A Deeper Dive into the 2012 CBECS Characteristics Data

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ENERGY STAR for Commercial Buildings

Agenda

- Overview
  - ENERGY STAR Score
  - Key Milestones

- Deeper Dive into CBECS data
  - Detailed Tables – Released in April
  - Microdata – Anticipated in June

- EPA Technical Development Process
  - Topics under review
  - Opportunities for input

- Next Steps

- Questions and Discussion

ENERGY STAR Score Objectives

- Reduce greenhouse gas emissions from energy use in buildings
  - Relies on actual, measured energy bill data

- Evaluate whole building energy use
  - Account for the combined effects of technology, operation, maintenance, and usage patterns
  - Recognize that these factors all affect each other and the bottom line measured energy consumption

- Provide a comparative national benchmark
  - Adjust for weather and certain business choices (e.g. hours of operation) to enable fair comparisons
  - Rank buildings relative to existing buildings in the market

- Identify the best performers in the market
  - Like the ENERGY STAR on products
  - Help consumers and business make smart choices

EPA

ENERGY STAR Score Development Process

- Analyze national survey data

- Develop regression model
  - Model computes average energy use for a building, given its operation
  - This is how we normalize for important factors like heating degree days and weekly hours of operation

- Use the model to asses the efficiency of each building
  - More efficient: Actual Energy < Normalized Mean
  - Less efficient: Actual Energy > Normalized Mean

- Create scoring lookup table
  - Score is based on the distribution of energy efficiency
  - One point on the scale represents 1% of the population

CBECS Data is Critical to the EPA Process

- CBECS data meets several important criteria
  - Is random and nationally representative
  - Includes measured whole building energy data
  - Captures data on numerous operational characteristics
  - Is conducted on a regular basis over time

- Portfolio Manager data does not meet these criteria
  - It would not be suitable to base our score on Portfolio Manager

- EPA is open to other data sets that meet these criteria
  - Fannie Mae industry survey was used for Multifamily
  - ASHE industry survey was used for Hospital

Property Types with ENERGY STAR Scores

Score based on CBECS data

Bank Branch

Barracks*

Financial Offices

K-12 Schools

Supermarkets

Wholesale club/ Supercenters

Medical Offices*

Hotels

Residence Hall/Dormitory*

Office Buildings

Courthouses

Worship Facilities

Retail Stores

Distribution Centers

Warehouses

Score based on other survey data

Data Centers

Hospitals

Senior Care Communities

Wastewater Treatment Plants*

Multifamily Housing

*These building types are not eligible for ENERGY STAR certification.

EIA CBECS Milestone Activities

- Publish Building Characteristic Data – ***Almost Done!***
  - Building Characteristics Detailed Tables – Released in March and April
  - Public Use Microdata – Anticipated later this month
  - This data includes information on size, activity, operation, and equipment

- Publish Building Energy Consumption and Expenditure Data
  - Preliminary Estimates – September 2015
  - Detailed Tables – November 2015
  - Public Use Microdata – December 2015
  - This is the energy use data that will let us calculate EUI and develop the ENERGY STAR score

- Begin soliciting input on the next CBECS Survey?!
  - Once they finish, it's time to start again ☺
  - Next survey will likely be for the calendar year 2017
  - Questionnaire development would be in late 2016 and early 2017 – look for opportunities for input

EPA

EPA Milestone Activities

- Biannual update webinars

May 2014	Introduction to the ENERGY STAR score and plans for updates
October 2014	Discussion of Preliminary Building Characteristics Data
June 2015	Deeper Dive into Building Characteristics Data
October 2015	Discussion of EPA's Methodology and Tentative Schedule
May 2016	Review of Final CBECS data and Timeline for Score Updates

- Ongoing solicitation of input
  - From technical experts with working knowledge of the score development methodology
  - From ENERGY STAR partners with experience with our methods and other approaches

- Data analysis and score development
  - Review of underlying methodology
  - Detailed review of CBECS data, when energy data is published

