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Commercial Mortgages: Energy Factors and Default Risk

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Outline

- Premise: why commercial mortgages?
- DOE scoping study findings

- Energy factors and mortgage default risk: **New results!**

Premise and Context:
Why Commercial Mortgages?

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What about commercial mortgages?

- Commercial mortgages currently do not fully account for energy factors in underwriting and valuation…
- …energy efficiency is not properly valued and energy risks are not properly assessed and mitigated.

- Commercial mortgages are a large lever and could be a significant channel for scaling energy efficiency.

Potential Interventions: Results from a Scoping Study

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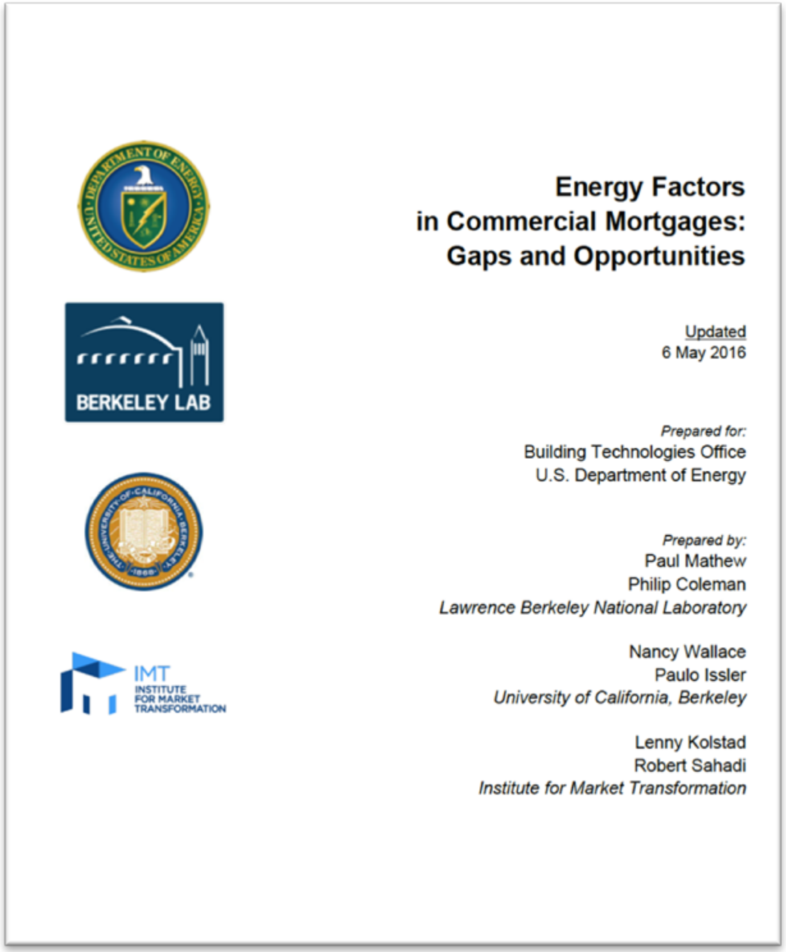
DOE Scoping Study

- Lit review and 40 stakeholder discussions
  - Lenders
  - Owners
  - Service providers
  - Industry orgs
- State-of-the-market
- Potential Interventions



Energy Factors in Commercial Mortgages: Gaps and Opportunities

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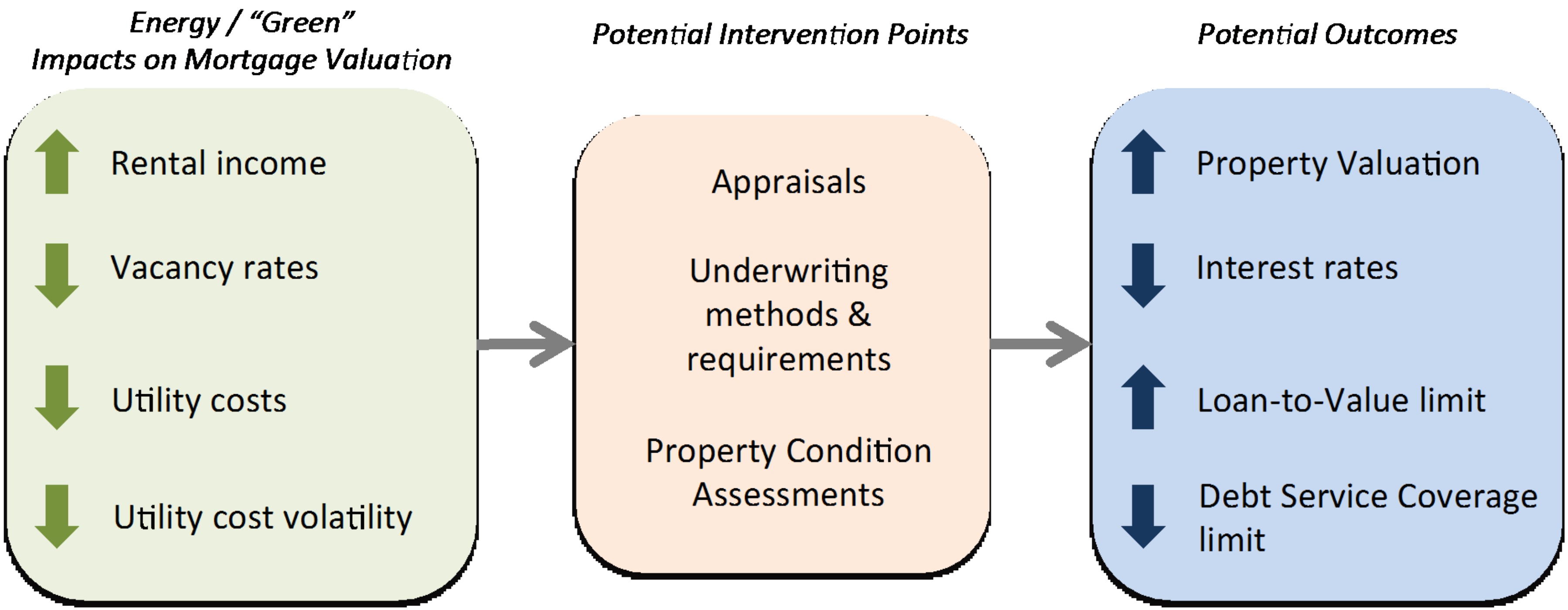
https://cbs.lbl.gov/energy-factors-commercial-mortgages

