CBECS 2012 Analysis Update: ENERGY STAR Score for Office

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Agenda

- **Kick-Off Survey Results**
  - Trends in the Market
  - Comparison to CBECS
  - Data Centers

- **CBECS Regression Modelling**
  - 2003 to 2012 Comparison
  - Base Model
  - Climate and Weather Findings
  - Remaining Factors to Analyze

- **Next Steps**

Are offices becoming more efficient?

- **You say…**
  - Yes
  - 75% of respondents think offices use less energy/are more efficient

- **CBECS says…**
  - Yes
  - The CBECS data also suggests lower energy intensity for 2012 as compared with 2003

- **What does this mean for you?**
  - If buildings are more efficient, then it is more likely that scores will decrease when we make changes
  - As the market improves, it requires better efficiency to reach a level of 75 or higher
  - This is what we have seen in the product market (computers, refrigerators, etc.)

What factors affect energy use in Offices?

- **You say…**
  - Climate
  - Hours of Operation
  - Percent Occupied
  - Data Centers
  - Restaurants

- **CBECS says…**
  - Climate – is relatively <u>less</u> important
  - Hours – is important
  - Occupancy – is very linked to worker density, with worker density likely being the more reliable variable
  - Data Centers – TBD (we still need to analyze)
  - Restaurant – TBD (we still need to analyze)

- **What does this mean?**
  - The data does not always match our perceptions
  - Climate factors usually less important in commercial buildings than they are in our homes
  - EPA score is based on what we see in the data

Your Responses: Important Factors
(# votes per category)

	No Effect	Small/ Medium Effect	Large/ Very Large Effect
Climate Zone	1	22	45
Hours of Operation	0	15	52
Workers	0	36	32
Percent Occupied	0	21	47
Computers	0	42	26
Refrigerators	5	39	21
Data Center	1	12	54
Restaurant/ Retail	2	16	47

What about other factors?

- Many comments about technology/maintenance
  - Efficient technology improves your score by lowering your actual energy consumption
  - To allow for this benefit, we should not incorporate these factors into a regression
  - Refer to our methodology discussion from last webinar

- Some notes about "plug load"
  - While we do not count up specific pieces of equipment, correlations with both workers and computers may reflect plug load impacts

- Comments about tenants and/or amenities
  - Effect of different "types" of tenants
  - Growing trend to offer more amenities, like yoga classes, cafeterias, and game rooms
  - Is it possible to account for visitors separately from workers?

→ *Note that we cannot account for factors that are not part of CBECS, but we could recommend new questions for the next survey…*
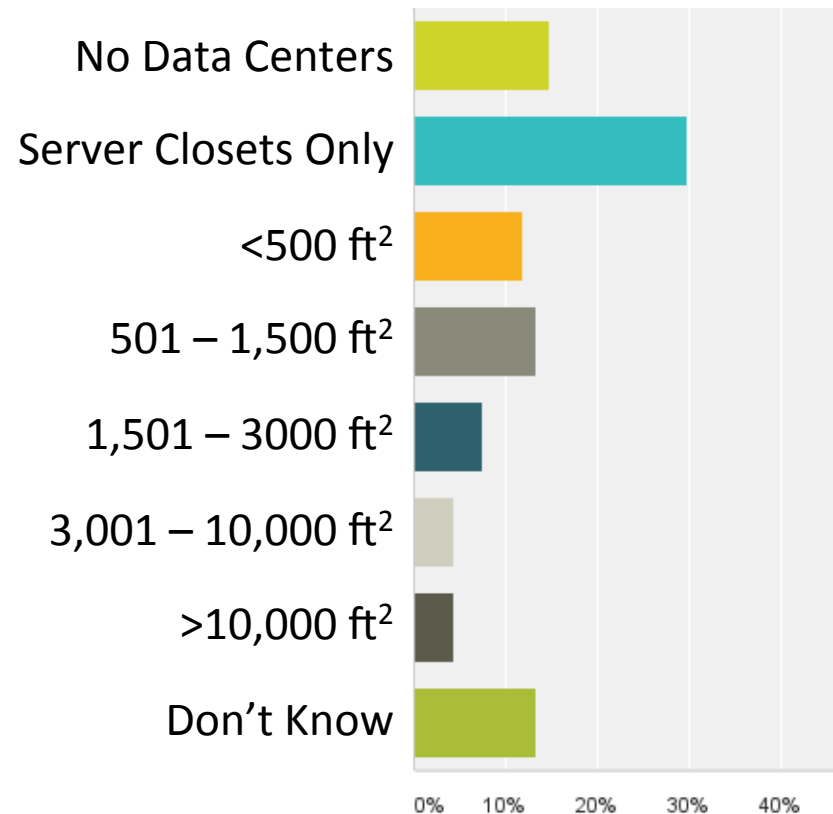
Poll: Tell us what you think