A Deeper Dive:
Available CBECS Data

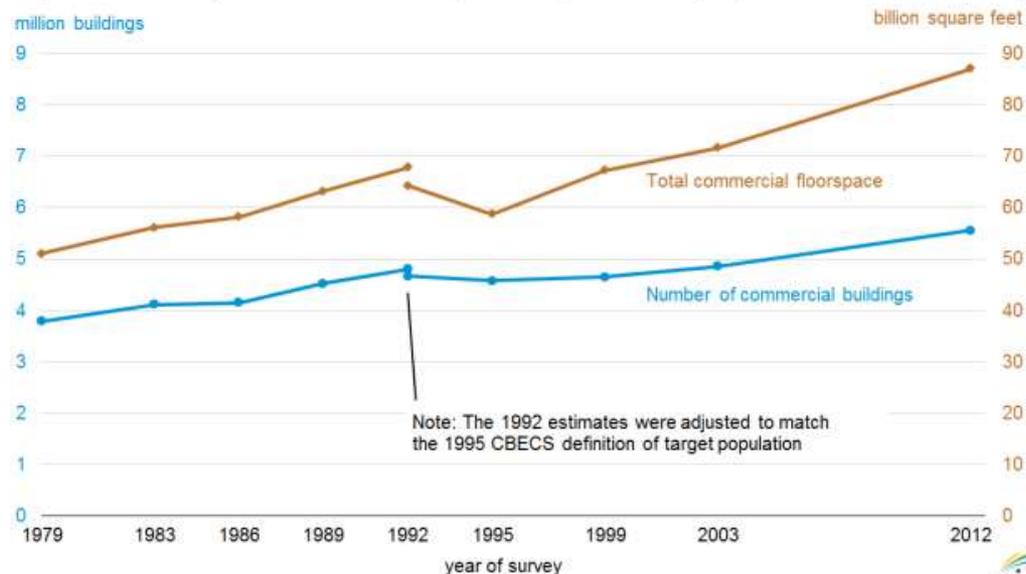# CBECS Building Characteristic Data: Detailed Tables

- Report on Basic Changes in Market
  - Overall growth
  - Growth by sector

- 46 Tables of data in different categories
  - Summary Tables
  - Geographic Region
  - Size and Age
  - Building Activity
  - Employment and Occupancy
  - Energy Source and End Uses
  - Floor Space Heated, Cooled, and Lit
  - End Use Equipment

- Tables show aggregate values
  - Building counts and square foot
  - According to many different categories, including principal building activity

- Link to view data:
  - http://www.eia.gov/consumption/commercial/data/2012/

Although this data does not enable us to assess correlations with energy, it is valuable for understanding trends in the market

Overall Market Growth

- Estimate 5.6 million commercial buildings representing 87 billion ft^2
  - 14% increase in the number of buildings since 2003
  - 22% increase in floor space since 2003
- 2012 survey sample size was just over 6,700 observations
  - 29% larger than 2003 survey
 - EPA will explore the possibility of ENERGY STAR scores for new property types

Figure 1. In recent years, commercial floorspace has grown more rapidly than the number of buildings

million buildings   billion square feet

Total commercial floorspace

Number of commercial buildings

Note: The 1992 estimates were adjusted to match the 1995 CBECS definition of target population

year of survey: 1979, 1983, 1986, 1989, 1992, 1995, 1999, 2003, 2012

Source: U.S. Energy Information Administration, Commercial Buildings Energy Consumption Survey

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Influence of New Buildings

- Newer buildings tend to be larger
  - 11% of buildings in the country were built after 2003 (the last survey)
  - 14% of square foot in the country was built after 2003
- It takes a long time for the building stock to turn over
  - 44% of square foot in the country was built before 1980 (over 35 years old)
- Changes to the market can be seen in older buildings, too!
  - For example, trends towards more dense work spaces or longer hours