Potential interventions and outcomes



Efforts currently underway

1. Demonstrate to lenders why, where, and how much energy factors “move the needle”
   - Focus of today’s presentation

2. Incorporate energy efficiency information in Property Condition Assessments (PCAs)
   - Seeking participants!

3. Incorporate energy efficiency routinely in appraisals
   - DOE working group

Impact of Energy Factors on Mortgage Default Risk

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Energy factors that directly affect valuation

- Energy use volume
  - Electricity kWh/kW, fuel therms
  - Driven by building features, operations, weather
- Energy use volatility (+/- %)
  - Driven by operations, weather
- Energy price
  - $/kWh, $/kW, $/therm
- Energy price volatility
  - e.g. forward curves

How much do these factors affect mortgage default risk?

Ideal analysis approach

- Analysis on an empirical data set that has:
  - Time-variant data on energy factors for specific buildings
  - Loan performance data for the same buildings
  - A representative sample across different market segments
- *Challenges:*
  - *Lack of time-variant consumption dataset that can be matched with loan data*
  - *Lack of tariff data for individual buildings*

Data sources considered

Loans

- TREPP
- Dataquick
- Real Capital Analytics

Energy Price

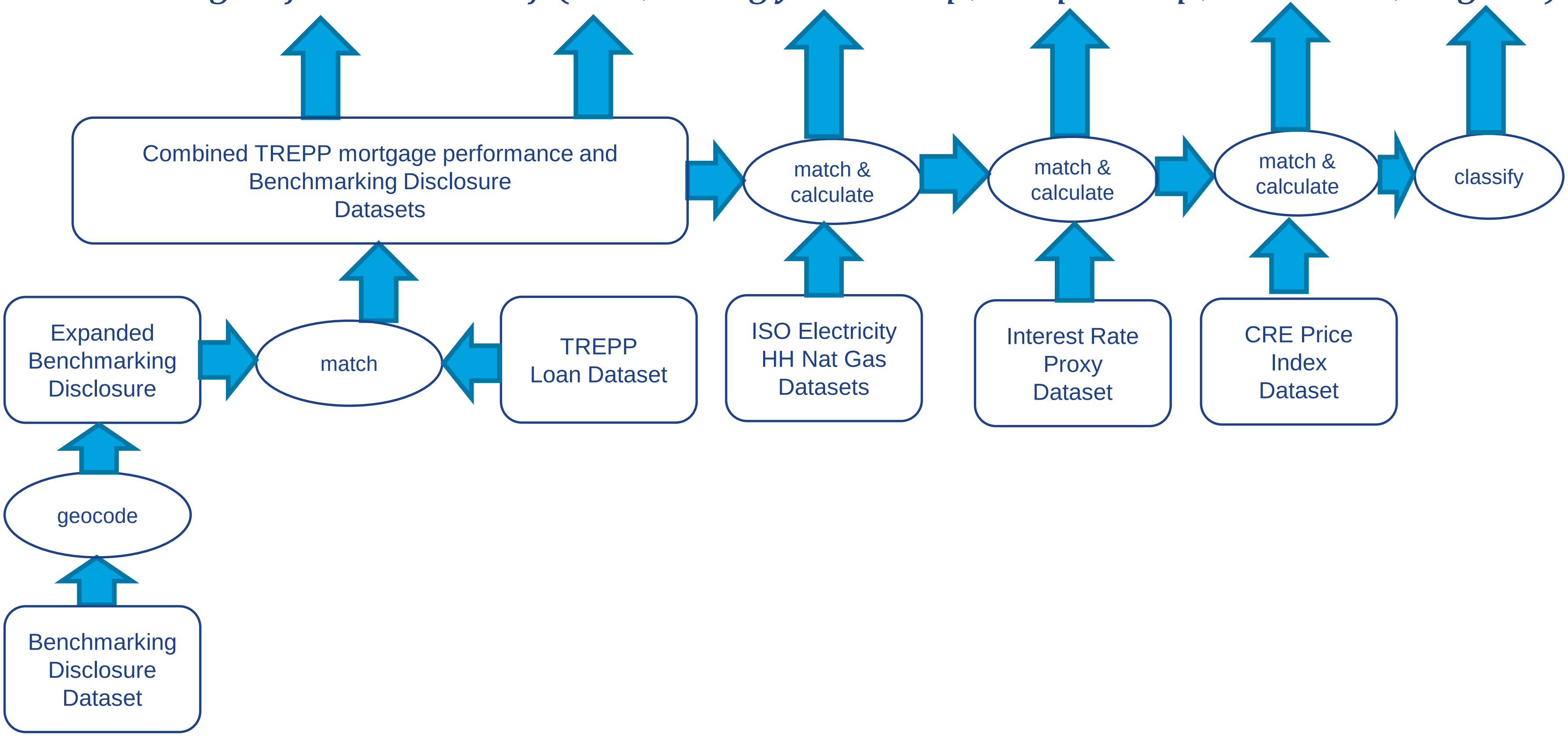
- Utility tariff data
- ISO/RTO
- Platts' forward prices

