Production or manufacturing
Laboratory (Lab)	Research and development
Museum	House/display objects
Navigation and Traffic Aids	Aircraft or ship navigation and traffic aides
Office	Office space
Other Institutional Uses	Other Institutional uses (such as out-patient healthcare facilities, libraries, chapels)
Post Office	Post Office
School	Formal training
Service	Maintenance and repair
Warehouses	Storing goods

Prisons and Detention Centers are also listed in GSA’s real property database but DOE did not have any buildings in this category.

Buildings classified as *Service* had the greatest number of buildings for all 6 years, followed by *Warehouses*, *Office*, and *Laboratories* (Figure 1). The *All Other* building types made up 8.9% and 8.7% of total number of buildings for FY2005 and FY2006, respectively, but declined to less than 1.0% for the next 3 years (Figure 1). *Communication Systems*, *Dormitory/Barracks*, *Family Housing*, *Hospital*, *Museum*, *Navigation and Traffic Aids*, *Other Institutional Uses*, *Post Office*, and *Schools*, each have less than 2.7% of the total number of buildings for all 6 years (Figure 2). DOE had two buildings classified as *Post Offices* from FY2005 through FY2009, then only one in FY2010. There were no *Museum* buildings from FY2005 through FY2007, then 15 in FY2008, and 14 in both FY2009 and FY2010.

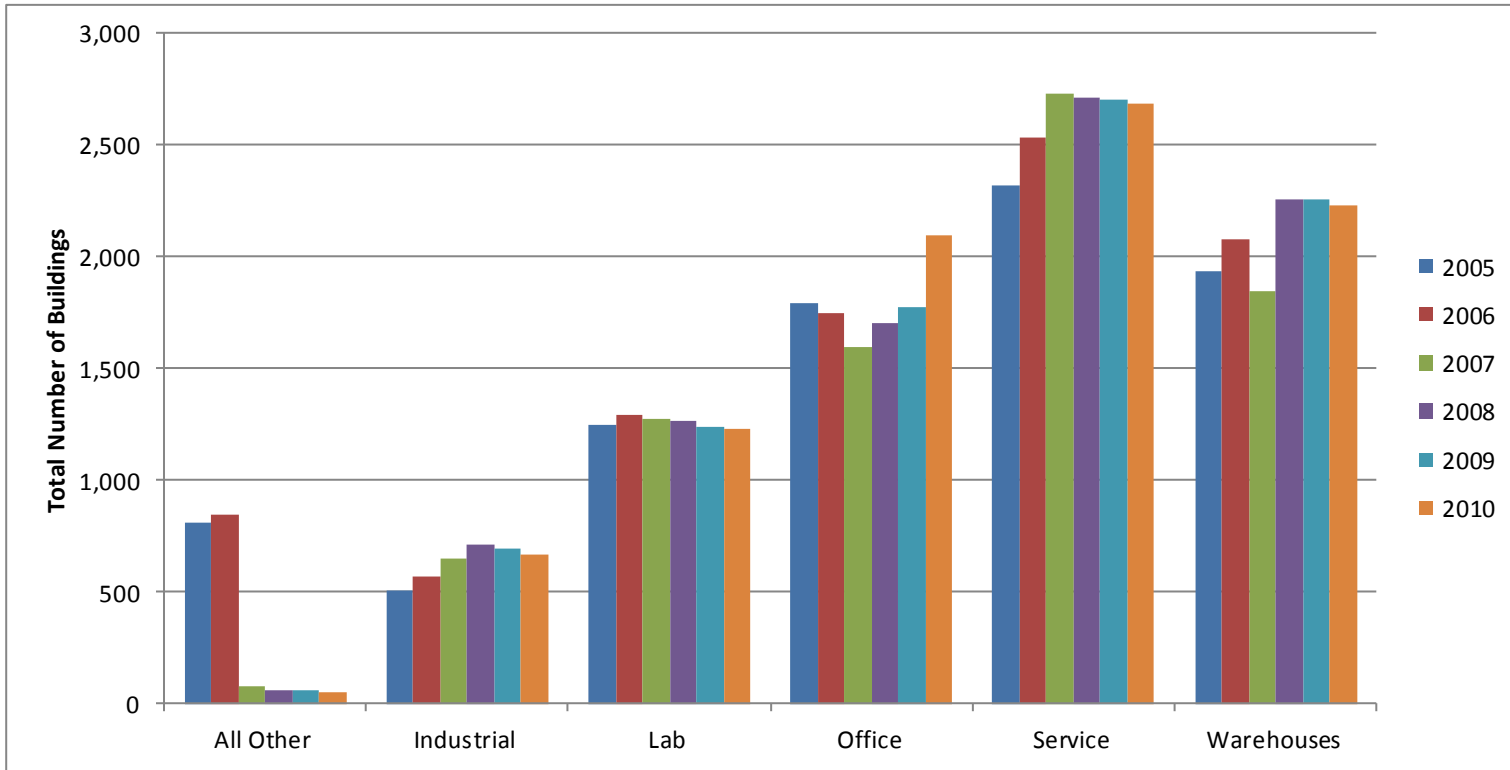


Figure 1. Annual Total Building Count by Building Type – Greater than 500 total buildings for any FY.

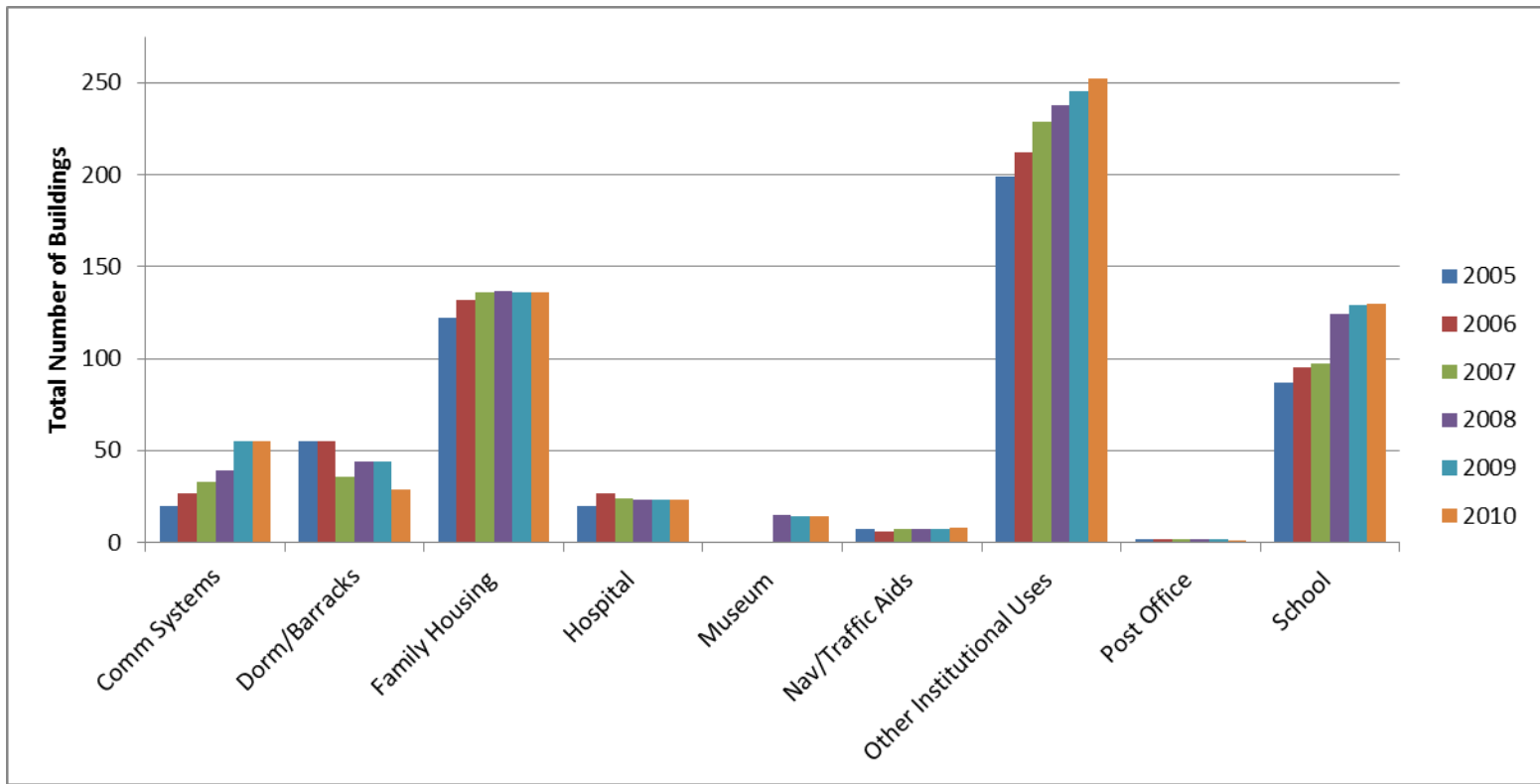


Figure 2. Annual Total Building Count by Building Type – Under 500 total buildings for any FY.

When looking at changes from year to year and overall from FY2005 to FY2010, there have been large changes in both number of buildings and total floor space. Buildings classified as *All Other* had the greatest change from FY2006 to FY2007, dropping from 841 total number of buildings to 81. This affected the total floor space in this category as well, dropping 93.6%, going from 3,520,788 ft² to 191,771 ft² for those 2 years. Overall, from FY2005 to FY2010, the *All Others* building category decreased 93.5% in the 6 years going from 812 buildings down to just 53. When comparing FY2006 with FY2007 data, 725 buildings that previously were classified as *All Other* in FY2006 were reclassified into one of the other building types in FY2007.