- **Do you think it would be useful to have a question in the CBECS analysis to capture the number of visitors?**
  - Yes
  - No
  - Don't Know

- **Are there any specific amenities that you think would make good CBECS questions (e.g. fitness center, game room)?**
  - Free Response

- **What types of tenants do you think use the most energy?**
  - Free Response

- **What types of tenants do you think use the least energy?**
  - Free Response

Data Centers – Survey Input

- **Server Closets are common**
  - These are likely common for CBECS offices, too

- **Data Centers over 3,000ft^2 are rare**

- **Free response comments**
  - It is important for EPA to adjust for Data Centers
  - It is difficult to measure IT Energy at Data Centers

No Data Centers

Server Closets Only

<500 ft^2

501 – 1,500 ft^2

1,501 – 3000 ft^2

3,001 – 10,000 ft^2

>10,000 ft^2

Don't Know

0%   10%   20%   30%   40%

Data Center Methodology

- **Today – Require IT Energy Measurement**
  - IT energy is the electricity that goes to the servers/storage devices (not the same as total data center energy)
  - It is a best practice to measure this if you want to track and improve your data center performance

- **Possible Alternatives?**
  - There is a new CBECS variable capturing data center size
  - We will explore correlations based on the presence and size of a data center
  - Will consider a "data center" use detail within office
  - Will consider an approach that does not require IT Energy measurements (e.g. a square foot approach)

- **Limitations**
  - Energy use in data centers is highly variable
  - It may not be possible to develop a good adjustment based on square foot
  - A number based on square foot may be very conservative
  - If an alternate approach is offered
    - It may be limited to smaller data centers
    - The IT measurement approach will still be the preferred/recommended approach

Poll: Tell us what you think

- **Do you have any offices that <u>do not</u> have server closets?**
  – Yes
  – No
  – Don't know

- **At what size threshold does the presence of a data center in one office building make it hard to compare against a second office building without a data center?**
  – When any Data Center is present
  – When a Data Center is 2% of the floor area or more
  – When a Data Center is 5% of the floor area or more
  – When a Data Center is10% of the floor area or more

- **Energy efficiency of my data centers is very important to my organization**
  – Strongly disagree
  – Disagree
  – Neutral
  – Agree
  – Strongly Agree
  – Don't Know/Don't Care

Preliminary CBECS Analysis and Regression Models

Median Value Comparison: 2003 to 2012

- Energy Intensity is lower for 2012
  - This trend may or may not hold true after we normalize for operational factors and climate within the regression
- Worker Density and Computer Density also appear lower in 2012
  - This data is the opposite of market trends that we hypothesized
  - Could it be that denser work areas are also counter-balanced by more common spaces and amenities, which lower the overall worker density of the building?
- Hours are also slightly lower in 2012
- Trends look the same for each subtype (Office, Bank, Court)
  - Exact values will be different for each type and may also show correlations with other factors, like size

|	2003	2012
Source EUI	154	129
Worker Density	2.04	1.88
Computer Density	2.29	2.00
Hours of Operation	48	46