Energy Use

- Bx Disclosure
- BPD
- Simulations

Modeling approach:
Estimate the loan-level probability of default

$$MtgDefualtRate = f(EUI, EnergyPriceGap, CouponGap, LTVRatio, Region)$$



Energy price gap

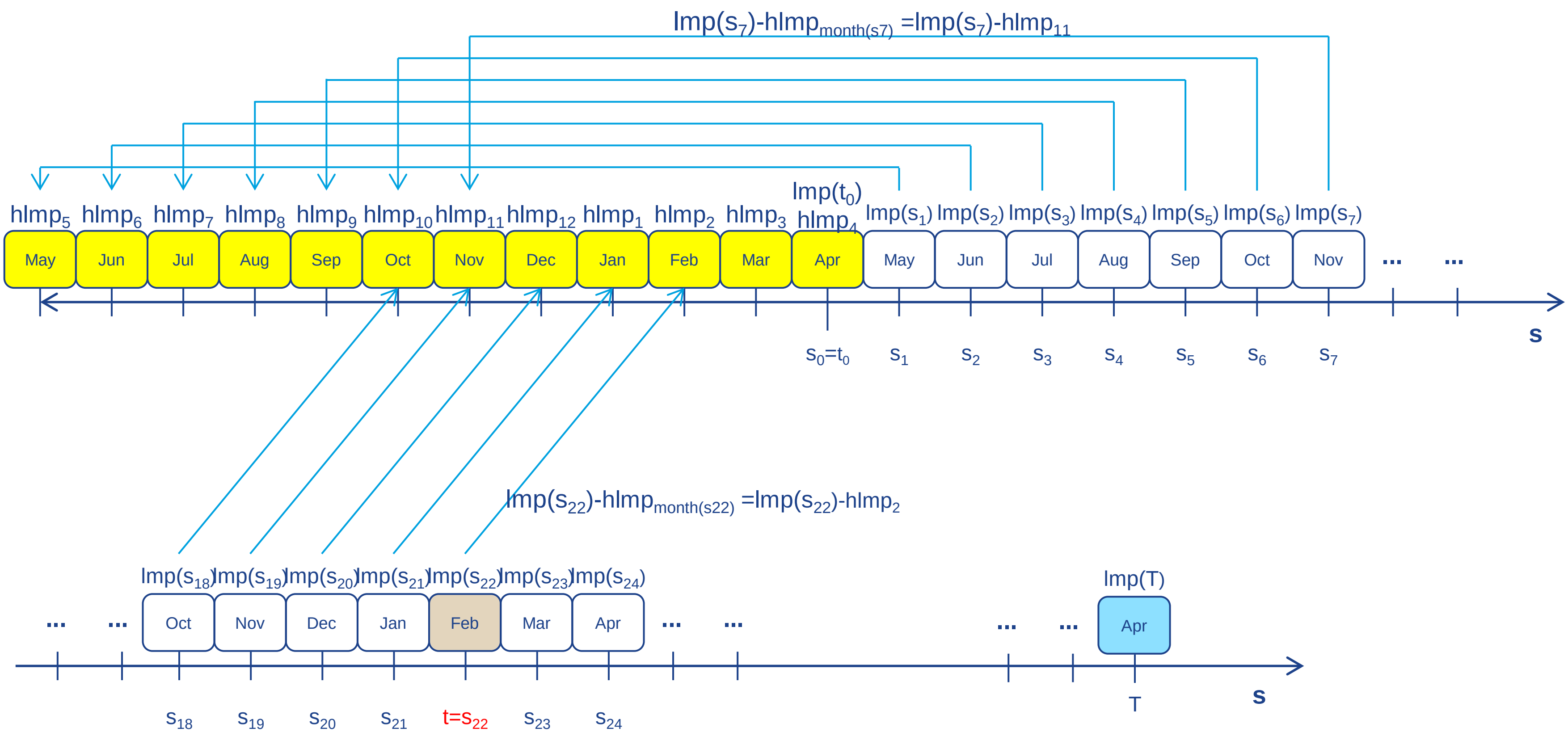
- Proxy for total unexpected energy expenditures
- Computed by summing monthly deviations of realized electricity prices from expected electricity prices at the time of mortgage origination
- Energy price gap, at time *t*, for a commercial mortgage originated at a time period t_0 within ISO zone *k* :

