



# EPA ENERGY STAR

## Score Update for Warehouse

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ENERGY STAR for Commercial Buildings

# Agenda

- ENERGY STAR score overview
- Update to Warehouse score using CBECS 2012
  - Objectives
  - New data available
  - Changes to the model
- Guidance moving forward



**The 1-100  
ENERGY STAR score**

# ENERGY STAR Score Objectives

- Provide a comparative, national benchmark for your buildings energy performance
  - Provide a single score for a whole buildings energy use
  - Fairly compare buildings nationwide
  - Rank buildings relative to similar peer buildings
  - Compare buildings on a 1-100 percentile scale, where 50 represents median energy performance
- Identify and recognize best performers in the market
  - Score of 75 required to earn ENERGY STAR certification.
- Motivate organizations to develop a strategic approach to energy management
  - Buildings with low scores (under 25) have room for efficiency improvements and savings.
  - Track improvement with ENERGY STAR Score

# ENERGY STAR Score Development Process

- **Analyze national survey data**
  - CBECS (Portfolio Manager Data is NOT used as an input)
- **Develop regression models**
  - Normalize for different business activities
  - Predict the average energy use for a building that operates just like yours (normalized mean)
- **Compare actual energy use with normalized mean**
  - Actual < Normalized Mean → More efficient
- **Create scoring lookup table**
  - Lower ratio of actual EUI vs normalized mean results in higher ENERGY STAR Score

# What does a regression model look like?

- Example model

$$\text{EUI} = C_0 + C_1 * \text{Char}_1 + C_2 * \text{Char}_2 + \text{etc...}$$

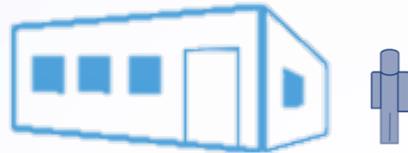
- Coefficient  $C_1$  represents the average effect of the operational characteristic  $\text{Char}_1$  on energy use intensity (EUI).
- Coefficients provide adjustments for each operational characteristic

# EPA Criteria for Including Variables in Analysis

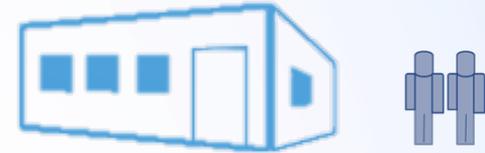
- Include key business activity/service provided variables
  - Examples: Workers, Operating Hours, Amount of Refrigeration
- Do not include or normalize for variables for specific technology choices.
  - Examples: Lighting Technology, Window Type

# EPA Criteria for Including Variables in Analysis

Number of workers included in the model



Predicted EUI = 106  
Actual EUI = 70  
Energy Star Score = 65

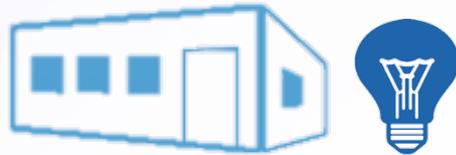


Predicted EUI = 121  
Actual EUI = 70  
Energy Star Score = 71

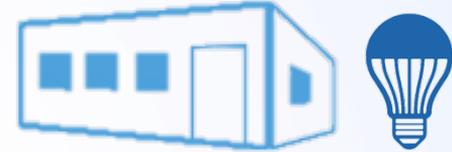
Operational Characteristic	Building #1		Building #2
Size	100,000	=	100,000
Operation Hours	100	=	100
Workers	30	<	45
Percent Cold Storage	5%	=	5%

# EPA Criteria for Including Variables in Analysis

Lighting technology excluded from the model



Predicted EUI = 117  
Actual EUI = 70  
Energy Star Score = 69



Predicted EUI = 117  
Actual EUI = 60  
Energy Star Score = 76

Operational Characteristic	Building #1	=	Building #2
Size	100,000	=	100,000
Operation Hours	100	=	100
Workers	30	=	30
Percent Cold Storage	5%	=	5%

# Data Available: New 2012 CBECS Survey Available

- Nationally representative survey of U.S. commercial buildings
- Collects energy usage data and building characteristics
- Published by EIA in 2016
  - More current data than 2003 CBECS used for current score
- Larger sample
  - 29% larger than 2003 (6,720 vs. 5,215 records)
- More buildings and bigger buildings in the U.S.
  - 14% increase in the total number of buildings
  - 22% increase in total building floor space

# Determining the Correct Model

- Statistical properties of CBECS data:
  - Regression model statistics ( $R^2$ )
  - Individual variable statistics (t-stats)
- Additional factors evaluated with both CBECS and Portfolio Manager
  - Distribution of scores
  - Scatterplots of score across key characteristics
  - Physical understanding of results
  - Relationship between EUI and score

# Objectives of Analysis and Score Update

- Leverage the most recent market data
  - This will show us if buildings are becoming more or less efficient
  - If the market is getting more efficient, then it may become harder to qualify for ENERGY STAR
- Re-assess key drivers of energy use
  - Have the relationships between operating characteristics and energy intensity changed in the last 10 years?
  - Are there new variables in CBECS that we should be adjusting for going forward?