Base Model Comparison

- We have identified basic terms that are statistically significant with any subset of the data
  - Hours, Worker Density, Computer Density, and Cooling Degree Days (CDD)
  - A p-value below 0.10 indicates significance at the 90% confidence level

- Model looks similar whether we run with a minimum of 1,000 ft^2 or 5,000 ft^2
  - EPA is considering lowering the size requirement below 5,000 ft^2 if possible

- We are using this baseline model to assess the impact of other factors
  - Data Center, Restaurant, Bank Branch

Regression Term	Base Model 1,000 ft^2 Minimum Size		Base Model 5,000 ft^2 Minimum Size	
	Coefficient	p-value	Coefficient	p-value
Constant	50.99	0.0003	23.68	0.1084
Hours	0.502	0.0032	0.7098	0.0000
Worker Density	14.13	0.0049	20.79	0.0006
PC Density	7.198	0.0226	10.54	0.0123
CDD times % Cooled	0.01651	0.0004	0.01323	0.0256

Base Model Performance

- Ideal graph should show 10% in each bin
  - Just as many buildings would score 1-10 as score 90-100
  - Common to see some slight variations from one bin to the next
- For CBECS data, both base models show expected performance
  - We will also test this type of graph using Portfolio Manager, including different subsets (Bank, Office, Court, different size categories, etc.)
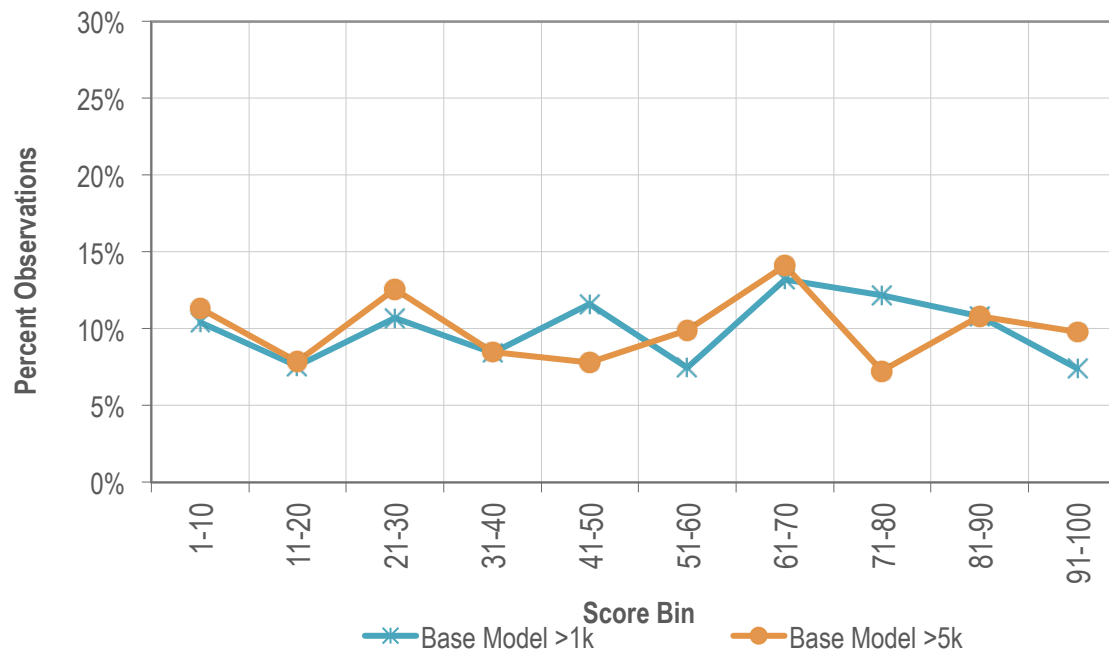
Poll: Tell us what you think