$$pgap_k(t_0, t) = \sum_{s=t_0}^{s=t} lmp_k(s) - hlmp_{k,month(s)}(t_0)$$

- Where:
  - *lmp* = monthly average on-peak locational marginal electricity price
  - *hlmp* = historical monthly average locational marginal price observed at the mortgage origination date.

Energy price gap

- Example: Evaluating the Energy Price Gap 22 months after the mortgage origination



Default risk and source EUI: Office and Retail – Linear probability model

	Coefficient Estimate	Standard Error	Coefficient Estimate	Standard Error
Intercept	-0.19342	0.16448	-0.40444**	0.18466
Log Source EUI	0.06001*	0.03159	0.07335**	0.03129
Origination Loan-to-Value Ratio			0.00258***	0.00096
Coupon Spread to 10 Year Treasury			0.02188	0.01565
Electricity Price Gap			0.00003***	0.00001
Time to Maturity on Balloon			-0.00189***	0.00060
Origination Year Fixed Effects	Yes		Yes	
N = 492 R2 = .0005			N = 473 R2 = .1052	

* p<0.1; ** p<0.05; ***p<0.01

Default risk and source EUI: Office and retail – linear prob. model

- The coefficient estimates for **BOTH** the *Electricity Price Gap* and *Source EUI* are significant at better than the .05 level of statistical significance.
- **Both** coefficient estimates are also economically meaningful:
  - The higher the *Source EUI* (the more energy usage per square foot) the higher the likelihood of default.
  - The higher the *Electricity Price Gap*, (the larger the difference between the realized and the expected electricity prices since the loan origination), the higher the likelihood of default.

Default risk and site EUI: Office and retail – linear prob. model

	Coefficient Estimate	Standard Error	Coefficient Estimate	Standard Error
Intercept	-0.05633	0.07404	-0.10734	0.08375
Log Site EUI	0.03169*	0.01711	0.02685	0.01658
Origination Loan-to-Value Ratio			0.0015**	0.00034
Coupon Spread to 10 Year Treasury			-0.00002	0.00014
Electricity Price Gap			0.00002***	0.00000
Time to Maturity on Balloon			-0.00048*	0.00028
Origination Year Fixed Effects/Year Fixed Effects	Yes		Yes	
N = 535 R2 = .002			N = 516 R2 = .0701	

* p<0.1; ** p<0.05; ***p<0.01

Default risk and site EUI: Office and retail – linear prob. model

- *Site EUI* is not statistically significantly different from 0 at better than .05 level.
- Electricity Price Gap is significant at better than the .05 level of statistical significance.
- Both coefficients have economically meaningful signs:
  - The higher the *Site EUI* (the more energy usage per square foot) the higher the likelihood of default.
  - The higher the *Electricity Price Gap*, (the larger the difference between the realized and the expected electricity prices since the loan origination), the higher the likelihood of default.

Default risk and ENERGY STAR Score: Office and retail – linear prob. model

	Coefficient Estimate	Standard Error	Coefficient Estimate	Standard Error
Intercept	0.18650**	0.05788	0.18383*	0.11046
Energy Star Score	-0.00102	0.00079	-0.00134*	0.00077
Origination Loan-to-Value Ratio			0.00183*	0.00099
Coupon Spread to 10 Year Treasury			-0.00028	0.00021
Electricity Price Gap			0.00004***	0.00001
Time to Maturity on Balloon			-0.00166**	0.00054
Origination Year Fixed Effects/Year Fixed Effects	Yes		Yes	
N = 448 R2 = .002			N = 432 R2 = .071	

* p<0.1; ** p<0.05; ***p<0.01

Default risk and ENERGY STAR score: Office and Retail – Linear Prob. Model

- *Energy Star Score* is not statistically significantly different from 0 at better than .05 level.
- Electricity Price Gap is significant at better than the .05 level of statistical significance.
- Both coefficients have economically meaningful signs:
    - The higher the *Energy Star Score* (the more energy efficient the building) the lower the likelihood of default.
    - The higher the *Electricity Price Gap*, (the larger the difference between the realized and the expected electricity prices since the loan origination), the higher the likelihood of default.

What are the impacts on specific cases? – Scenario analysis

- Develop range of scenarios that have different energy factor risks
  - Range of locations, building features, operations, etc.