Buildings classified in the categories of *Communications Systems*, *Dormitory/Barracks*, and *Schools* had large fluctuations in total number of buildings within the 6 years. However, overall change in both total number of buildings and total floor space from FY2005 to FY2010 was greatest for buildings classified as *Communication Systems*. The total number of buildings rose 175%, going from 20 buildings to 55 and total floor space increased 94.8% going from 26,641 ft² to 57,745 ft². For all 6 years, buildings classified as *Schools* increased 49.4%, from 87 buildings to 130, but the change in total floor space was only 20.8%. Buildings classified as *Dormitories/Barracks* decreased 47.3% over the 6 year period going from 55 buildings to 29 buildings and decreasing total floor space 43.2%, from 315,899 ft² to 179,367 ft².

Buildings classified in the *Industrial* category made up the greatest total floor space for all 6 years, followed by *Laboratories*, then *Offices* (Figure 3). Buildings in the categories *Post Office*, *Navigation* and *Traffic Aids*, and *Communication Systems* having some of the smallest total floor space for all years (Figure 4).

When total number of buildings in each building type is compared to total floor space there is not always a correlation between the two. For example, between 5% and 8% of the total number of buildings were classified as *Industrial* buildings (Figure 5), but this type has had 27% to 30% of the total floor space (Figure 5). Whereas, buildings classified as *Warehouses* had around 20 and 24% of the total number of buildings for the 6 years, but only around 10% total floor space (Figure 5). There were also a high number of total buildings in the *Service* category, between 25% and 31%, but a lower total floor space, around 8% (Figure 5). So, although DOE has a larger number of buildings classified as in the *Warehouse* and *Service* category, they are relatively small in size. Conversely, there are fewer *Industrial* building types, but they tend to be larger in total floor space.

Buildings classified in the *Communication Systems*, *Dormitories/Barracks*, *Family Housing*, *Hospital*, *Museums*, *Navigation/Traffic Aids*, *Other Institutional Uses*, *Post Office* and *School* types are each under 3.3% for total number of buildings and for total floor space during each year from FY2005 to FY2010 (Figures 2 and 4).

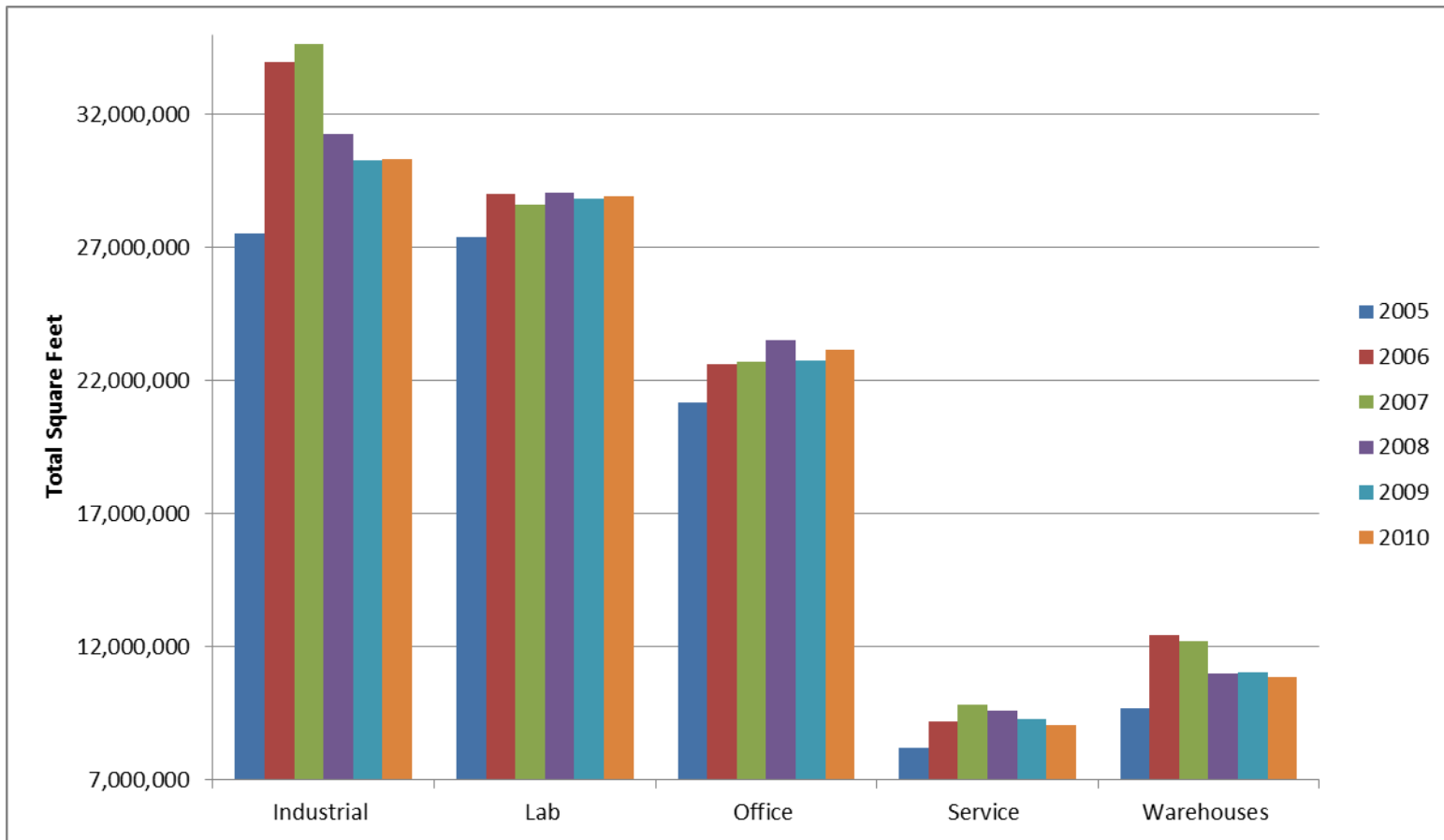


Figure 3. Annual Total Floor Space by Building Type – Greater than 7,000,000 ft² for any FY.

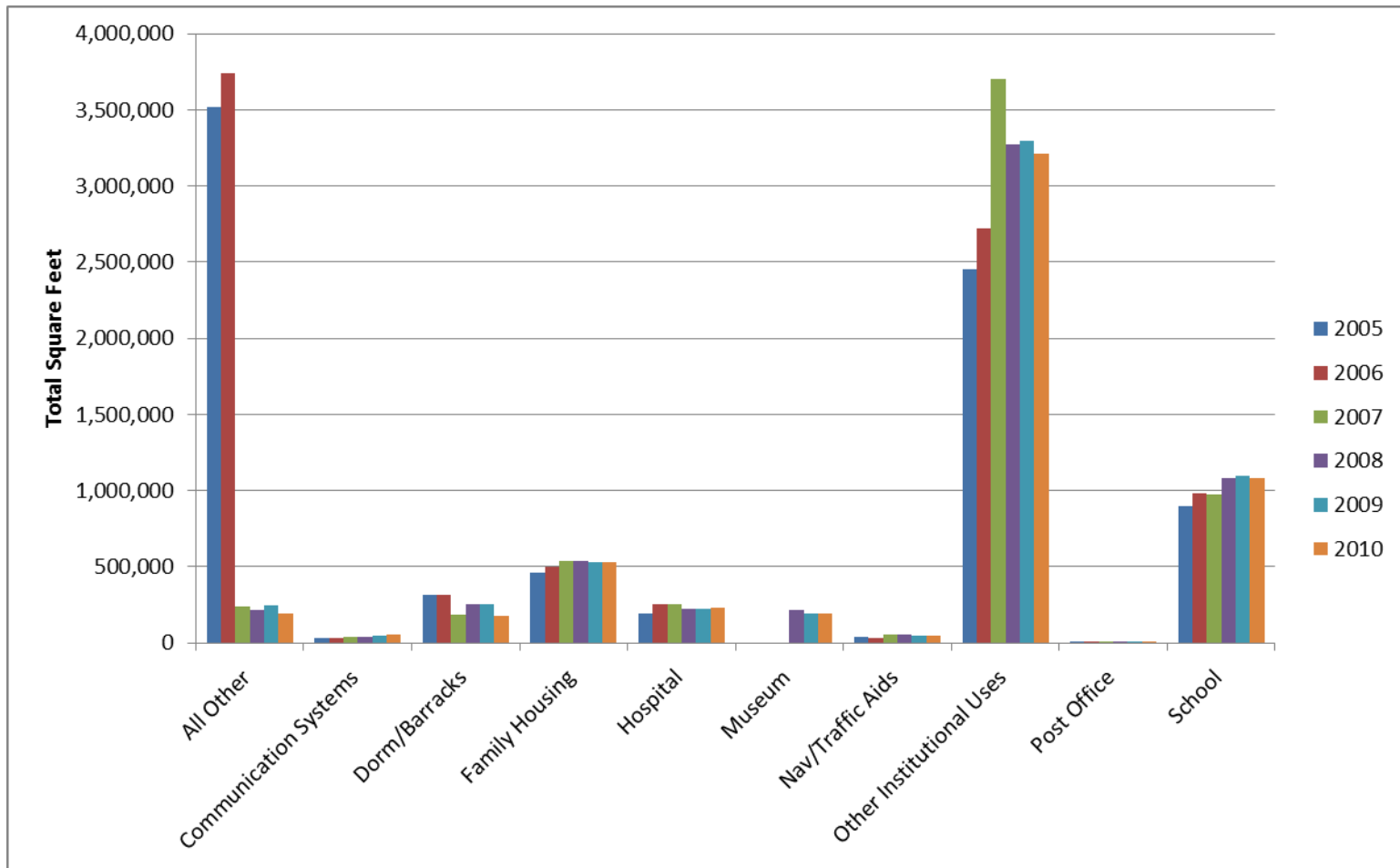


Figure 4. Annual Total Floor Space by Building Type – Less than 7,000,000 ft² for any FY.