Percent of Gross Square Foot by Year Built
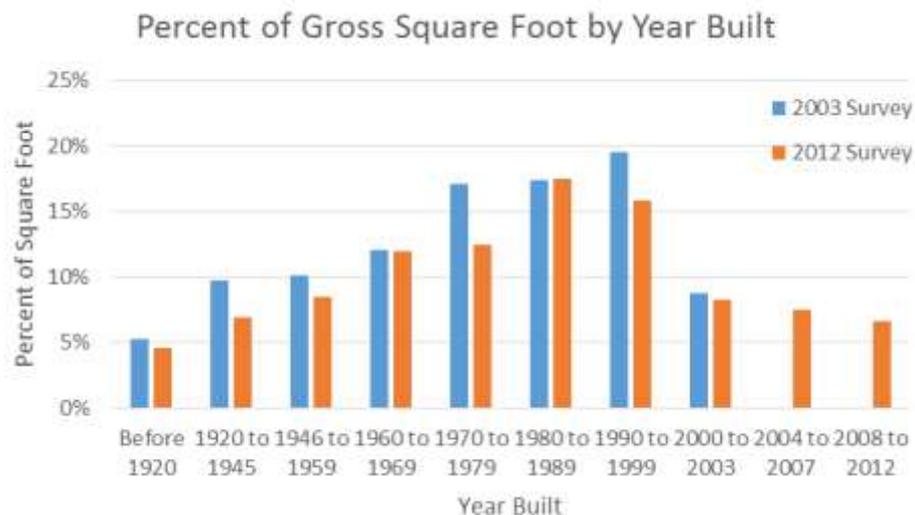
Market Growth by Sector

- Statistically significant growth in some sectors
  - Office
  - Warehouse
- Statistically significant decrease in one sector!
  - Food Sales
- No statistically significant change for some sectors
 - Healthcare
  - Lodging
  - Education
  - Retail