For each scenario:

- Determine energy consumption and price volatility.
  - Use combination of empirical and simulation approaches
- Use hazard model coefficients to determine impact on default risk

Asset types

Use	Size	Climate	Asset eff	Notes
Office	500,000	4A	High	~ 90.1-2013
Office	500,000	4A	Medium	~ 90.1-2004
Office	500,000	4A	Low	Pre-1980 envelope
Office	500,000	2A	High	~ 90.1-2013
Office	500,000	2A	Medium	~ 90.1-2004
Office	500,000	2A	Low	Pre-1980 envelope
Office	200,000	4A	Medium	~ 90.1-2004
Office	25,000	4A	Medium	~ 90.1-2004
…				

A wide range of factors affect year-to-year energy use variations

Facilities management

Economizer settings

VAV box minimum flow setting

Supply air temperature reset

Static pressure reset

Chilled water/Hot water supply temperature reset

Condenser water temperature reset

Chiller /boiler sequencing

…

Weather

Vacancy rates

Occupant behavior

Lighting controls

Window operation

Thermostat setpoints/setback

Local heating/cooling equipment

Plug in equipment

Maintenance

Damper/ valve check

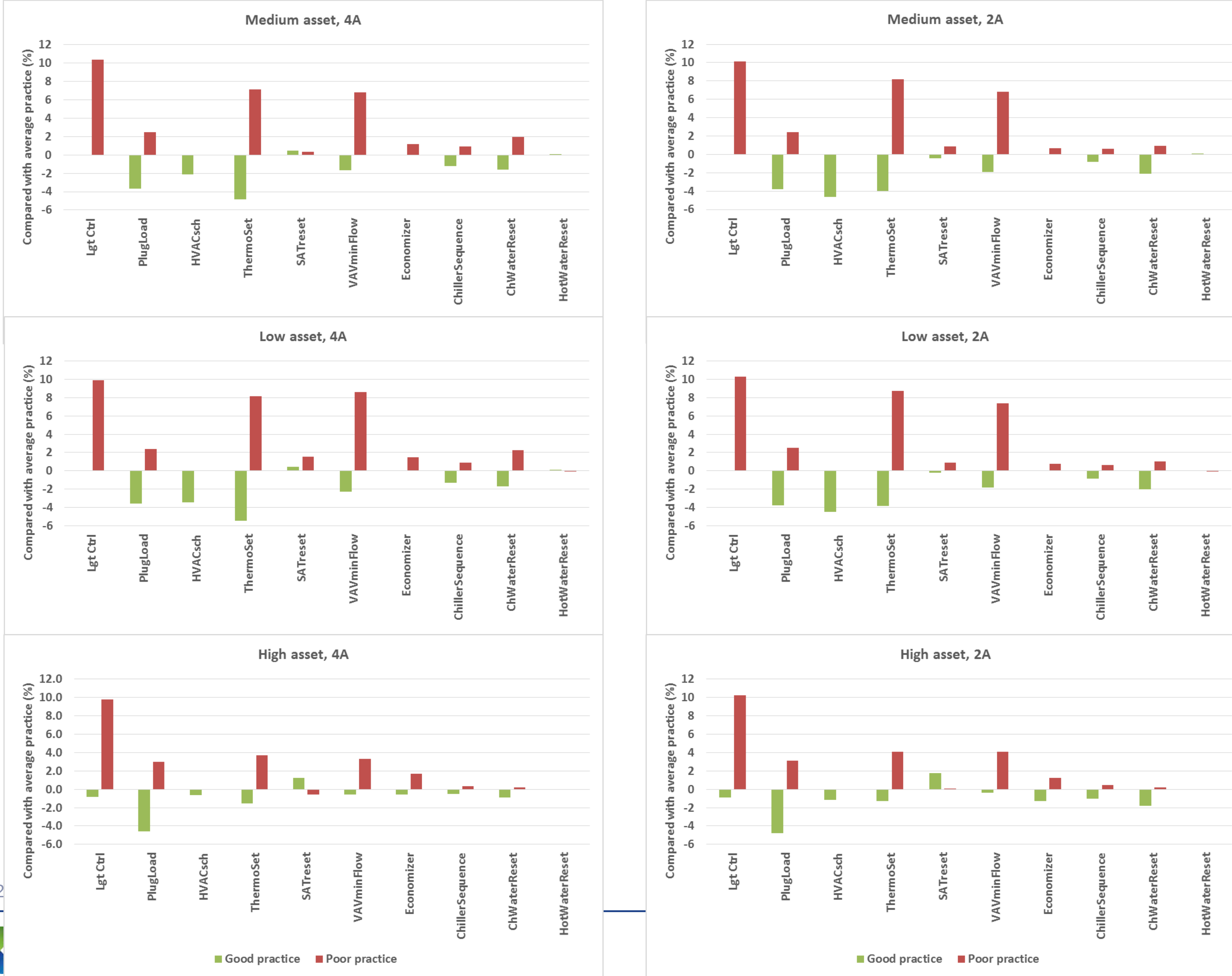
Filter change

Coil cleaning

…

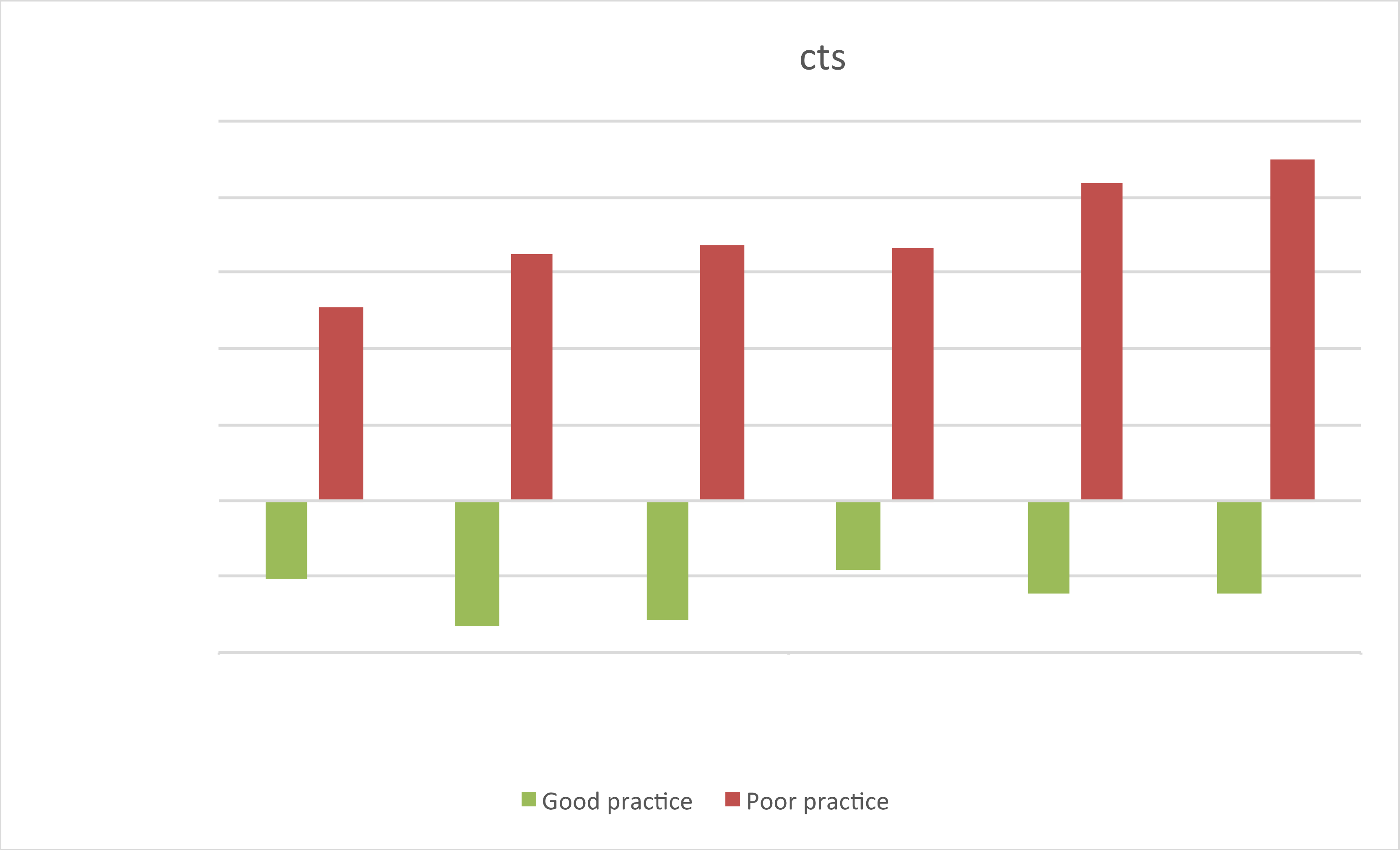
Range of practice for each factor

Factor	Good practice	Average practice	Poor practice
Lighting controls	Daylight-dimming + occ	Occ only	Timer only
Plug load controls	Turn off when occupants leave	Sleep mode by itself	No energy saving measures