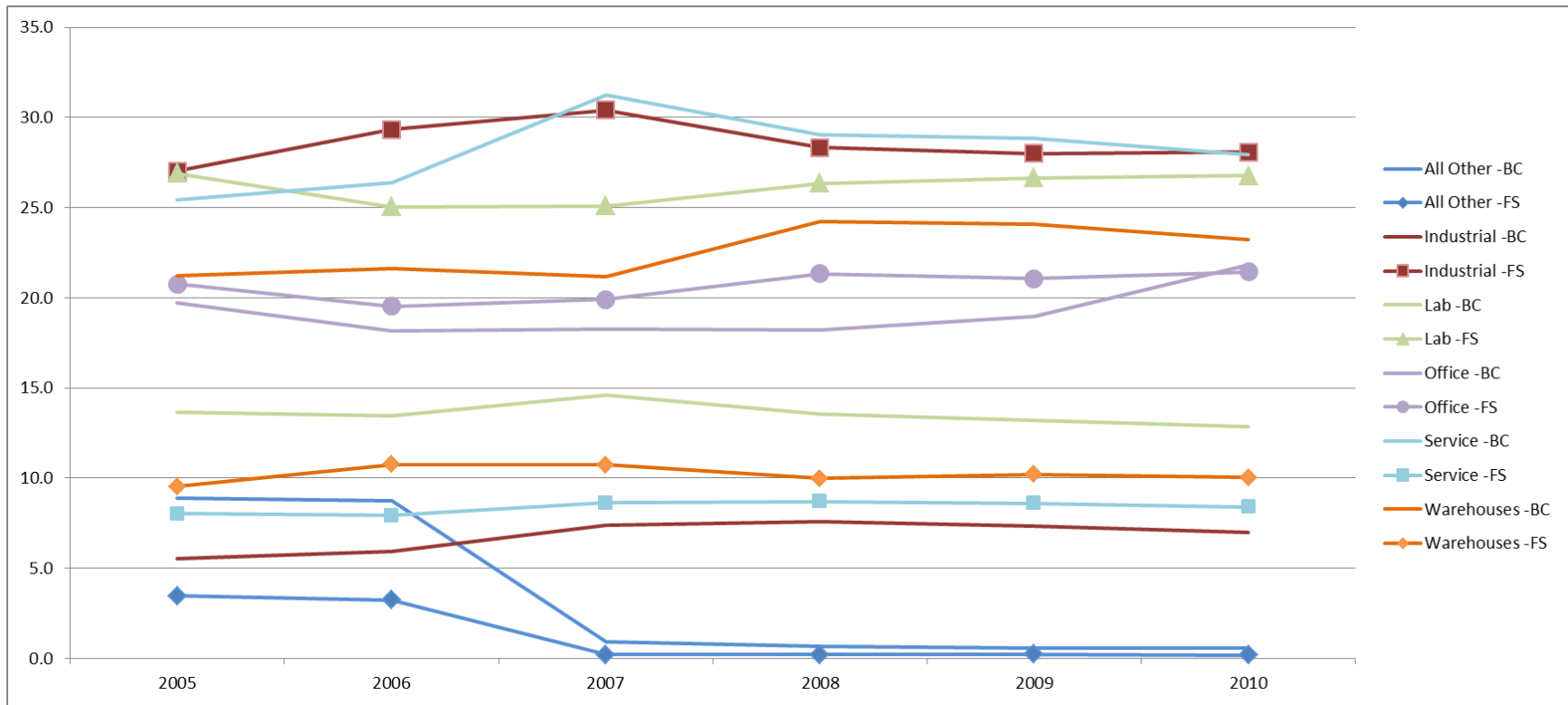


Figure 5. Percent Totals for Number of Buildings (BC) and Total Floor Space (FS) by Building Type.

4.0 Floor Space per Building Type - FY2010

Using average floor space calculations for a specific building type is not effective in the ultimate design of energy and water efficiency programs because the size of the individual buildings varies markedly across the Federal building inventory and within a specific category. For FY2010, total floor space by individual building type varies from 8 ft² (*Communications Systems*) to 2,850,216 ft² (*Industrial*). Of all buildings, 72% were less than or equal to 5,000 ft²; whereas, less than 1% were greater than 200,000 ft² (Figure 6). Figures 7 through 20 show the total floor space by building type within certain size ranges. Information on the *Post Office* type is not included because there is only one building in this building type (size of building is in the 5,001-10,000 ft² category).

Of all building types classified as *Communications System*, 87% have floor space less than or equal to 1,000 ft². The remaining buildings in this building category have floor space ranging from greater than 1,000 up to 25,000 ft² (Figure 8). Over 50% of the buildings classified as either *All Others*, *Service*, or *Warehouses* are less than or equal to 1000 ft² (Figures 7, 19, 20). Over 50% of the buildings classified as either *Dormitories/Barracks* or *Family Housing* have floor space that is greater than 1,000 but less than 5,000 ft² (Figures 9 and 10). Of the buildings classified as *Hospital*, 43% have floor space that is greater than 10,000 but less than 25,000 ft² (Figure 11). Only the *Industrial* and *Laboratory* building types have individual buildings with total floor space over 500,000 ft² (Figures 12 and 13).

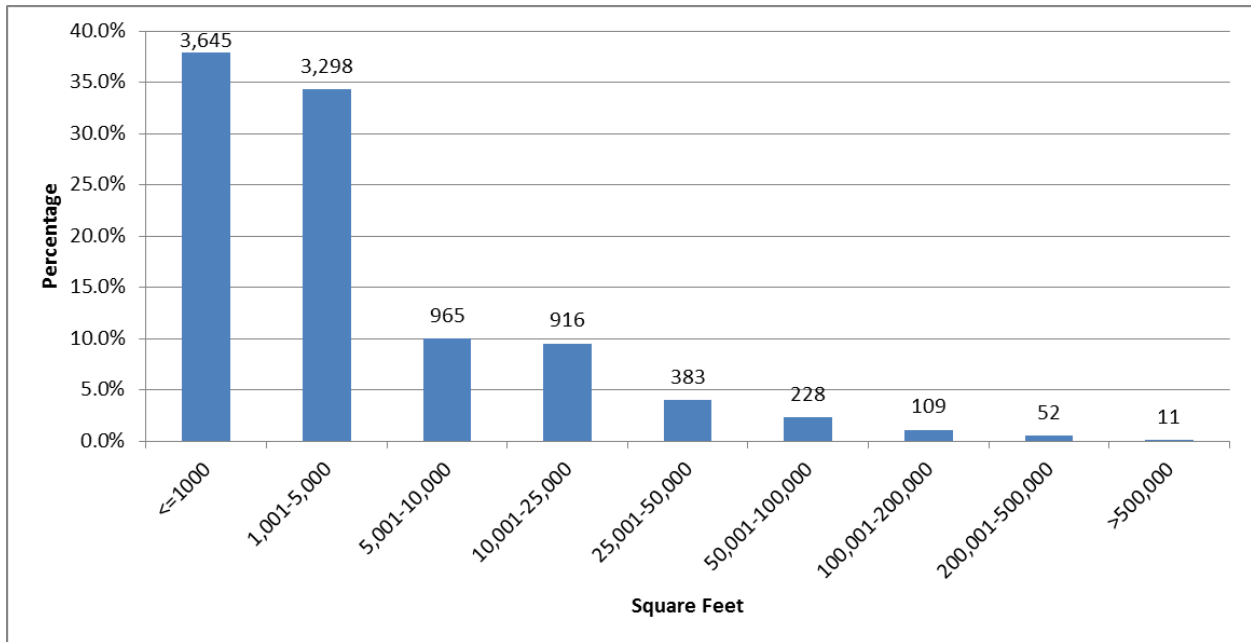


Figure 6. Total Floor Space per Building (ft²) for All Buildings Types – DOE FY2010.¹

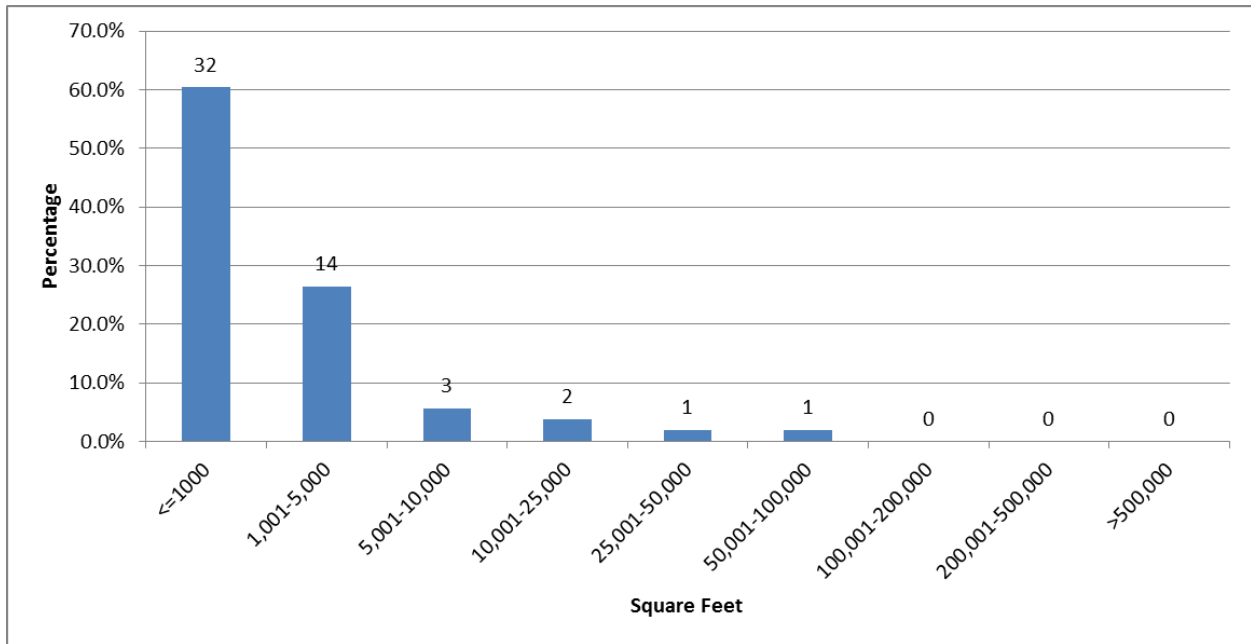


Figure 7. Total Floor Space per Building (ft²) for All Others Building Type – DOE FY2010.¹

¹ Numbers above bar are total number of buildings in that size category.