Number of Buildings

2012 CBECS   2003 CBECS
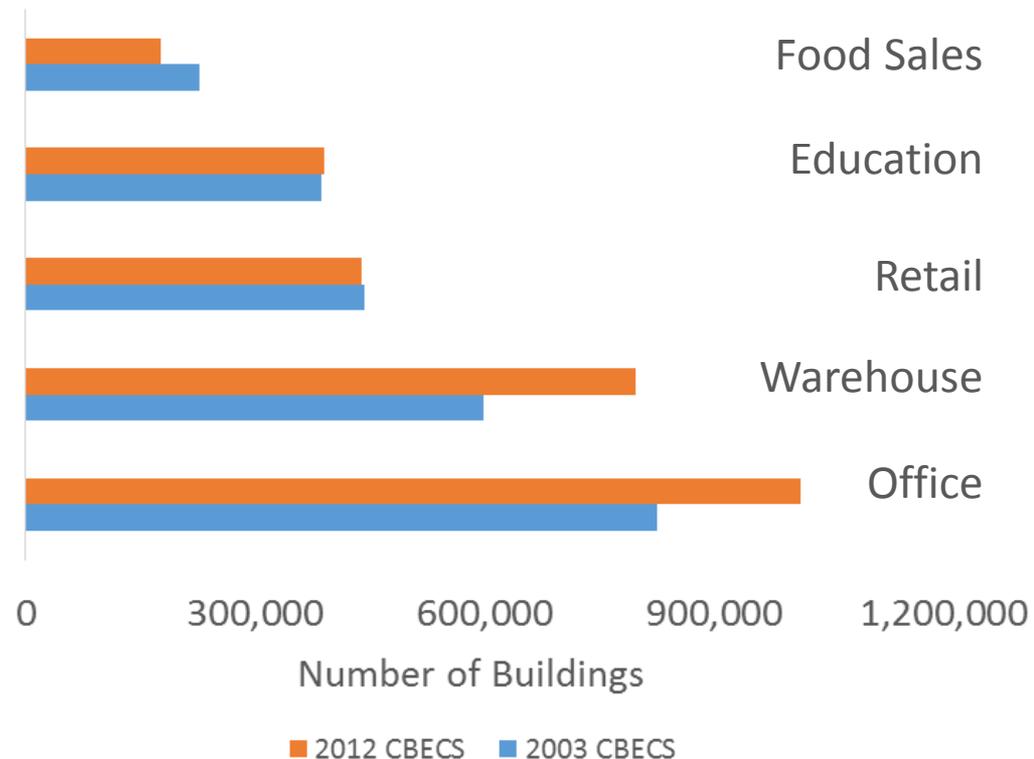
Top 5 Market Sectors

- The top 5 market sectors by floor area are the same in 2012 as they were in 2003
  - But the "mercantile" category moved from #2 to #4

|	2003	2012
1	**Office** 12.2 Billion ft2	**Office** 16.0 Billion ft2
2	**Mercantile** 11.2 Billion ft2	**Warehouse** 13.0 Billion ft2
3	**Warehouse** 10.1 Billion ft2	**Education** 12.2 Billion ft2
4	**Education** 9.9 Billion ft2	**Mercantile** 11.3 Billion ft2
5	**Enclosed and Strip Malls** 6.9 Billion ft2	**Enclosed and Strip Malls** 5.9 Billion ft2

Change in Building Size by Sector

- The average building in the country is less than 20,000 square foot
  - Largest building types are Inpatient Healthcare (not shown on graph), Lodging, Malls, and Education
- Average building size is generally larger in 2012 than it was in 2003
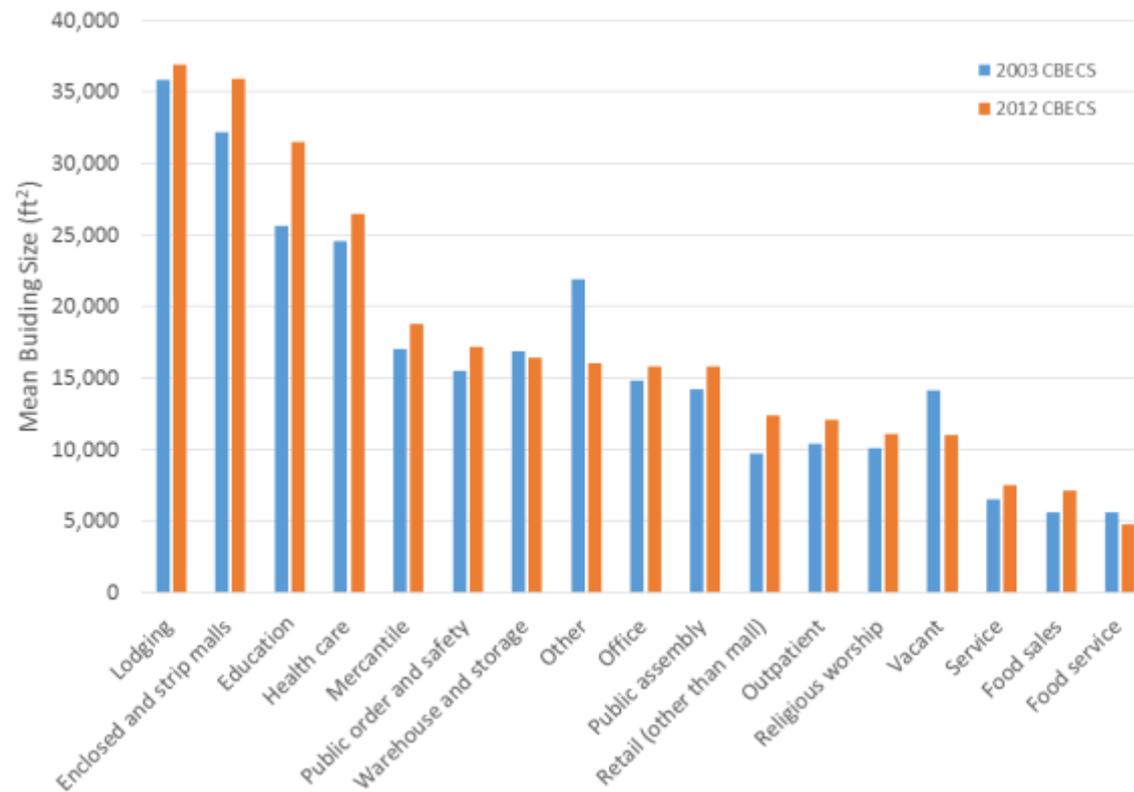
Why Do Average Building Sizes Appear Low?