# 1-100 ENERGY STAR Score Update for Warehouse

# Existing ENERGY STAR Score for Warehouse

- Developed using Nationally Representative CBECS 2003 data
- Contains Adjustments for
  - Building Size
  - Number of Workers
  - Operating Hours
  - Refrigeration
  - Climate and Weather
- Updated Score scheduled to launch August 2018

# Update to Warehouse Score - New 2012 CBECS Survey

- **Slight decrease in energy use**
  - Median energy use for Warehouses has decreased slightly from about 54 to about 53 kBtu/sqft
- **New variables in CBECS related to Warehouse**
  - Ceiling Height
  - Gross Floor Area Used for Cold Storage
  - Presence of Machine, Manufacturing or Laboratory Equipment

# New Warehouse Model – Major Findings

Adjustments in Current Warehouse Model - 2003 CBECS	Keep?	Adjustments in New Warehouse Model - 2012 CBECS
Workers on the Main Shift per 1000 sq. ft.	✓	Workers on the Main Shift per 1000 sq. ft.
Weekly Operating Hours	✓	Weekly Operating Hours
Weather and Climate (using Heating and Cooling Degree Days)	✓	Weather and Climate (using Heating and Cooling Degree Days)
Percent of the Building that is Heated and Cooled	△	Percent of the Building that is Heated and Cooled (percent of building that is cooled will be combined with the percent used for cold storage)
Whether or not the Building is a Refrigerated Warehouse	△	Percentage of Gross Floor Area Used for Cold Storage
Number of Walk-in Refrigerators per 1000 sq. ft.		
Square Feet	✗	N/A

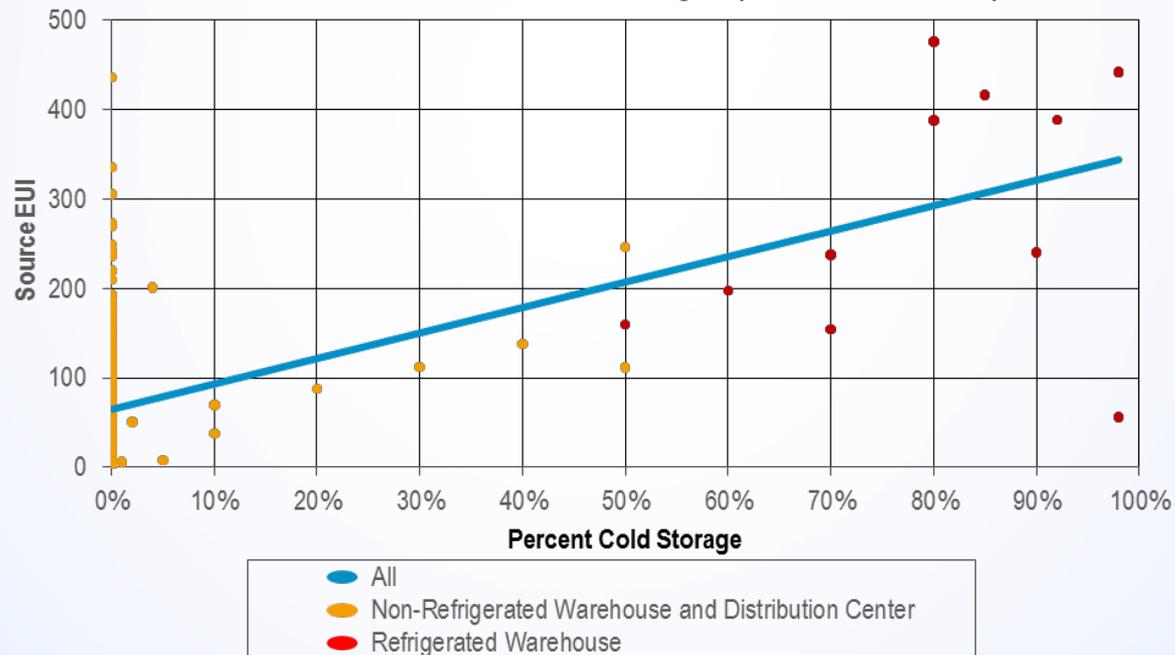
# New Warehouse Model – Major Findings

- **The average ENERGY STAR Score of Warehouses increases from about 51 to 54**
- Overall adjusts for very similar characteristics as previous model
- New Percentage of Gross Floor Area Used for Cold Storage term adjusts for refrigeration
- No longer adjusts for Square footage separately in the model
- Model coefficients now based on 2012 CBECS data