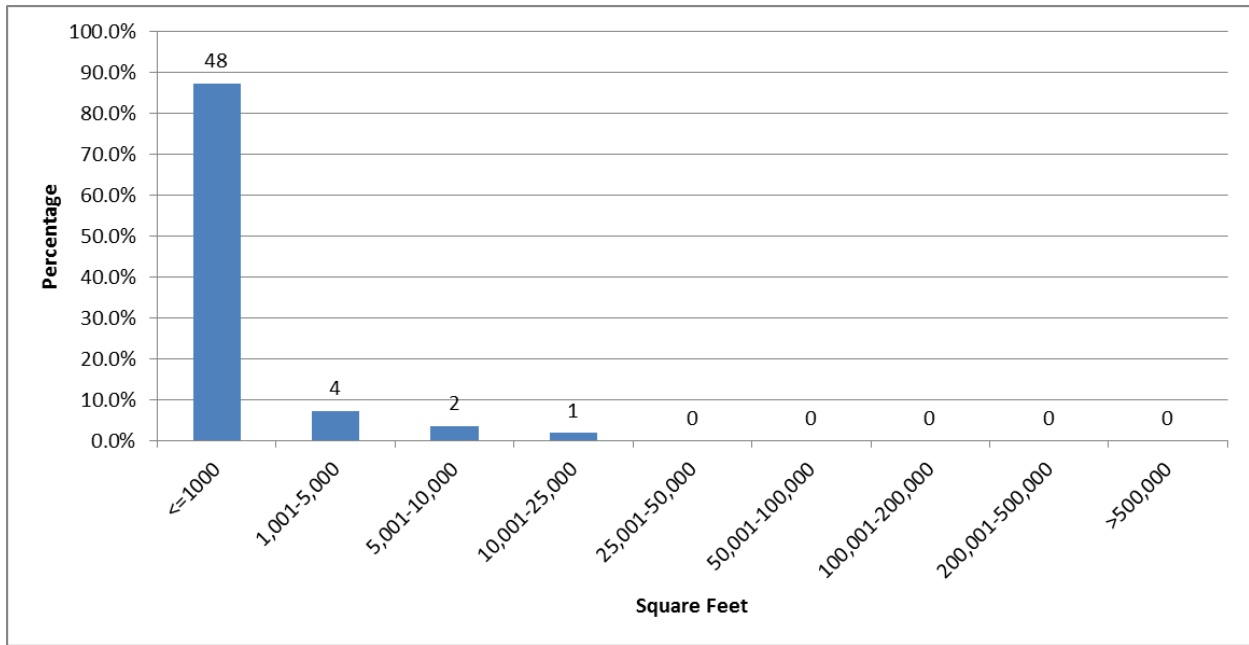


Figure 8. Total Floor Space per Building (ft²) for Communications Systems Building Type – DOE FY2010.¹

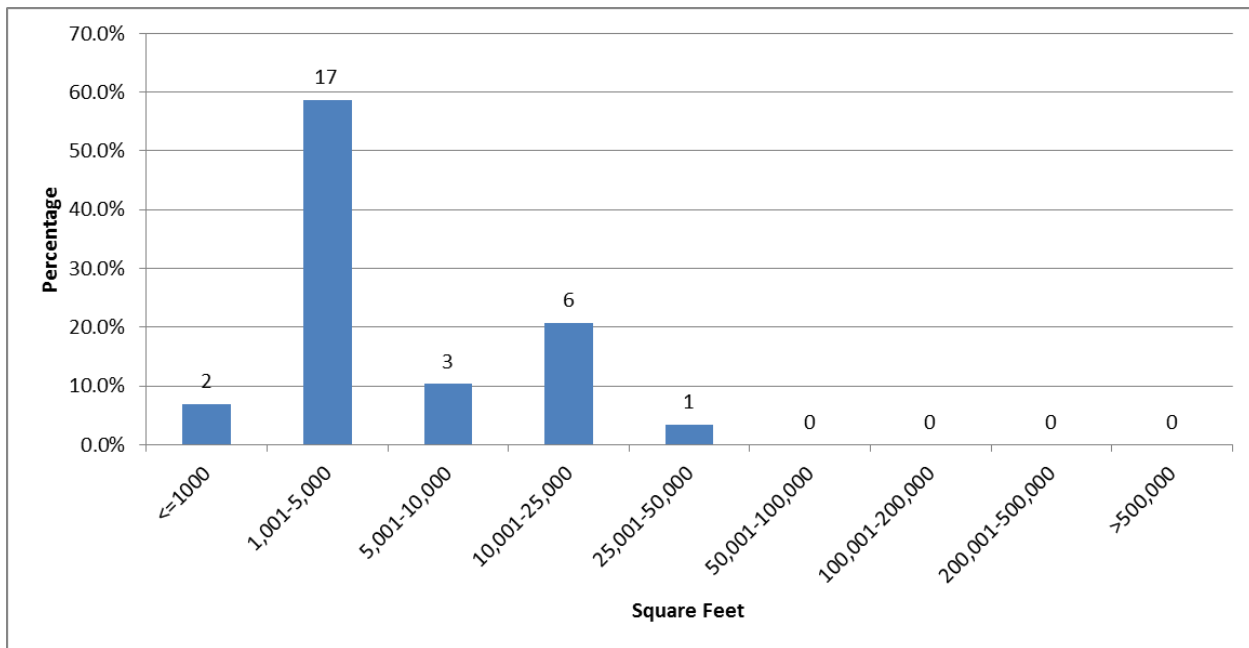


Figure 9. Total Floor Space per Building (ft²) for Dormitories/Barracks Building Type – DOE FY2010.¹

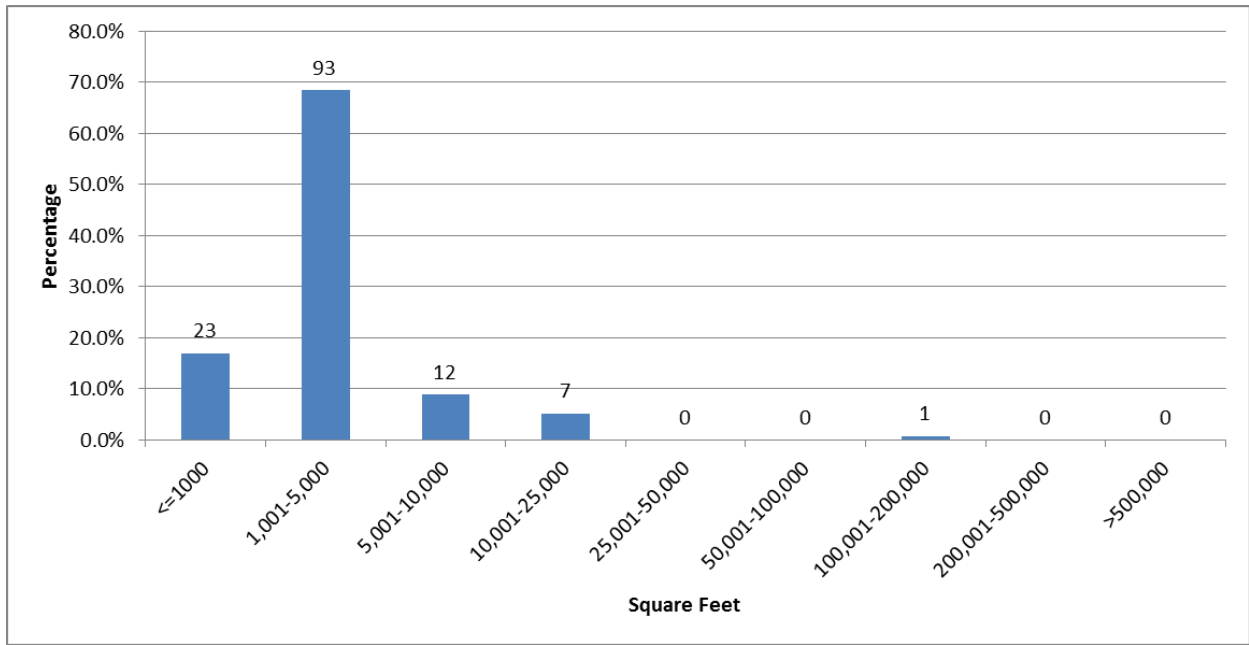


Figure 10. Total Floor Space per Building (ft²) for Family Housing Building Type – DOE FY2010.¹