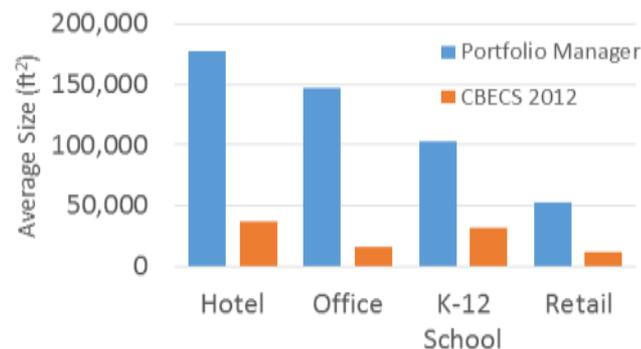Figure 2. About half of all commercial buildings make up less than 10% of total floorspace
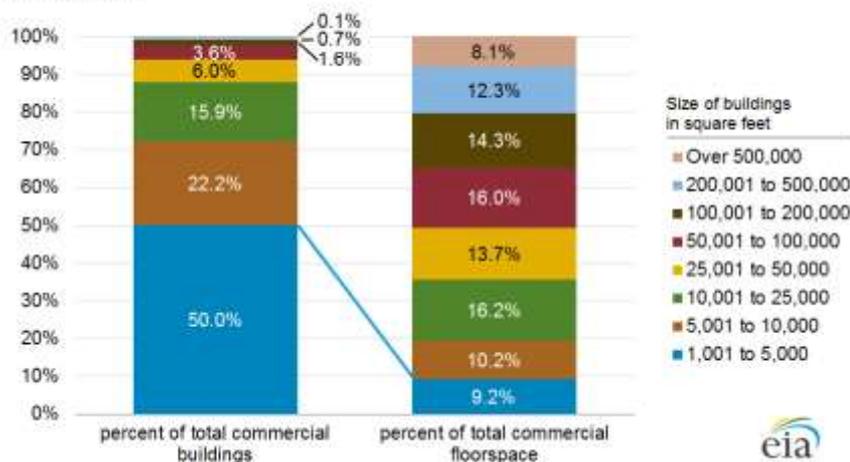
Source: U.S. Energy Information Administration, 2012 Commercial Buildings Energy Consumption Survey

- There are 5.6 million commercial buildings in the U.S
  - Vast majority are small, non-urban
- The smallest 50% account for only 9.2% of floor area
- The largest 0.8% account for 20.4% of floor area
  - 38 thousand buildings that are between 200,000 and 500,000 ft2
    - *284,300 ft2 on average*
  - 8 thousand buildings that are over 500,000 ft2
   - *885,000 ft2 on average*

What is the Average Size of Buildings in Portfolio Manager?

- Buildings in Portfolio Manager are larger for all categories
  - Average Office in Portfolio Manager is nearly 150,000 ft2
  - Even the average school in Portfolio Manager is larger
- It is critical to EPA that the ENERGY STAR score is equitable for all sizes
  - Models developed with CBECS are always tested using Portfolio Manager, too
  - EPA looks for equitable scores across the full range of sizes

note: CBECS Hotel and K-12 specific data is not yet available, numbers represent Lodging and Education, respectively

How Does EPA Account for Building Size in Analysis?