# Adjusting for Refrigeration

- New adjustment for Percentage of Gross Floor Area Used for Cold Storage
- Will replace Refrigerated Warehouse (y/n) and Number of Walk-in Refrigerators adjustments
- More significant and versatile

EUI vs Percent Cold Storage (CBECS Data)



# Adjusting for Climate

- The climate adjustment now also accounts for the percent of the warehouse that is used for cold storage in addition to the percent that can be cooled (air conditioned) when adjusting for Cooling Degree Days:
- Interpretation: The impact of the number of Cooling Degree Days' on a building's energy use depends on both the amount of the building that needs to be cooled (air conditioned) as well as the amount used for cold storage
  - From an engineering perspective this also makes sense

# Percentage of Gross Floor Area Used for Cold Storage

- The total percentage of your property that is enclosed insulated storage space intended for the cooling or freezing of goods, merchandise, raw materials, or manufactured products in buildings (or portions of buildings), at or less than 50 degrees F. This typically includes large cold storage areas, but the area associated with small walk-in refrigeration/freezer units may also be included in this space.

# Entering Percentage of Gross Floor Area Used for Cold Storage

- New field in Portfolio Manager that will go live with the August 2018 score update.
- Initially the value will default to 0
  - No adjustment for cold storage
  - Inaccurate score for buildings that actually have cold storage space.
- If your property has cold storage space
  - You can login to Portfolio Manager and enter the percent cold storage as soon as new scores launch in August 2018
  - Will result in the most accurate ENERGY STAR Score

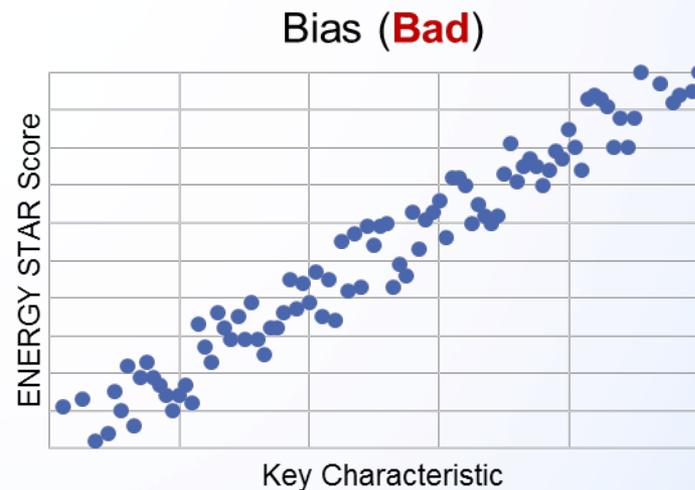
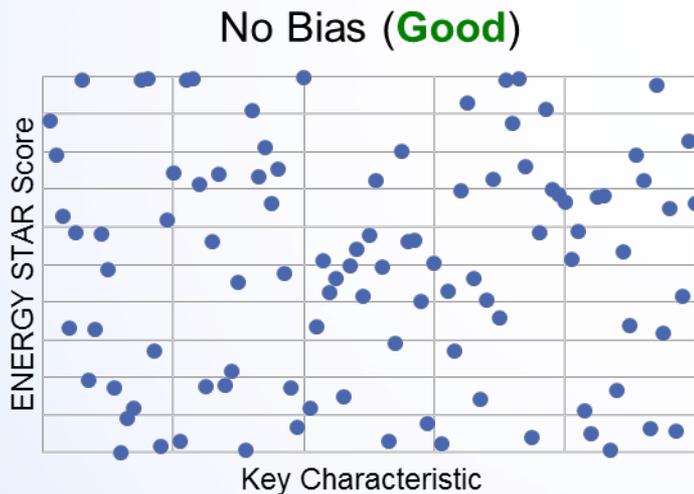
# Entering Percentage of Gross Floor Area Used for Cold Storage

- Percent Cold Storage
  - Enter the percent of the building that is used for cold storage
  - Should not include any space that is not cold storage
- Percent That Can Be Cooled
  - Do not include the space that is cold storage space