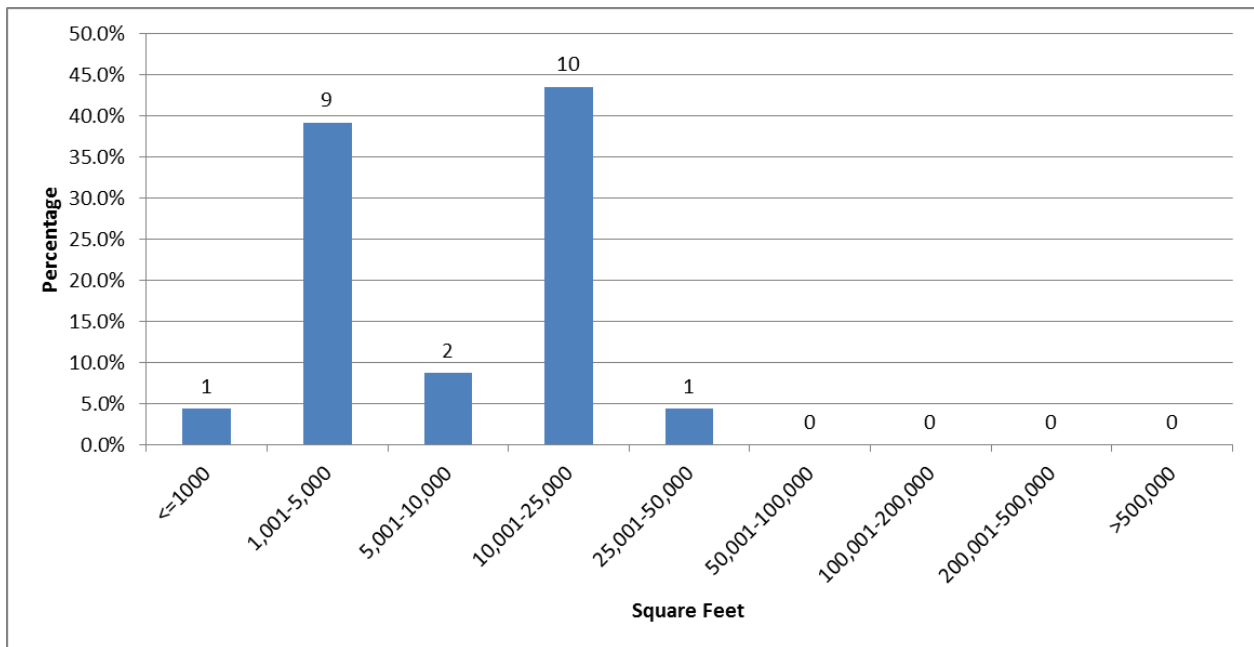


Figure 11. Total Floor Space per Building (ft²) for Hospital Building Type – DOE FY2010.¹

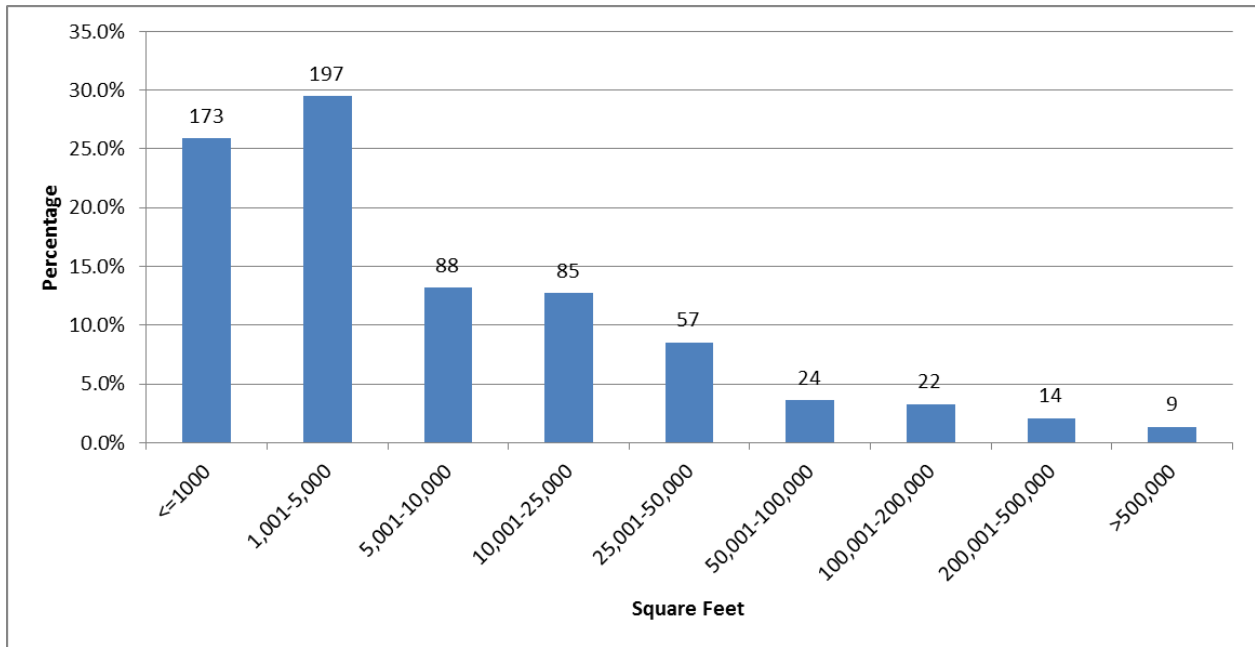


Figure 12. Total Floor Space per Building (ft²) for Industrial Building Type – DOE FY2010. ¹

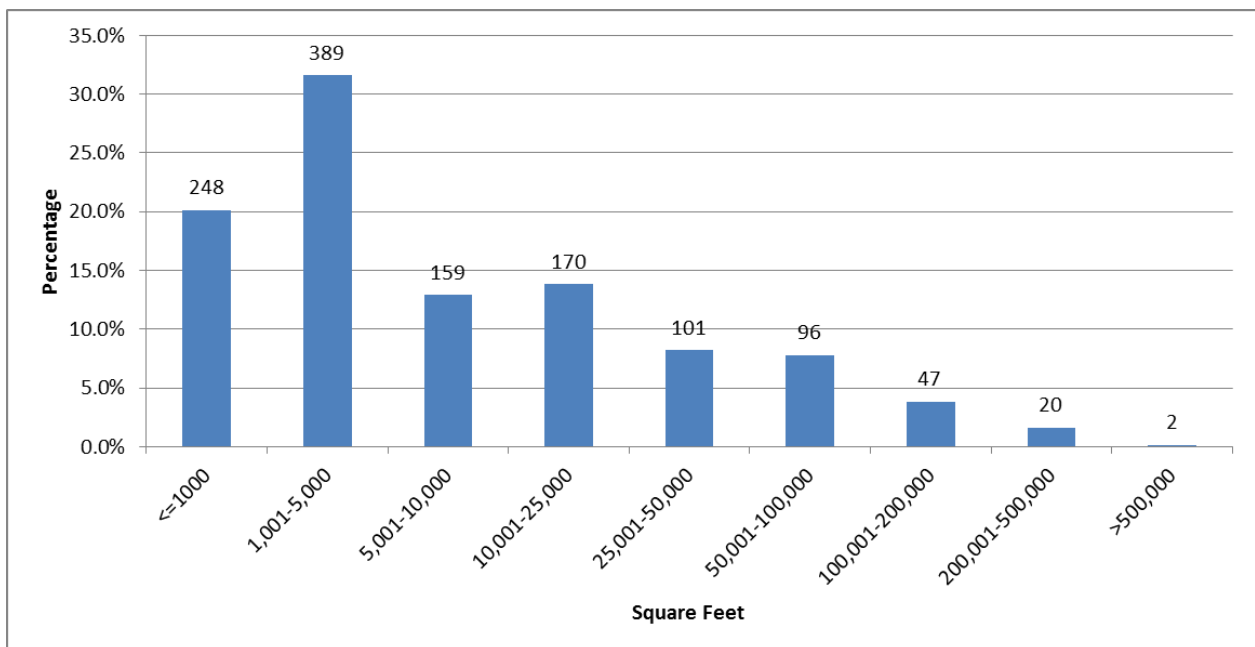


Figure 13. Total Floor Space per Building (ft²) for Laboratory Building Type – DOE FY2010. ¹

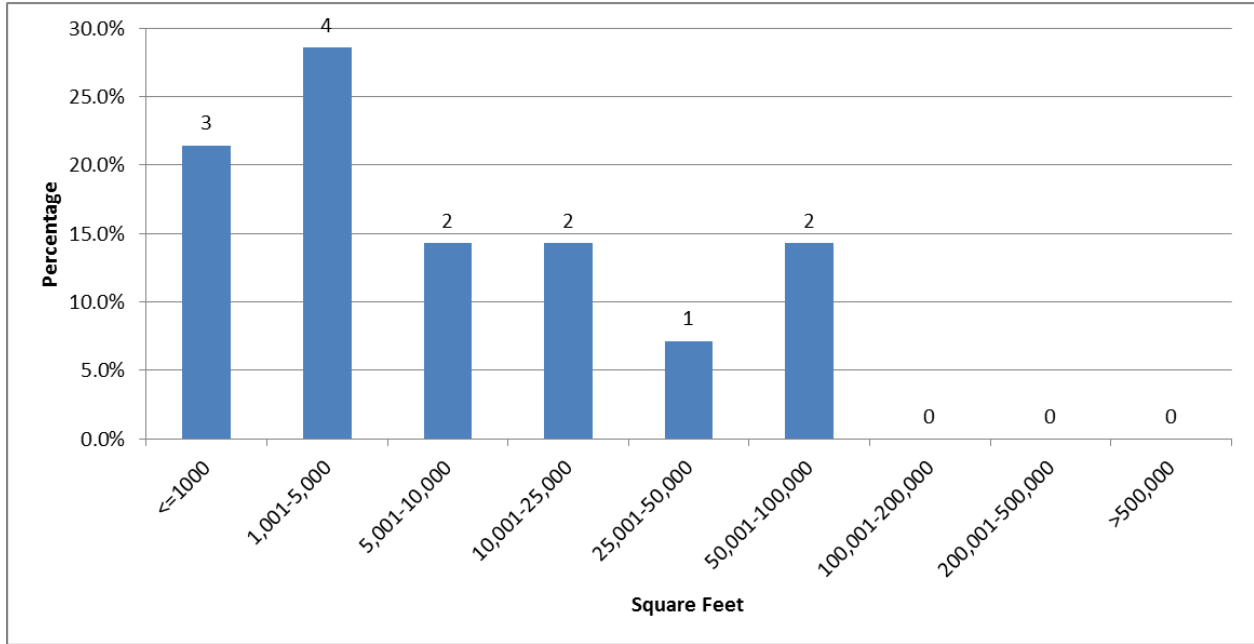


Figure 14. Total Floor Space per Building (ft²) for Museum Building Type – DOE FY2010.¹