- **How important is it to you to have a score that can accommodate offices that are smaller than 5,000 square feet in size?**
  - Not important, I don't have small buildings
  - Good to have
  - Extremely Important
  - Don't Know

- **Do you think that large buildings should score differently than small buildings?**
  - No – if EPA does the model right, all buildings should score the same
  - Yes – Larger buildings are more efficient and should score better
  - Yes – Larger buildings are less efficient and should score worse

Climate: A Closer Look at CBECS

- **There is a stronger positive trend for Cooling Degree Days (CDD) than for Heating Degree Days (HDD)**
  - Offices are more heavily driven by internal loads
  - Dark lines on graph show linear trend in the data

- **Trend for HDD is slightly negative**
  - HDD and CDD can have a correlation with each other

- **Not all ENERGY STAR scores adjust for both HDD and CDD**
  - In Canada (colder climate) we have models that have only HDD
  - In the US, the Hospital model relies on CDD only (not HDD)
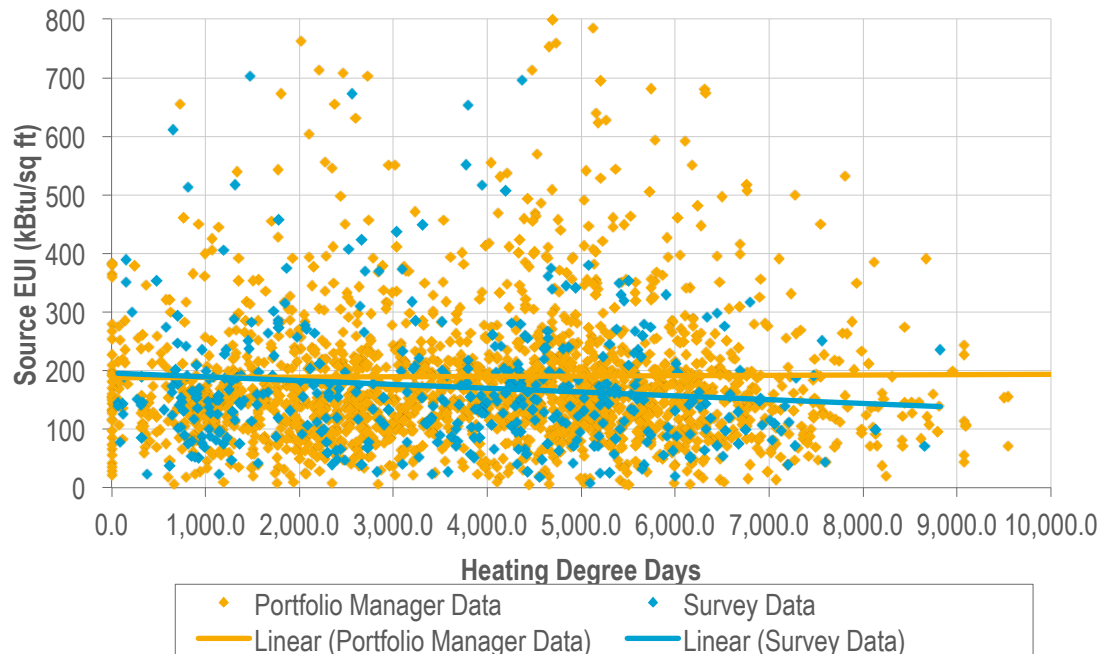   - Likely due to internal loads
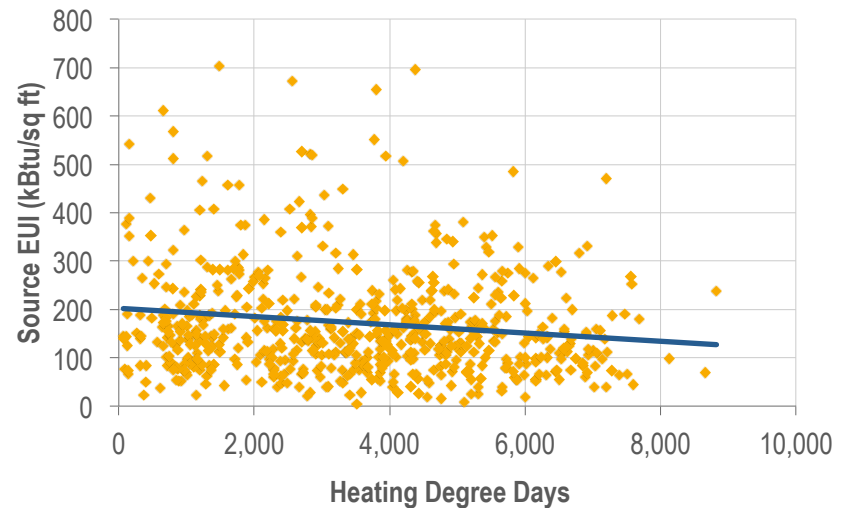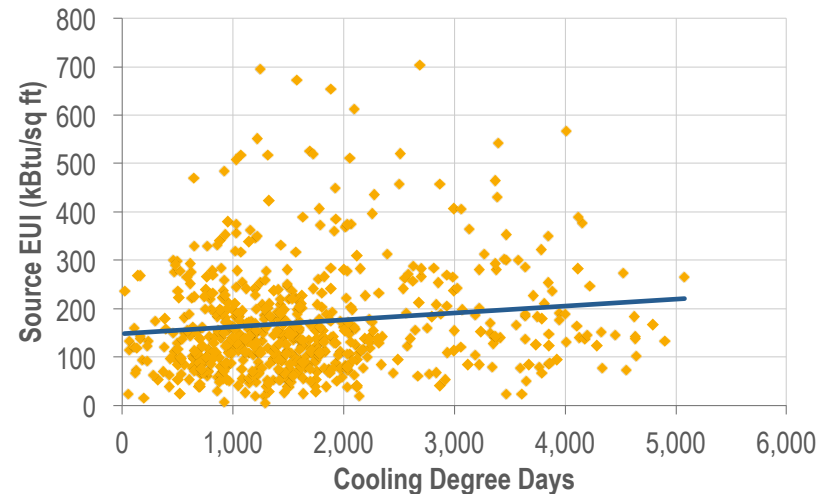
How does climate compare to other factors?