Benchmarking buildings with Cold Storage Space		
	Refrigerated Warehouse	Non-Refrigerated Warehouse
Square Footage	100,000	100,000
Percent Cold Storage <i>Used for refrigeration adjustment</i>	80%	20%
Percent That Can Be Cooled	20%	60%
Percent That Can Be Cooled + Percent Cold Storage <i>Used for climate adjustment</i>	100%	80%

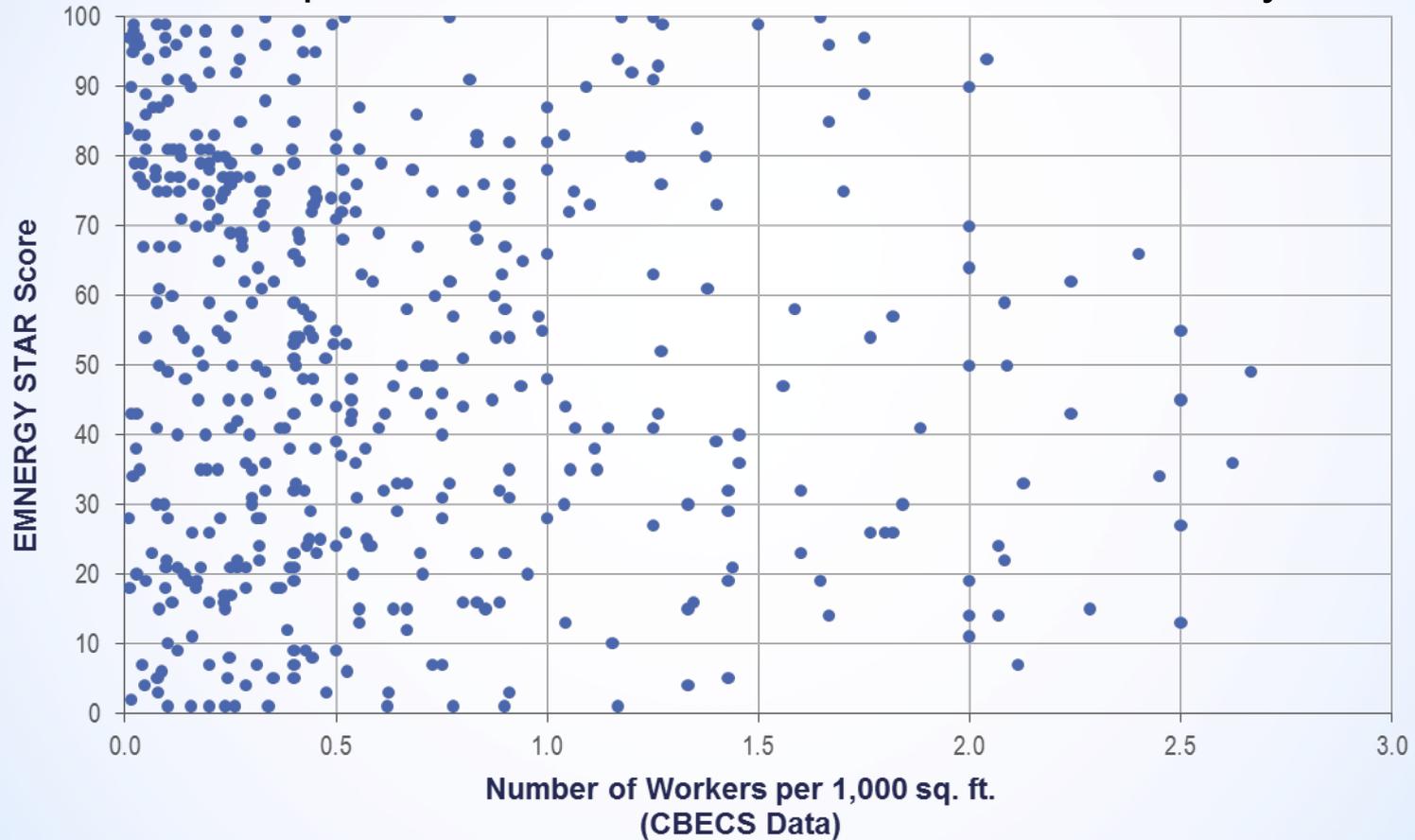
# Bias for or Against Business Characteristics

- Plot of ENERGY STAR Score vs. key building characteristics
  - Plots are examined to ensure there is no bias for or against any key characteristics.