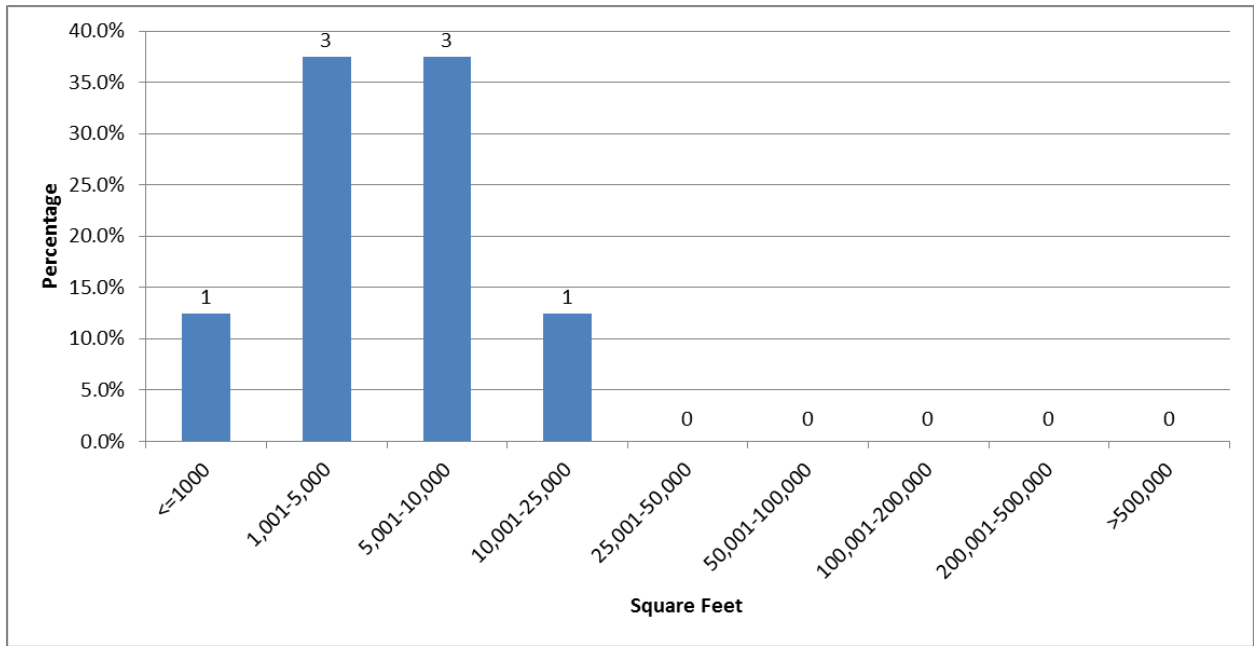


Figure 15. Total Floor Space per Building (ft²) for Navigation/Traffic Aids Building Type – DOE FY2010.¹

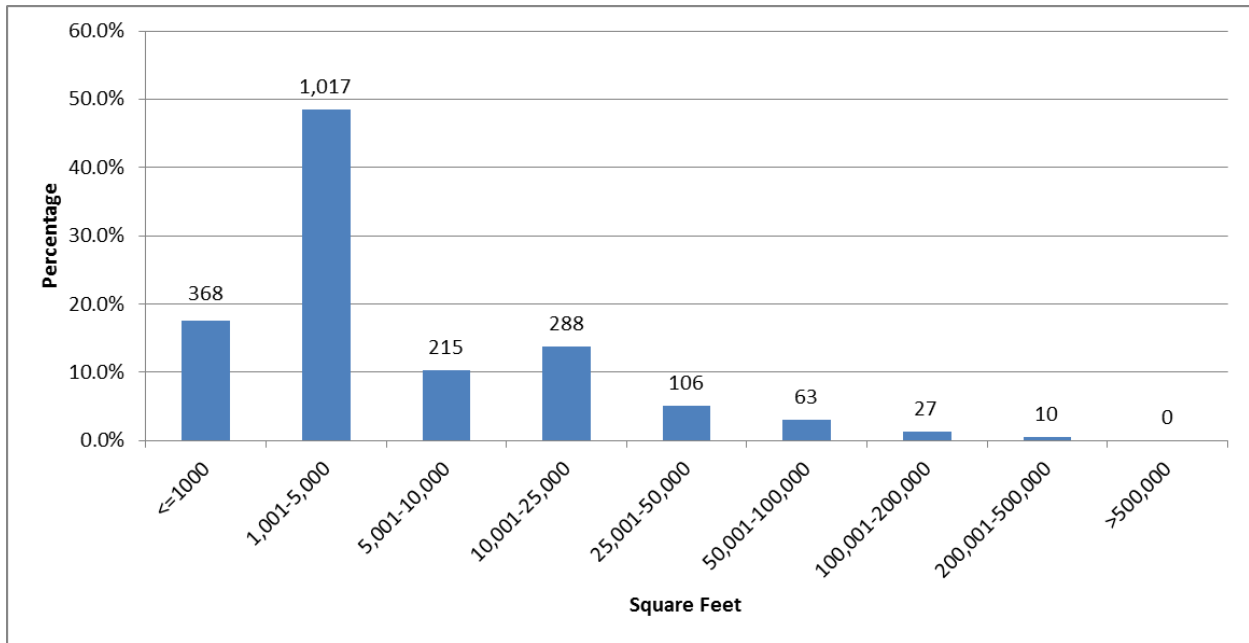


Figure 16. Total Floor Space per Building (ft²) for Office Building Type – DOE FY2010.¹

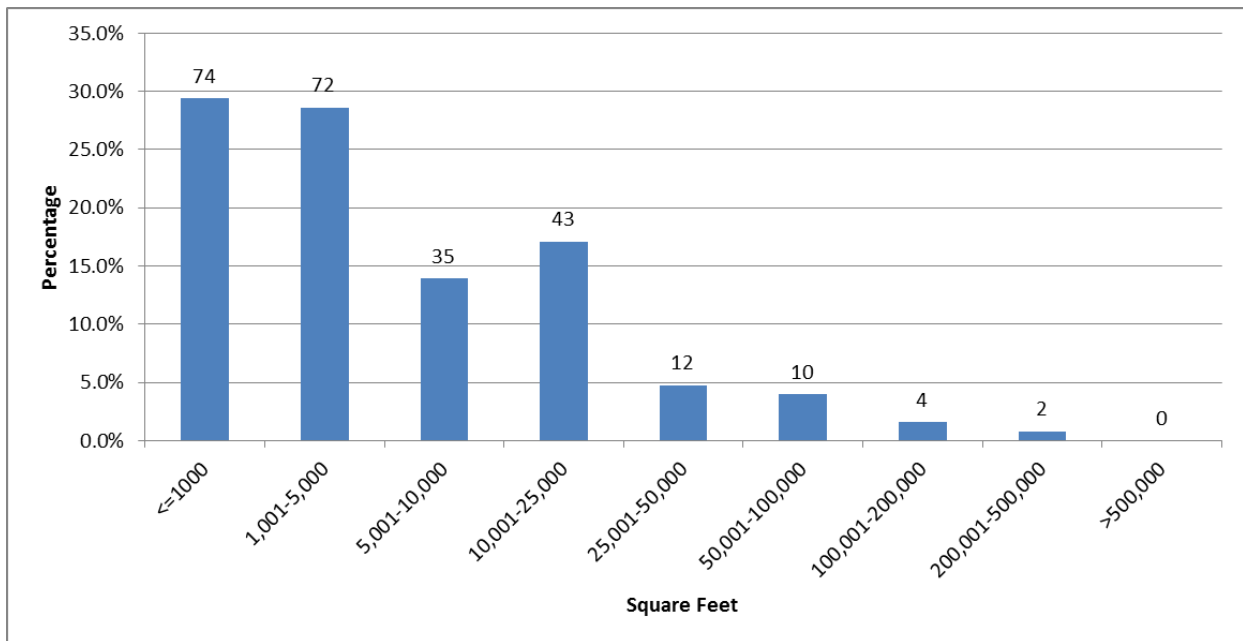


Figure 17. Total Floor Space per Building (ft²) for Other Institutional Uses Building Type – DOE FY2010.¹