HVAC schedule	optimal start	2hr +/- Occupanct sch	n/a
Thermostat settings	68°F for heating and 78°F for cooling Setback: 60 - 85	70°Ffor heating and 76°F for cooling Setback: 68 - 80	72°F for heating and 74°F for cooling No setback
Supply air temp reset	SAT reset base on warmest zones	SAT reset based on the stepwise function of outdoor air temperature	Constant supply air temperature
VAV box min flow settings	15% of design flow rate.	30% of design flow rate.	50% of design flow rate.
Economizer controls	Enthalpy	dry bulb	none/broken
Chilled water supply temp reset	Reset chilled water temperature based on cooling demand.	Linear relationship with outside air temp (OAT).	No reset with constant year-round.
Chiller sequencing	Kick on the lag chiller when the lead chiller reaches its peak efficiency.	Kick on the lag chiller when the chilled water temperature cannot be maintained.	Always running two chillers
Hot water supply temp reset	Reset the hot water supply temperature according to heating load.	Linear relationship with OAT.	No reset with constant year-round.
Boiler sequencing	Kick on the lag boiler when lead boiler reaches its peak efficiency.	Kick on the second boiler based on OAT.	No sequencing and always running two boilers.
Plug load intensity	0.4 W/sf	0.75 W/sf	2.0W/sf
Occupant density	400 sf/per	200 sf/per	130 sf/per
Occupant schedule	8 hour WD	12 Hr WD	16 Hr WD