- Review the relationship between size and EUI
  - Typically there is more variability in EUI for small buildings
  - Small buildings may be less uniform, for example they could be homes that were converted into other commercial uses
- This process may include reviewing graphs, correlations, and regressions
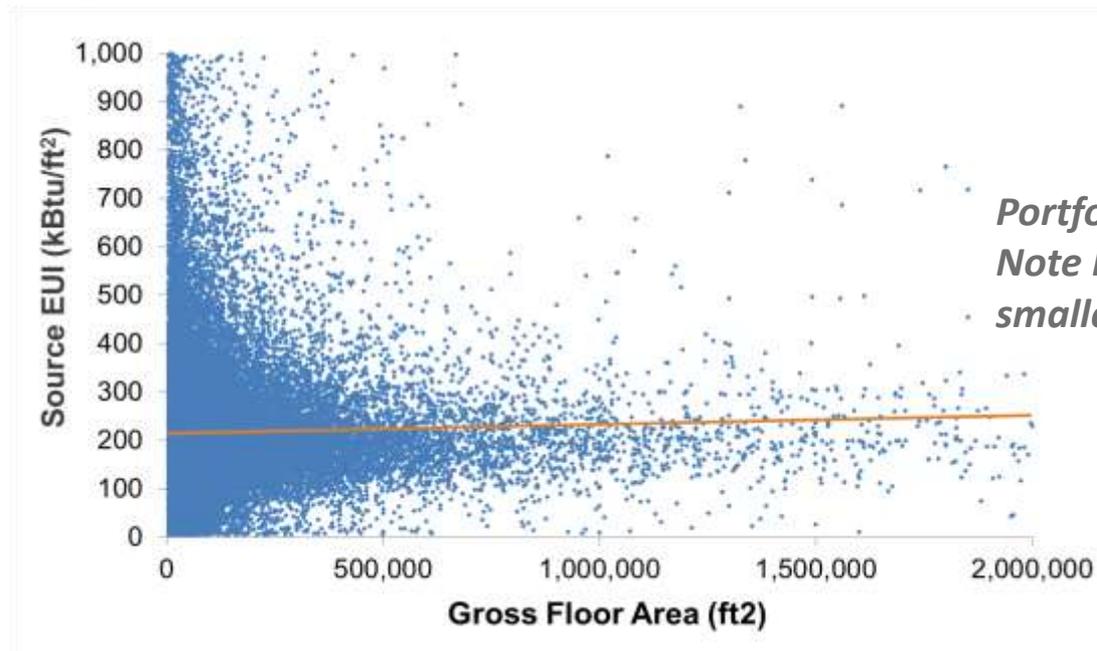
Portfolio Manager Offices: Note large range of EUI at the smallest properties

How Does EPA Account for Building Size in Analysis? (con't)

- Determine if a minimum size cut-off is needed
  - Perform regressions on CBECS with different samples
    - All offices
    - Offices above 1,000 ft^2; Offices above 2,000 ft^2; Offices above 3,000 ft^2; etc
  - Explore how results change
    - Statistical significance
    - Scores for different size ranges
    - Correlations for other factors like workers and computers
  - Most models have a minimum size requirement
    - 1,000 or 5,000 ft^2

- Determine if there is a significant relationship between EUI and size
  - Our office model includes a specific size adjustment
  - Larger offices have higher EUI than smaller offices

- Test CBECS models with Portfolio Manager data
  - Because the Portfolio Manager data has more large buildings, we can use this sample as a test during development

Market Trends for Variables in the ENERGY STAR Score

- Most common variables in score
  - Hours
  - Workers
  - Computers
  - Heating Degree Days & Cooling Degree Days

- Summary data available information in detailed tables
  - Median hours by type
  - Median square foot per worker

- Can assess if median (typical) values are different within each sector

- ***No way to know yet if scores will go up or down!***
  - It is possible to see a change in the correlation whether or not we see a change in median (or average) hours!
    - Example: median hours could be longer but the relationship between hours and energy could be the same
    - Example: median hours could be identical but the relationship between hours and energy could be different