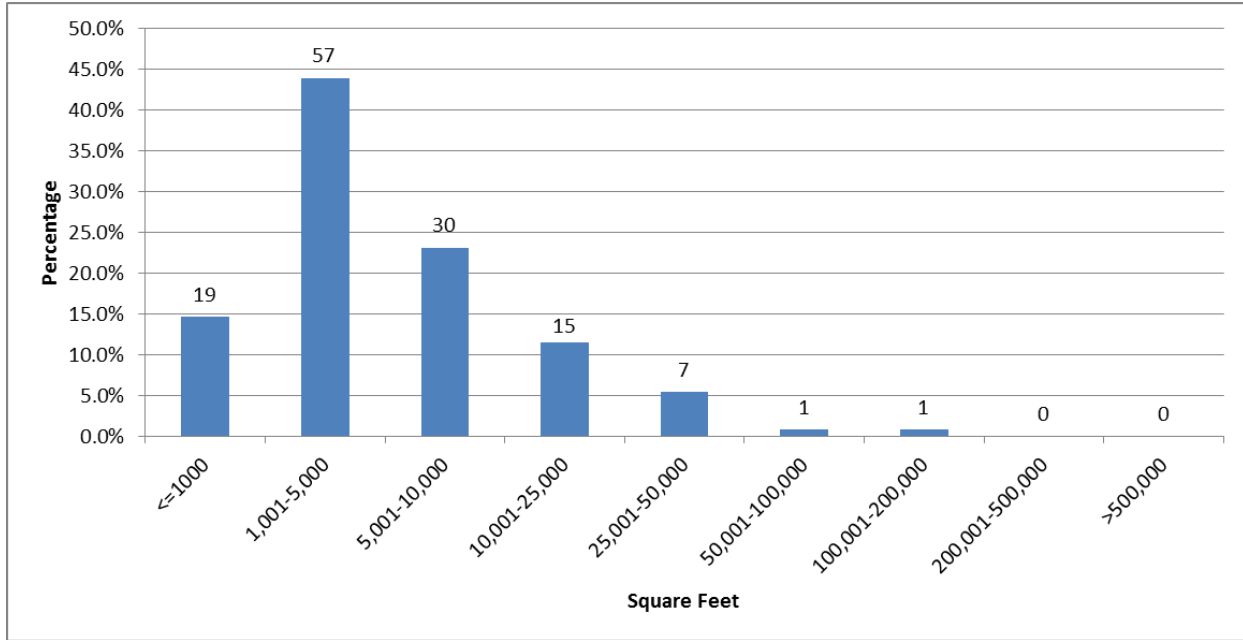


Figure 18. Total Floor Space per Building (ft²) for School Building Type – DOE FY2010.¹

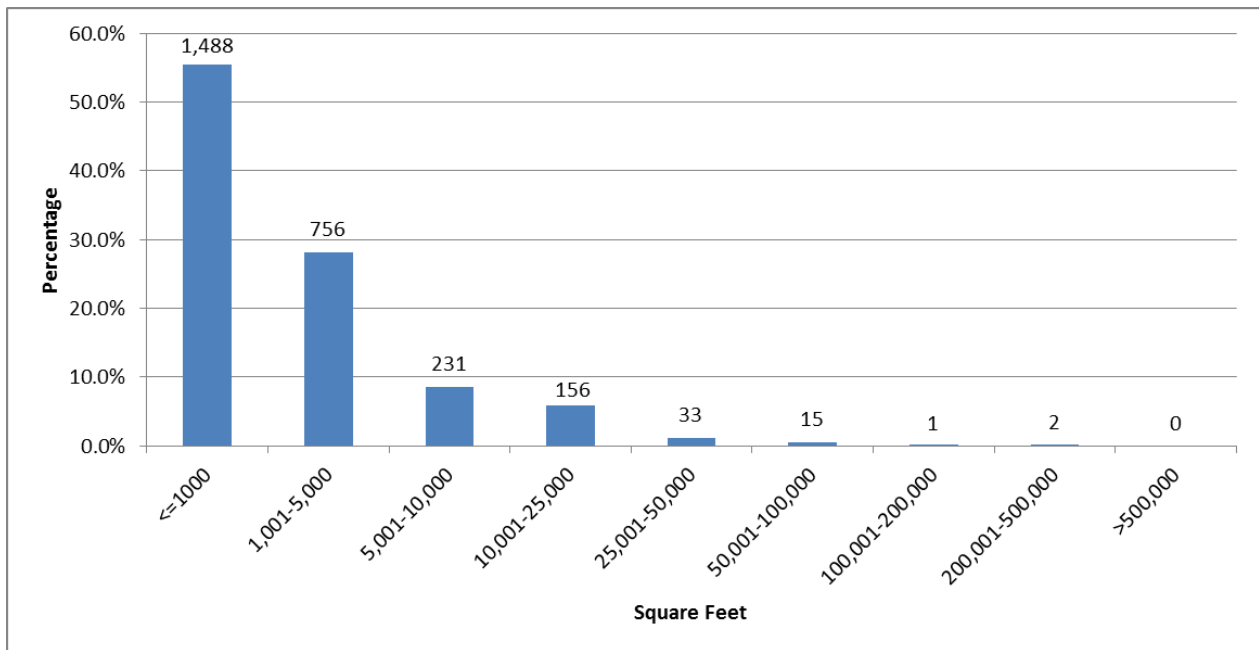


Figure 19. Total Floor Space per Building (ft²) for Service Building Type – DOE FY2010.¹

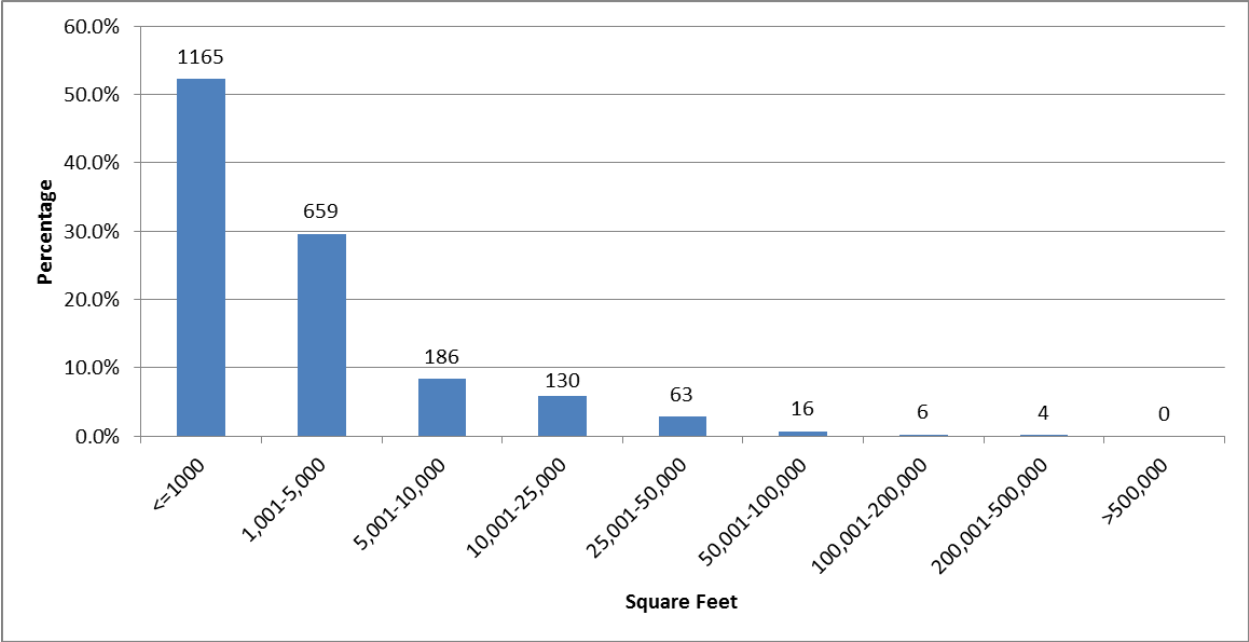


Figure 20. Total Floor Space per Building (ft²) for Warehouse Building Type – DOE FY2010.¹

5.0 Top 10 Sites and Distribution of Sites

The top 10 sites (in FY2010) in terms of total number of buildings and total floor space were identified and change from the preceding years determined (Table 4). For 7 of the top 10 sites, the total building count stayed fairly consistent over the 6 years (Figure 21). The other three sites, however, had dramatic changes. LANL has the largest number of buildings during the study period, but, the total number of buildings declined 24% from FY2005 to FY2010 (Figure 21). SNL reported a large decline in FY2007, but increased significantly in FY2008 (Figure 21). This appears to indicate the data reported in FY2007 was likely erroneous. SRS reported an increase of 21% in total number of buildings from FY2005 to FY2010 (Figure 21), with the increase primarily occurring between FY2009 and FY2010.

Considering total floor space, the Portsmouth site reported the largest total floor space for all 6 years. Total floor space went down in FY2006, but went up in FY2007 to a level near that reporting in FY2005. A slight decrease was reported in FY2008, and then remained fairly the same in FY2009 and FY2010 (Figure 22). The data reported for the other sites have stayed somewhat consistent over the 6 years (Figure 22).

Location of DOE sites is important in terms of available incentives from either the state, state run organizations, or utilities. These available incentives may be used to offset the cost of implementing efficiency programs. Geographic location is also important in terms of baseline energy and water cost, which is important in determining the cost-effectiveness of specific energy and water efficiency measures.

In terms of geographic location, DOE buildings can be found in 39 States and the District of Columbia. Colorado has 15% of all DOE sites, followed by South Dakota and Wyoming with 11% each, North Dakota with 9%, and Montana with 8%. New Mexico has 21% of the total number of buildings followed by California and South Carolina with 9% each, Tennessee with 8%, and Texas with 7%. New Mexico also has 14% of the total floor space, followed by Ohio with 12%, California and Tennessee with 11% each, and Kentucky with 8%. South Carolina has one site, but it is the 3rd largest site in terms of the number of buildings it has, and it is 6th in terms of the total floor space.