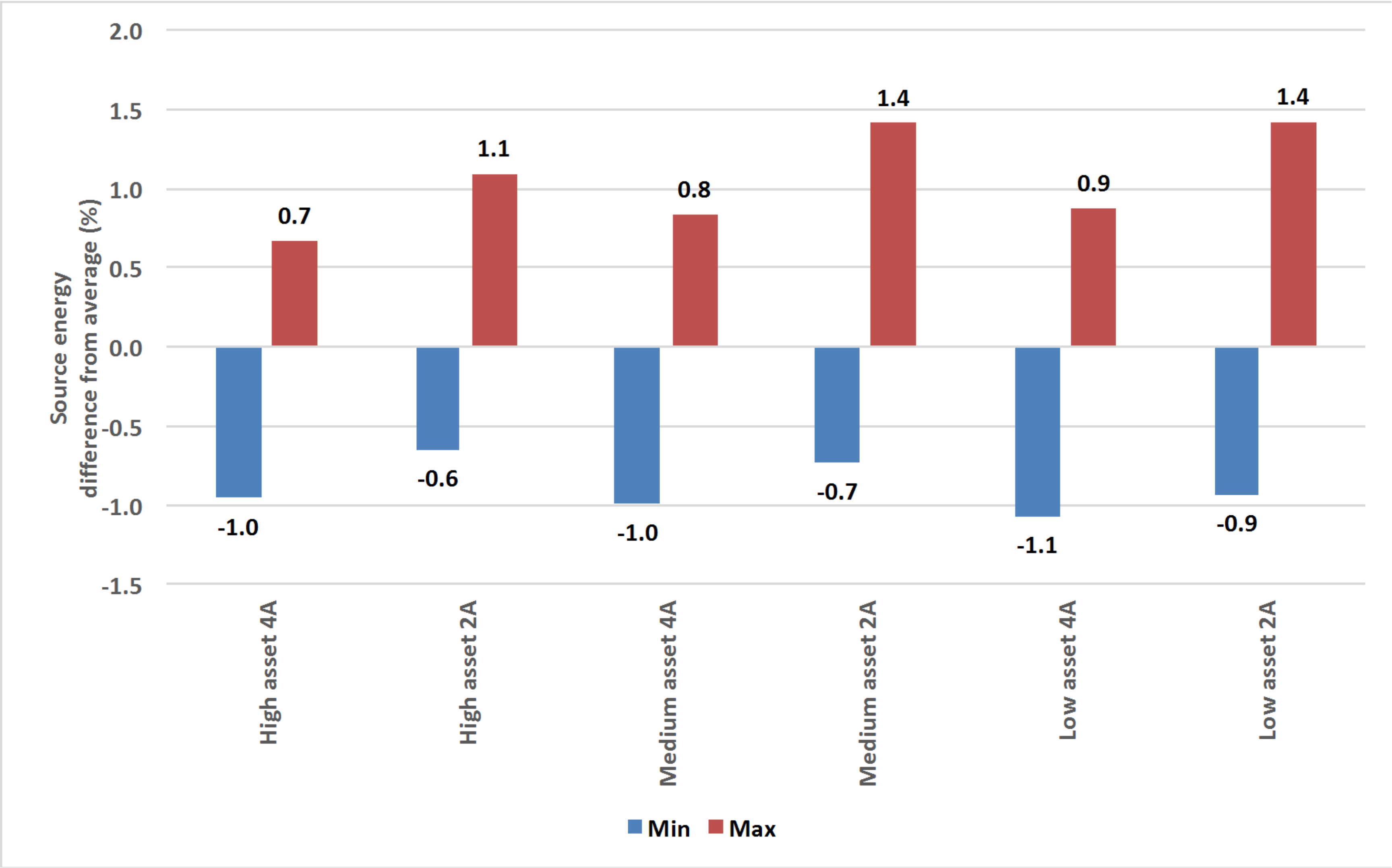


Medium asset, 4A
Medium asset, 2A
Low asset, 4A
Low asset, 2A
High asset, 4A
High asset, 2A
Compared with average practice (%)
12
10
8
6
4
2
0
-2
-4
-6
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
Lgt Ctrl
PlugLoad
HVACsch
ThermoSet
SATreset
VAVminFlow
Economizer
ChillerSequence
ChWaterReset
HotWaterReset
Good practice
Poor practice

Range of variation due to operation factors



Range of variation due to weather: 2000-2015



Net impacts on default risk - illustrative

Case	Source EUI (kBtu/sf.yr)	Change in default risk (absolute)	% Change in default risk (relative to TREPP avg)
Baseline	200	-	-
Poor operational practice	260 *(+30%)*	+0.0084	**+ 10.5%**
Good operational practice	180 *(-10%)*	-0.0034	**- 4.25%**

Limitations of these results

- Limited to CMBS.
- Uses proxies for energy cost i.e. source EUI and wholesale energy price gap.
- Source EUI data is only an annual "snapshot”.
- Matched data scope is limited by location, building types, and size.