- **Worker Density is a good point of comparison**

- **The graph shows a steeper line/ bigger effect**

- **This result does not mean that we don't use a lot of energy for cooling**
  - Rather, this aspect of operation is not as important when comparing energy use between buildings
  - The difference between an office with 4 workers per thousand square foot as compared to one with 2 workers per thousand square foot is bigger than the difference between one in a cold climate and one in a hot climate
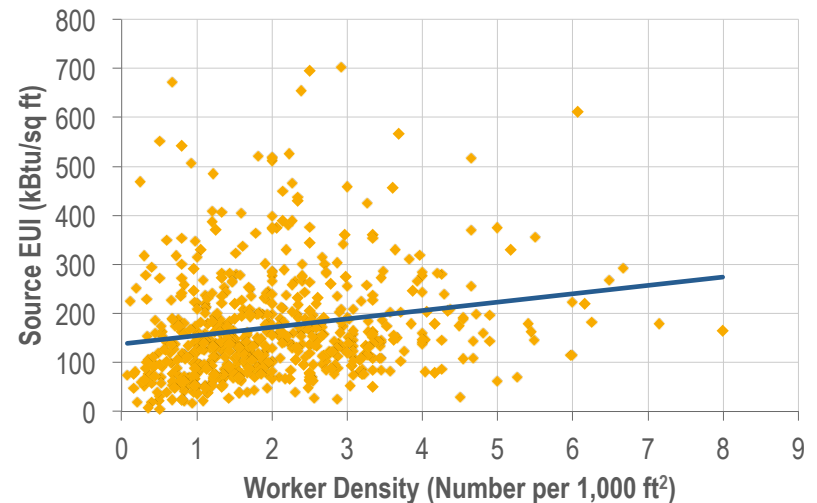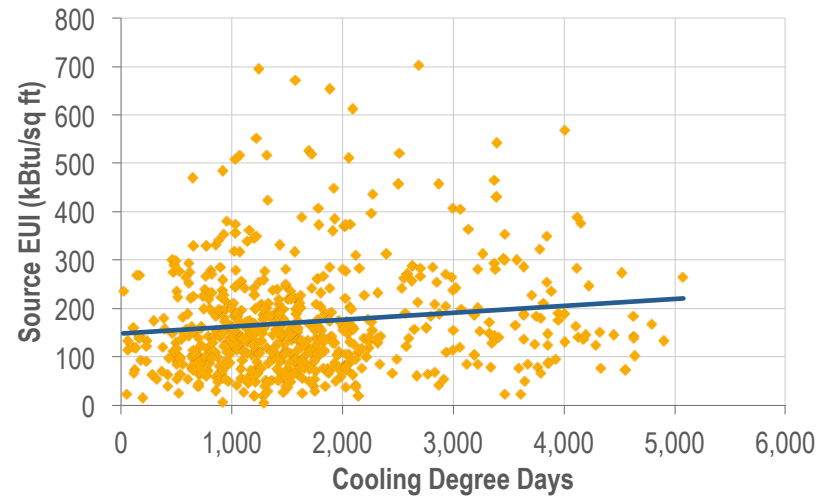
What does the data in Portfolio Manager say?

- Similar to CBECS, the data in Portfolio Manager also does not exhibit a strong correlation with Heating Degree Days
    - Graph shows a random sample of 2,000 Offices in Portfolio Manager
    - Portfolio Manager does not slope downward like CBECS, but does not slope upward either
    - Properties in areas with higher HDD do not show higher EUI for either set

- Also similar to CBECS, the Portfolio Manager relationships for Worker Density and Operating Hours are stronger than for Cooling Degree Days
   - https://www.energystar.gov/buildings/tools-and-resources/datatrends-energy-use-office-buildings

Model with and without HDD

- The following comparative models show that the term for HDD is **not** statistically significant
  - To be statistically significant, the p-value must be less than 0.10

- Similar results seen with other variable formats
  - HDD on its own, natural log of HDD

Regression Term	Base Model		Base Model with HDD	
	Coefficient	p-value	Coefficient	p-value
Constant	50.99	0.0003	47.47	0.0210
Hours	0.502	0.0032	0.502	0.0032
Worker Density	14.13	0.0049	14.15	0.0049
PC Density	7.198	0.0226	7.204	0.0226
CDD times % Cooled	0.01651	0.0004	0.01740	0.0039
HDD times % Heated	--	--	0.00064	0.8126

How would a model without HDD score properties in cold climates?

- Using the base model without a term for HDD, we observe the full range of scores (1 to 100) for buildings in all climates