Hours of Operation

- Mean values are generally higher than medians
  - Mean values are often skewed high by buildings with long hours
  - Median is the center of the population
- For most property types the median values observed in the 2003 and 2012 surveys are similar
  - Office and Retail show slightly higher medians
  - Food Service shows slightly lower median
- Median hours of operation can differ greatly across property type
  - Food Service is open much longer hours than Religious Worship
  - Office and Retail are similar


Median Weekly Operating Hours
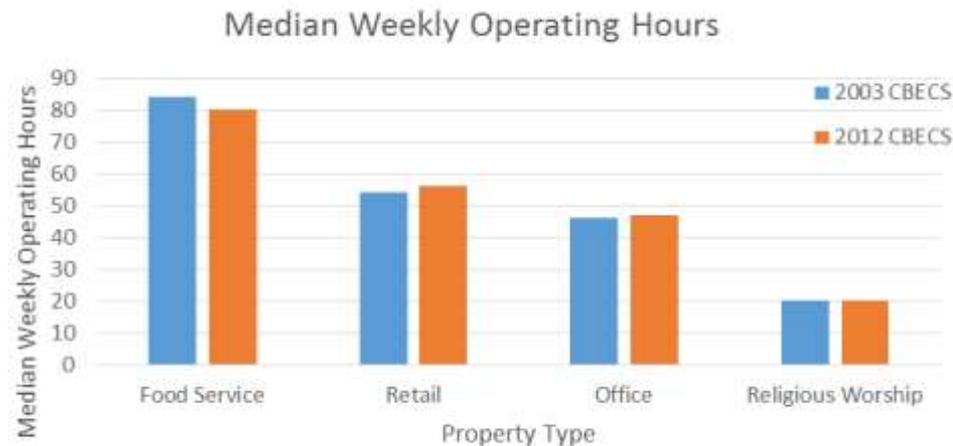
Square Foot Per Worker

- Two related metrics
  - Workers per 1,000 square foot (ENERGY STAR score)
  - Square foot per worker (CBECS detailed tables)

- Both are measures of workspace patterns
  - Open workspaces have higher densities (lower square foot per worker) than offices where each worker has his/her own office
  - A value of 500 square foot per worker does not mean everyone has a giant office
    - Value is computed from total square foot – which includes hallways, break rooms, conference rooms, etc.

- Have densities changed since 2003?
  - Remember, whether or not the density has changed we could still see a change in the correlation with energy use

Square Foot Per Worker

- Most property types have higher values values in 2012 as compared with 2003
  - Retail Stores: Perhaps this means larger stores, more space per worker
  - Education: This may be indicative of larger buildings with more facilities for students
  - Office: implies larger offices or more common areas like atria and conference rooms
    - Unexpected given industry trends towards high density staffing areas
    - Will need to explore more in the building-level data
    - Could observe different trends in large offices vs. small offices
- As with Hours, we can see great diversity across different property types

Median Square Foot Per Worker
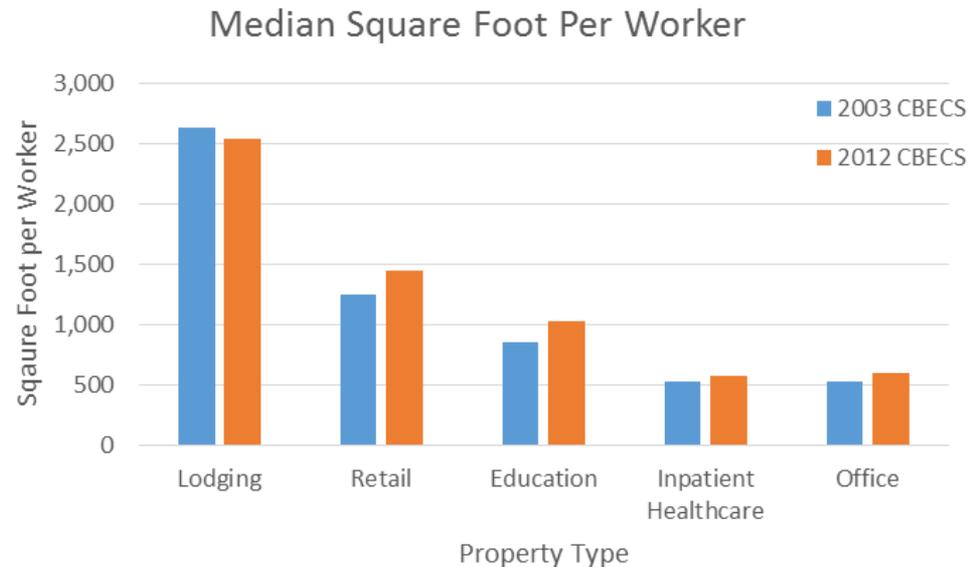
CBECS Building Characteristic Data: Microdata