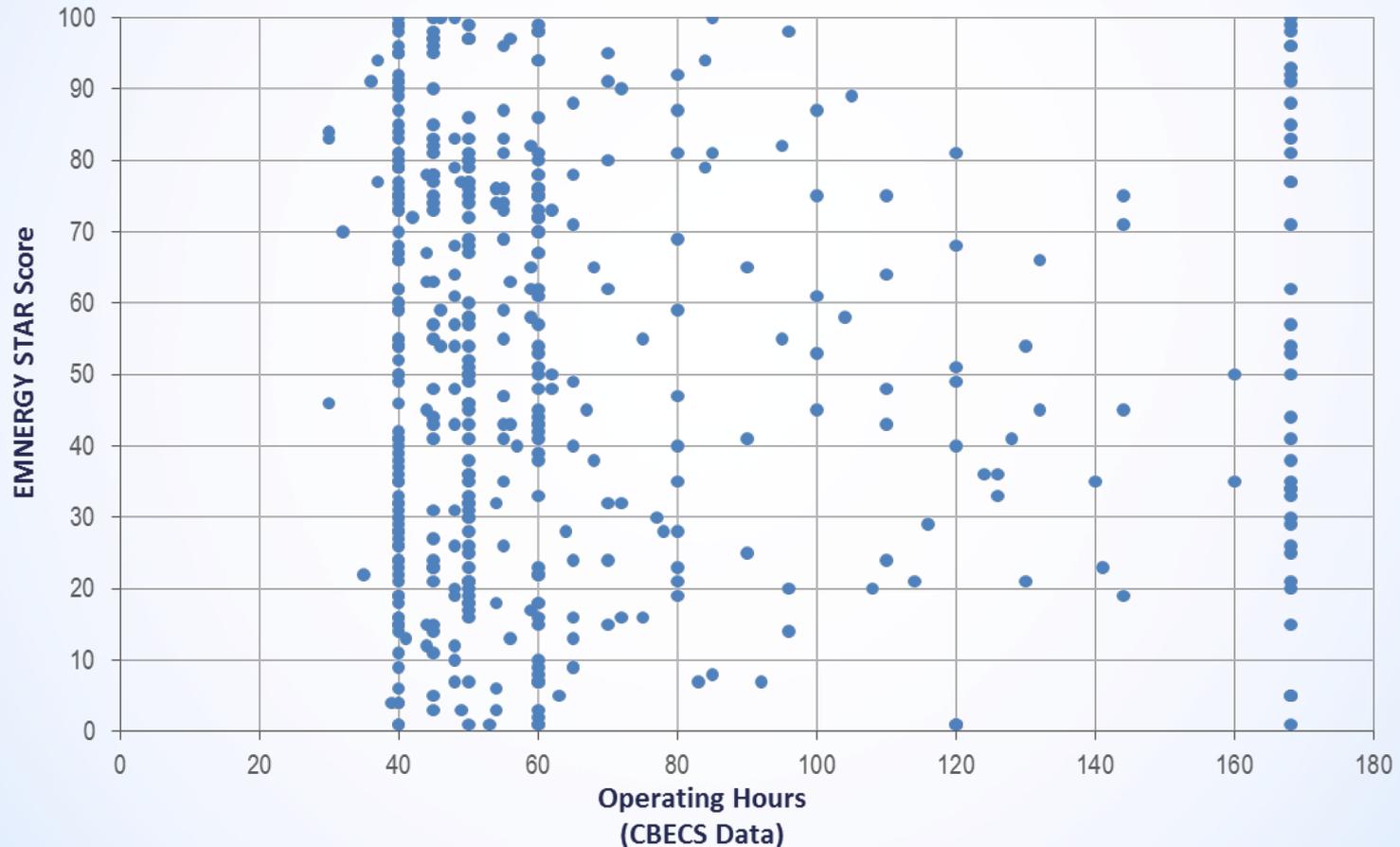
# ENERGY STAR Score vs. Worker Density

- Worker Density included in model
- Scores are equitable across all values for Worker Density