- When the model is working, the graph below should appear to be scatter, with no clear trend
  - See high and low scores at both high and low HDD climates
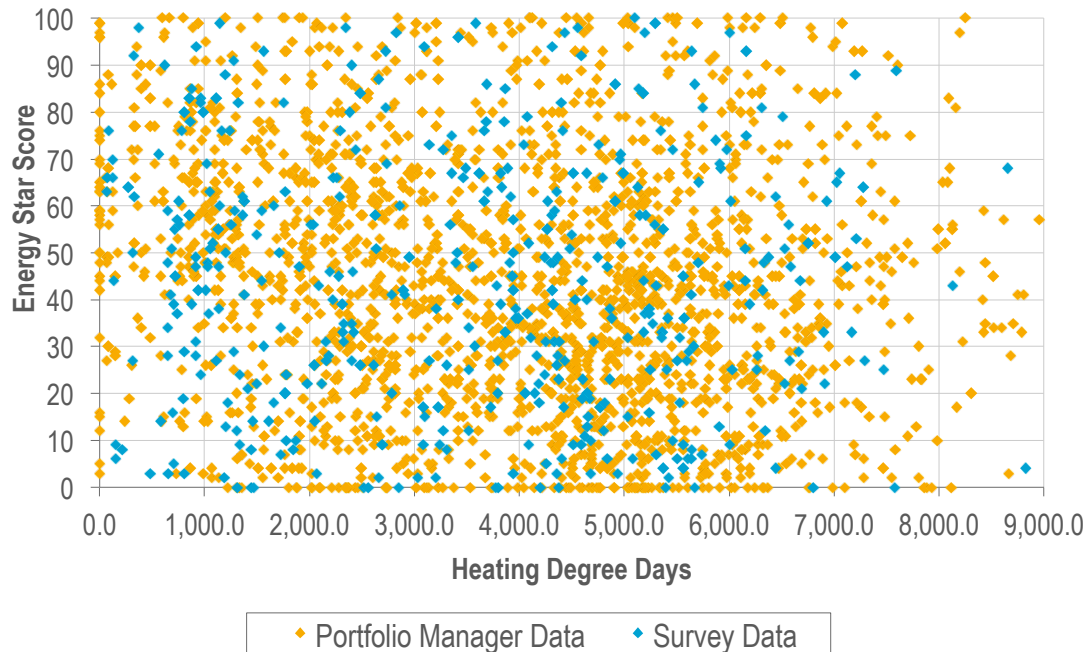
Poll: Tell us what you think…

- **Based on the findings presented today, if EPA were to proceed with a model that did not include a specific term for HDD, would you be satisfied?**
  - Yes – I would be satisfied
  - No – I want to see HDD in a model
  - Neutral – I don't have a strong opinion
  - Don't know/Maybe – I'd like to see more information

- **On average, how many months of the year do you cool your building(s), either with an economizer or a mechanical system?**
  - 0-2 months
  - 3-4 months
  - 5-6 months
  - 7-8 months
  - 9-10 months
  - 11-12 months

- **On average, how many months of the year do you heat your building(s)?**
  - 0-2 months
  - 3-4 months
  - 5-6 months
  - 7-8 months
  - 9-10 months
  - 11-12 months

Factors still to analyze

- **Data Center** – Do the new CBECS variables provide us with new information that can allow us to offer a different approach for data centers?

- **Size Effects** –
    - What will be the minimum size requirement for Offices?
    - Do larger buildings behave differently than smaller ones?

- **Restaurant** – Do variables about restaurants and/or refrigeration improve the base model?

- **Percent Occupancy** – Do percentage occupancy and/or percent cubicle space enable us to refine the adjustment for worker density?

- **Bank Branch and Courthouse** – How do Bank Branches and Courthouses differ from Offices? What additional adjustments are necessary?

Schedule Reminder

- **Spring/Summer 2016**
  - Bulk of Office analysis will be completed by the end of the summer

- **Fall 2016 – Spring 2017**
  - Focus will be on other property types (hotel, K-12, etc.)
  - Based on our findings we may revisit our office analysis

- **Summer 2017**
  - Run comparative analysis across property types
  - Re-estimate all models with updated source factors

- **Fall 2017**
  - Programming/Testing in Portfolio Manager

→ *Hope is to launch new scores in early 2018*

Next Webinar: July

- Please be on the lookout for our next webinar
  - Date TBD
  - https://esbuildings.webex.com/

- We will cover the results of our remaining analysis and provide our recommended office model

- Between now and then, feel free to reach out with questions and suggestions at any time
  - www.energystar.gov/BuildingsHelp

Questions & Discussion