- Released planned for mid-June

- Data available in two formats (CSV and SAS) with information on individual buildings
  - Hours of Operation
  - Number of Workers
  - Number of Computers

- Over 400 pieces of information for each property

- Valuable data to understand changes in common business practices
  - Even without the energy data we can dig into the raw data behind the graphs shown today
  - Understand if/how commercial buildings are changing in their operation (longer hours, more computers per worker, etc)
    - That is, we can dig into the median values presented to learn more about changes in typical operations

- EPA will start looking at this data this summer
  - You can look at it too ☺

New Data in the 2012 Survey!

- Medical Offices
  - Yes/No for the presence of MRI and CT Scan
  - Count of X-Rays
  - Operating Rooms for Outpatient Surgery

- Hotels
  - Occupancy
  - Presence of conference/event space
  - Separate counts for commercial ice makers and mini-refrigerators

- Offices
  - Occupancy
  - Presence and Square Foot of Data Center
  - Presence of Open Plan office spaces

- Warehouses
  - Ceiling Height

→ *These are examples of new factors we will want to explore to see if there are relationships with energy use*

EPA Technical Development Process

Review Objective and Topics

- Objective
  - Review our underlying technical approach and statistical methods
  - Ensure that we continue to have a robust and meaningful metric for the market to use
  - We're always open to new ideas for assessing energy performance

- Main Topic Areas
  - Are there surveys in addition to CBECS that we can use?
  - What is the most appropriate dependent variable?
    - Today we use Source EUI
    - Before the 2003 CBECS Survey we used LN(Source Energy)
  - How should we use the CBECS survey weights?
  - How should we assess mixed use properties?
  - What is the best way to fit the distribution curve?

EPA

Technical Input to our Review Process

- Welcome feedback from all of our partners
  - We review questions received through customer support and monthly Office Hours
  - What do our partners ask? What is confusing or could be improved?
  - Do you have suggestions?
    - If you've performed statistical analysis or have other observations from your Portfolio, please email us: www.energystar.gov/BuildingsHelp

- Coordinated a half day meeting in January 2015
  - Invited academics who have performed research on energy performance and the ENERGY STAR Score
  - Solicited recommendations on our overall approach
  - Asked specific questions about some of our main topic areas

- Continue to explore research questions
  - Based on our meeting in January we answered some questions
    - Everyone agreed we should use the CBECS weights in developing our regression and lookup table, as we do today
  - But we still continue to look at some questions
    - What does a model look like with the natural log of source EUI as its dependent variable?

What's next?

- **EPA**
  - Finalize our review of our underlying methodologies by the time the new CEBCS data is available
  - Review other newly available building characteristics microdata from CBECS
  - Develop a schedule for releasing revised ENERGY STAR scores

- **EIA**
  - Publish Building Characteristics Microdata
  - Finalize review of energy consumption and expenditure data
  - Publish detailed energy consumption tables and microdata

- **You!**
  - Remember that your score is likely to change when EPA updates the scores
  - Let us know if you have suggestions about our statistical methodology
  - Look for our next webinar in October to hear the latest updates

Questions & Discussion