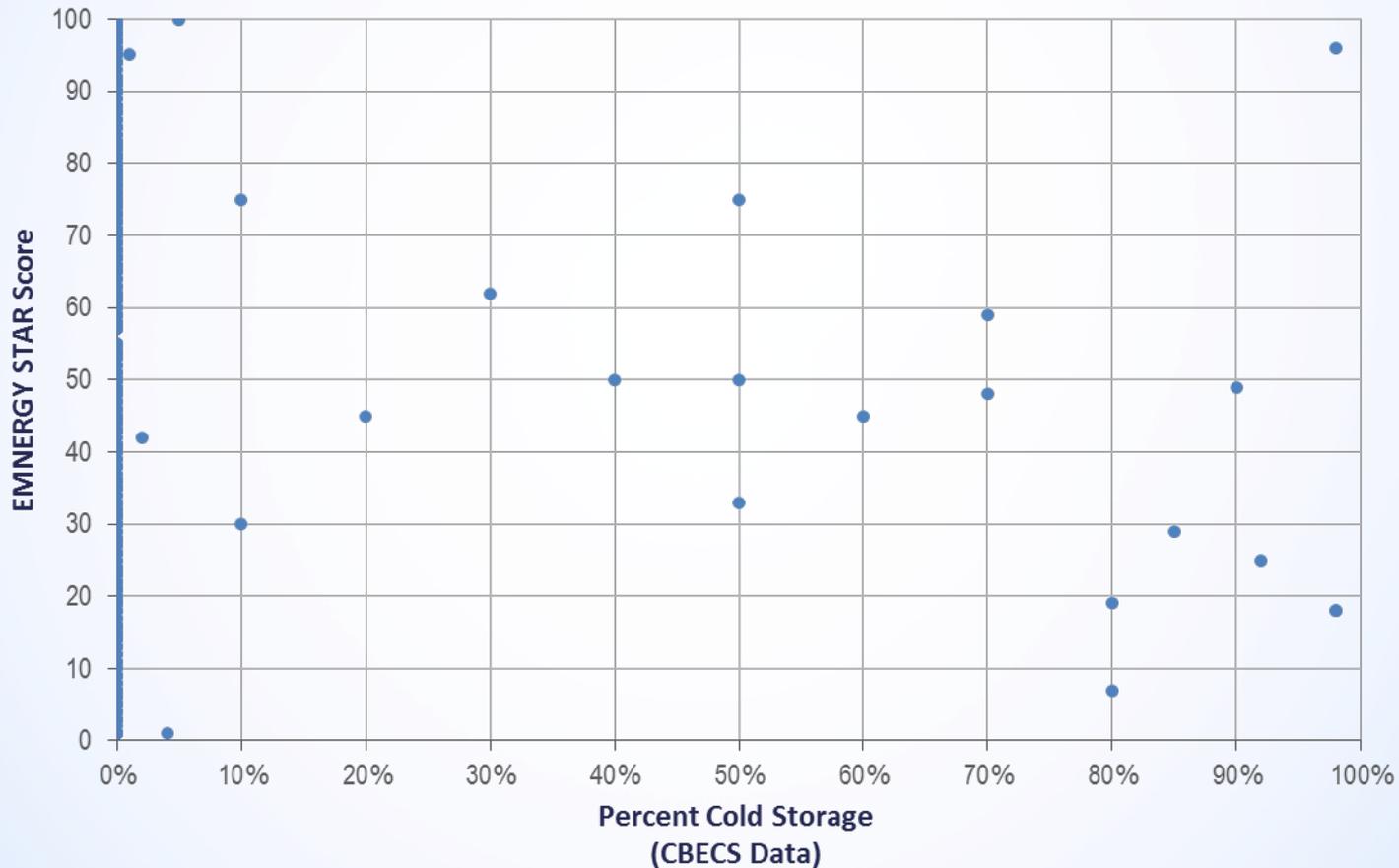
# ENERGY STAR Score vs. Operating Hours

- Operating Hours included in model
- Scores are equitable across all values for Operating Hours



# ENERGY STAR Score vs. Percent Cold Storage

- Percent Cold Storage included in model
- Scores are equitable across all values for Percent Cold Storage