Table 4. Top 10 DOE Sites in terms of Buildings and Floor Space

Installation Name	City	State	Top Ten - Number of Buildings	Top Ten - Square Feet
Argonne National Laboratory (ANL)	Argonne	Illinois		X
Brookhaven National Laboratory (BNL)	Upton	New York	X	X
Fermi National Accelerator (Fermi)	Batavia	Illinois	X	
Idaho National Laboratory (INL)	Scoville	Idaho	X	
Lawrence Livermore National Laboratory (LLNL)	Livermore	California	X	X
Los Alamos National Laboratory (LANL)	Los Alamos	New Mexico	X	X
Nevada National Security Site (NNSS)	Mercury	Nevada	X	
Oak Ridge National Laboratory (ORNL)	Oak Ridge	Tennessee		X
Paducah Uranium Separation and Enrichment Center (Paducah)	Kevil	Kentucky		X
Pantex Site Office (Pantex)	Panhandle	Texas	X	
Portsmouth Uranium Separation and Enrichment Center (Portsmouth)	Piketon	Ohio		X
Savannah River Site (SRS)	Aiken	South Carolina	X	X
Sandia National Laboratory (SNL)	Albuquerque	New Mexico	X	X
Y-12 Site Office (Y-12)	Oak Ridge	Tennessee	X	X

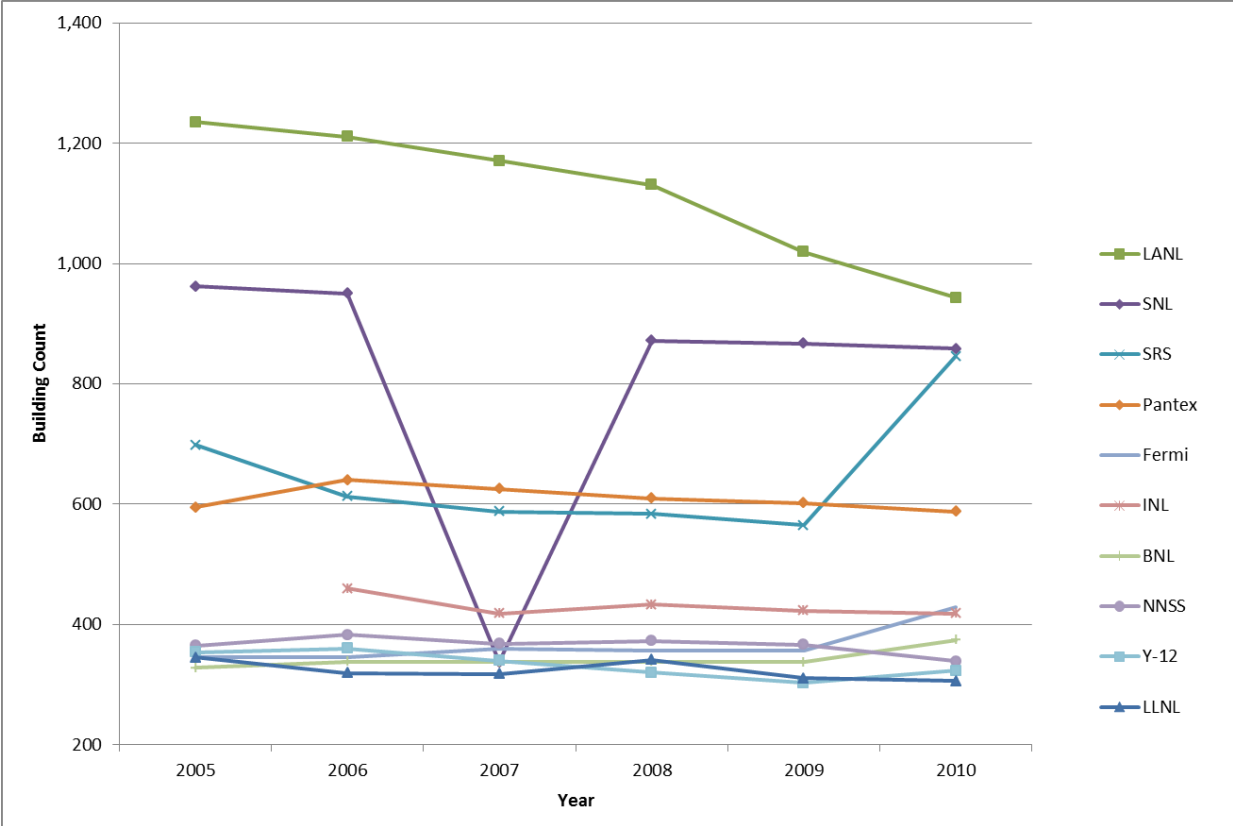


Figure 21. Total Building Count, FY2005-FY2010, Top 10 Sites.

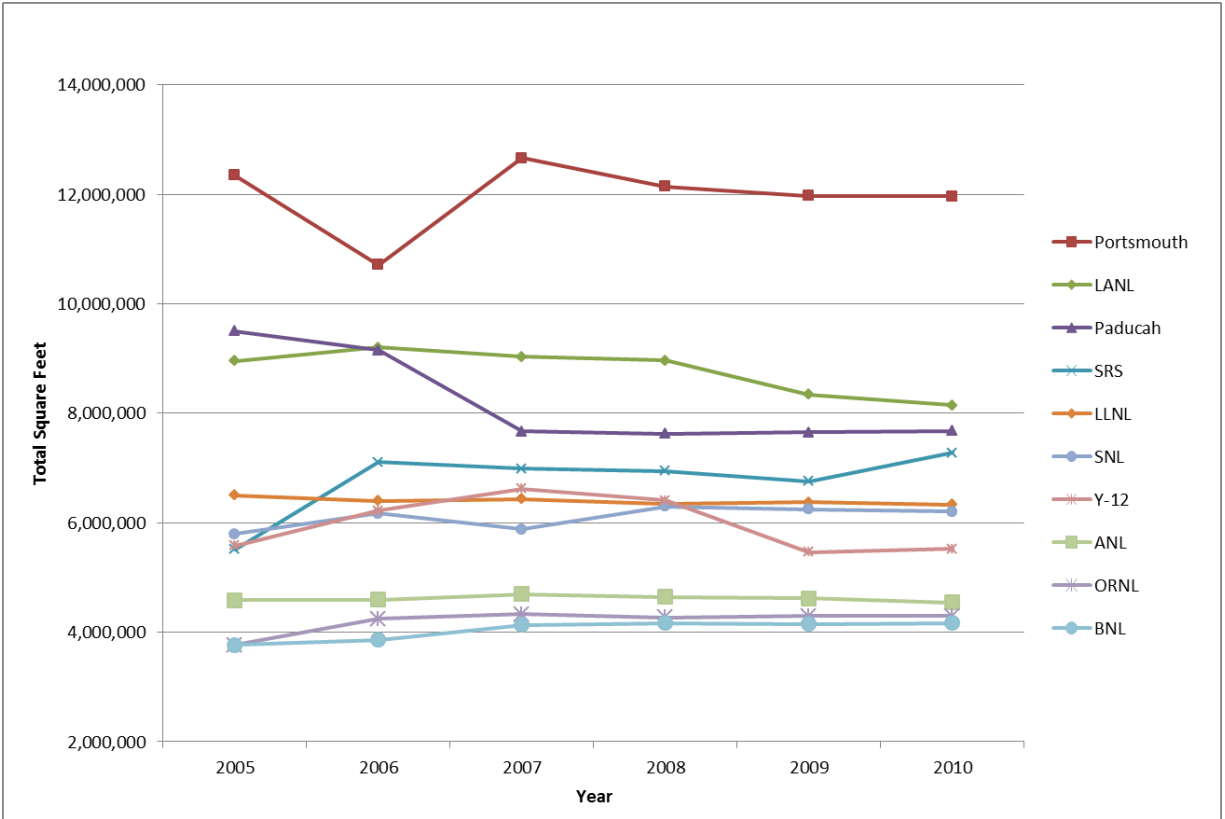


Figure 22. Total Floor Space (ft²), FY2005-FY2010, Top 10 Sites.

6.0 Conclusions

Changes in inventory can be useful to an agency to assist in understanding the influences on energy and water use. As building inventory changes, so should the agency's water and energy consumption. Annual DOE building inventory for FY2005 through FY2010 was analyzed to identify the changes in real property over time. When comparing data between these years, total number of sites increased 7% from FY2005 to FY2010 (mainly with the addition of substations, communication, and disposal sites), total building counts increased 5% and total floor space increased 6%. It appears that the DOE's building inventory is slightly increasing over time, and that needs to be taken into consideration when identifying efficiency potentials. Knowledge of how any agency's building count and floor space varies over time can be useful in the development of effective and sound energy efficiency and water conservation implementation programs. These programs can then be evaluated and modified as necessary over time to ensure a maximum level of impact for each agency.

Overall, a vast majority of the DOE buildings (72% for FY2010) have floor space of less than 5,000 ft² with only a small percentage (18% for FY2010) having total floor space of greater than 10,000 ft². DOE has a large number of buildings classified as *Warehouse* and *Service*, but they tend to have more buildings that are relatively smaller in size. Whereas, there are fewer *Industrial* building types, but they tend to be larger in total floor space.

Care must be taken when looking at total floor space and generalities should be avoided. Differences in size of individual buildings within each building type can be useful to managers in assisting them in understanding the influences on energy and water intensity. Industrial buildings tend to be more energy and water intensive than office buildings and applying appropriate measures for each building type may help in reducing overall energy and water use.

7.0 References

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