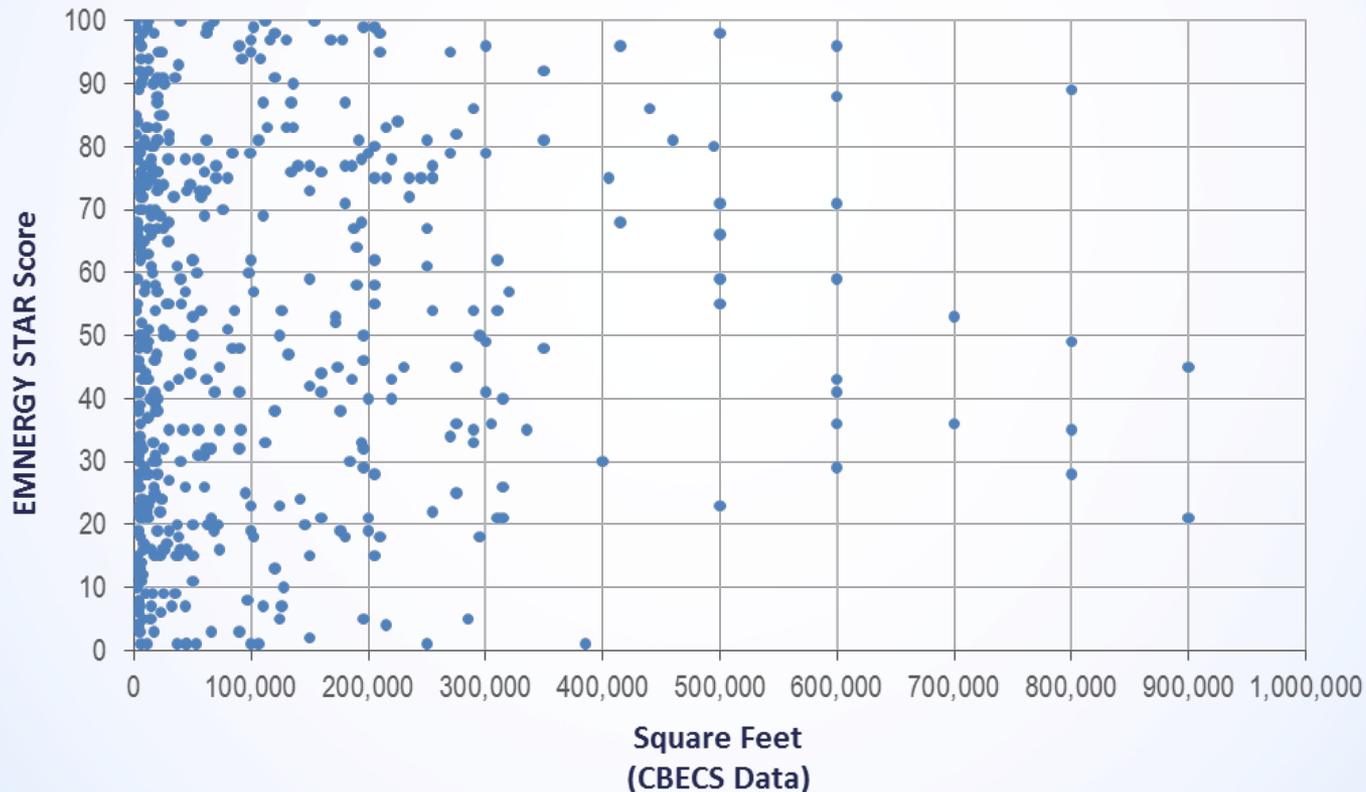


# Business Characteristics NOT Included in the Model

- Analysis showed that certain characteristics did not belong in the model
  - Building square footage
  - Ceiling height
  - Distribution centers
- Still examined Graphs of score vs. characteristics NOT included in the regression model to ensure no bias.
  - ENERGY STAR Score is still equitable across all values of these characteristics

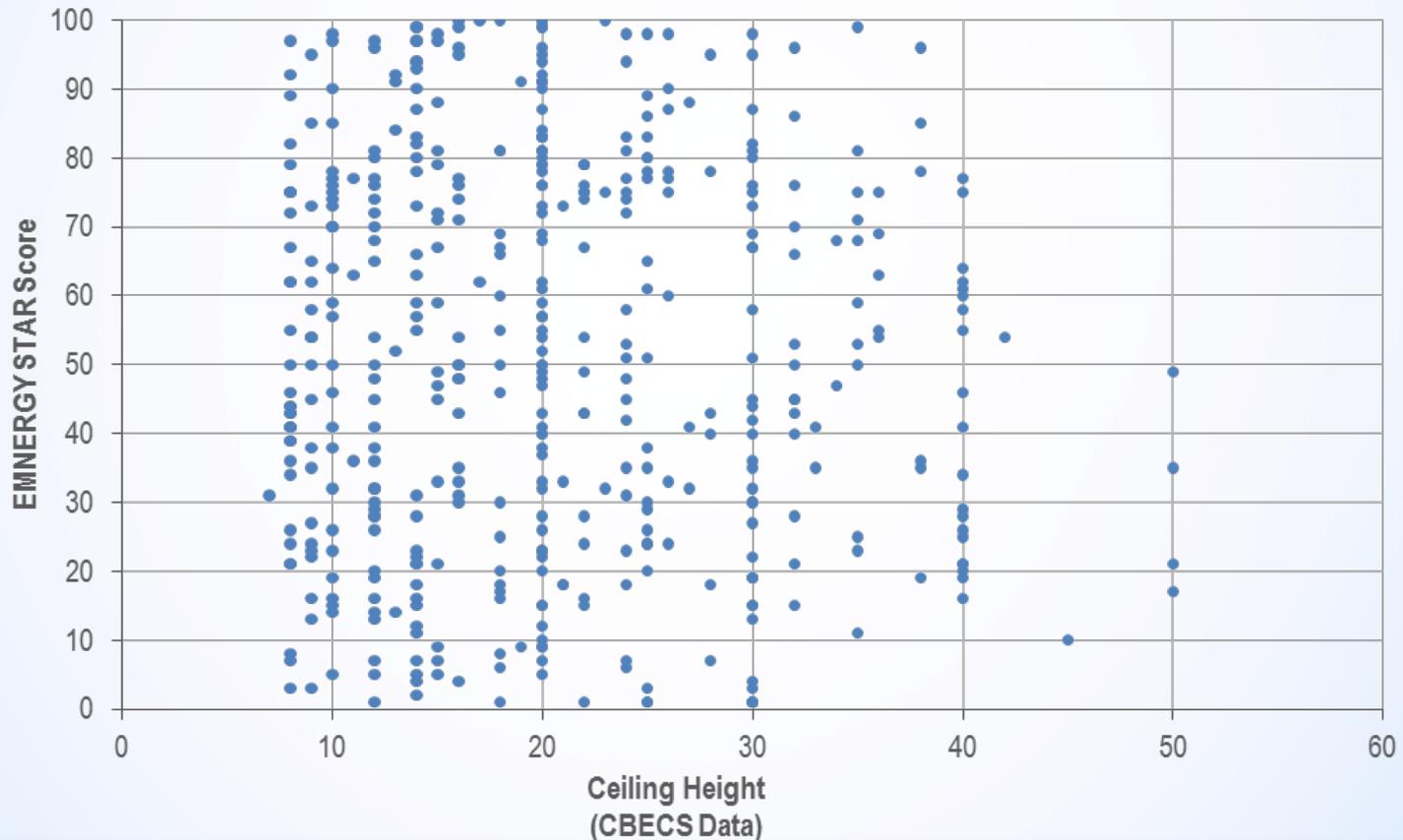
# ENERGY STAR Score vs. Square Feet

- Square footage of a building is still being accounted for in the dependent variable - EUI (Energy use per Square Foot)
- Not significant and preferable to not include square foot term in the model



# ENERGY STAR Score vs. Ceiling Height

- Ceiling Height term was not significant, so it was not included in the final model



# Distribution Centers

- Despite operational differences, the model scores Distribution Centers and Non-Refrigerated Warehouses similarly

Average Characteristic (CBECS Data)	Non-Refrigerated Warehouses	Distribution Centers
Operation Hours	63	70
Worker Density	0.72	0.54
Source EUI	66	66
ENERGY STAR Score	52	51

# Other Terms Tested in the model

- 2012 CBECS included the following variable fields:
  - Presence of Manufacturing Equipment
  - Presence of Machine Equipment
  - Presence of Lab Equipment
  - Number of Computers
- Analysis showed that these terms were not needed in the model
  - Presence of equipment variables were insignificant
  - Number of computers did not improve score equitability

# Next Steps

# EPA Schedule for Score Revisions

- **Perform detailed analysis**
  - Started May 2016
  - Analyze energy performance by property type
  - Explore new variables captured by CBECS
  - Determine appropriate changes to regression models used for score calculations
- **Order of Analysis**
  - Office & Retail / Supermarket
  - Hotel & K-12 School
  - Warehouse & Worship Facility
- **Program new scores into Portfolio Manager**
  - Documentation / extensive testing
- **Release new scores to the public (August 2018)**

# What should you expect?

- **Expect some changes**

- New user inputs in Portfolio Manager – “Percentage of Gross Floor Area Used for Cold Storage”
- *The scores of your properties!*

- **EPA’s basic approach is not changing**

- Provide a national level benchmark
- Use regression models to assess/adjust for factors that impact energy consumption
- Include variables that capture weather and business activity
- Exclude technology variables, in order to reward technology that saves energy

# Continue Benchmarking

- **There is time**

- Score updates are not anticipated until August 2018.
- We will give ample notice of the exact date.

- **Prepare for the update**

- Building w/ cold storage space - be prepared to enter % into Portfolio Manager August 2018
- Score will be inaccurate until this information is entered

- **We will not revoke prior certifications**

- All of your certified properties will still be on our registry.
- If you have top performers that are not certified, now is a good time to pursue certification.

- Questions & Discussion