Looking ahead

- Analysis
  - Default risk analysis using RCA bank loan data.
  - Actuarial-style “look up” of energy risks based on key asset and operational characteristics.
- Disseminate analysis results
  - Primary audience: Lenders and owners
  - via webinars, conferences, technical reports
- Engage lenders and owners to:
  - Develop methods and procedures to fully incorporate energy factors in mortgage valuation.
  - Apply these methods and procedures in commercial mortgages and document results in case studies.

Please let us know if you would like to participate!
Contact Cindy Zhu (DOE): Cindy.Zhu@ee.doe.gov

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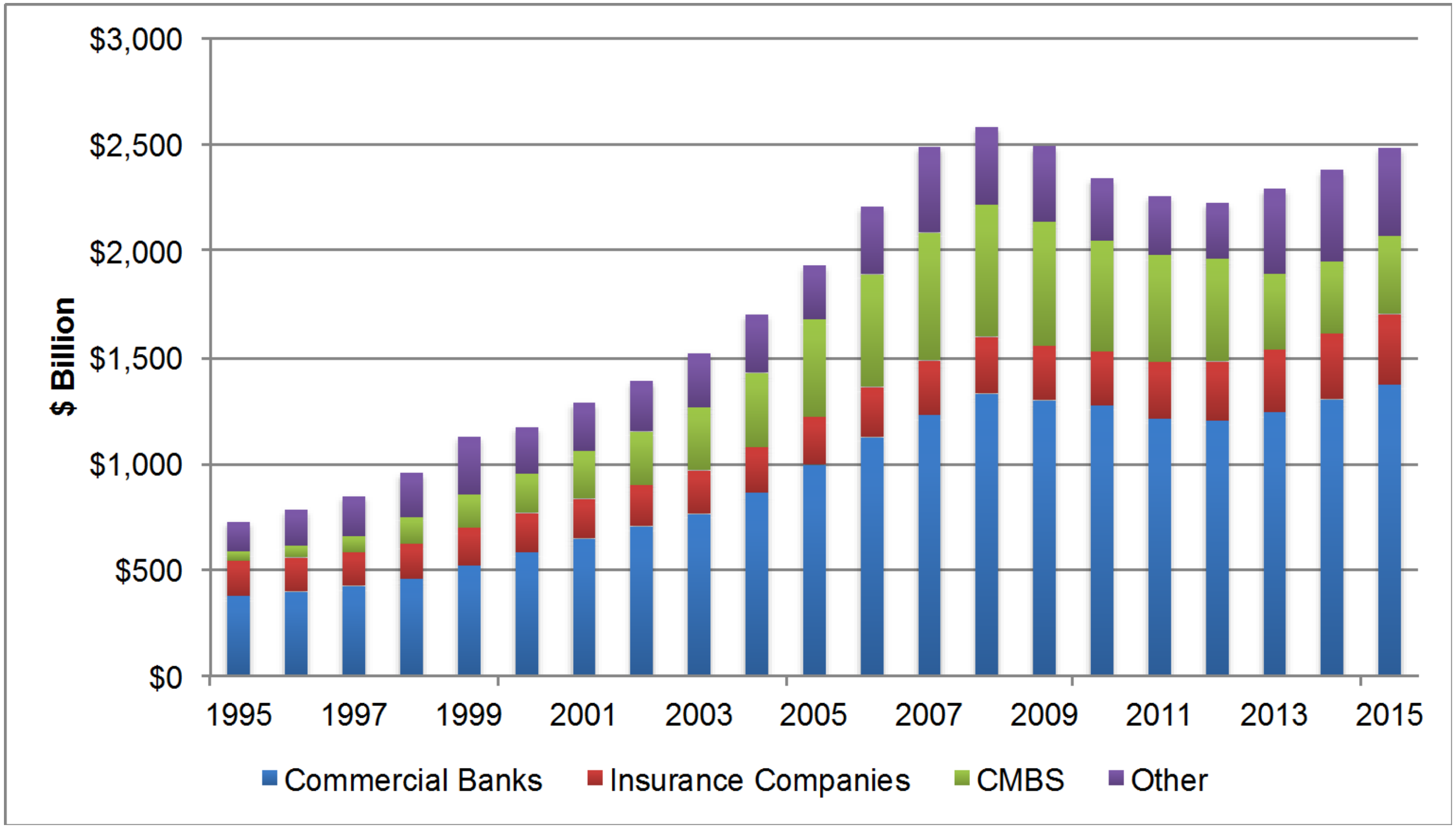
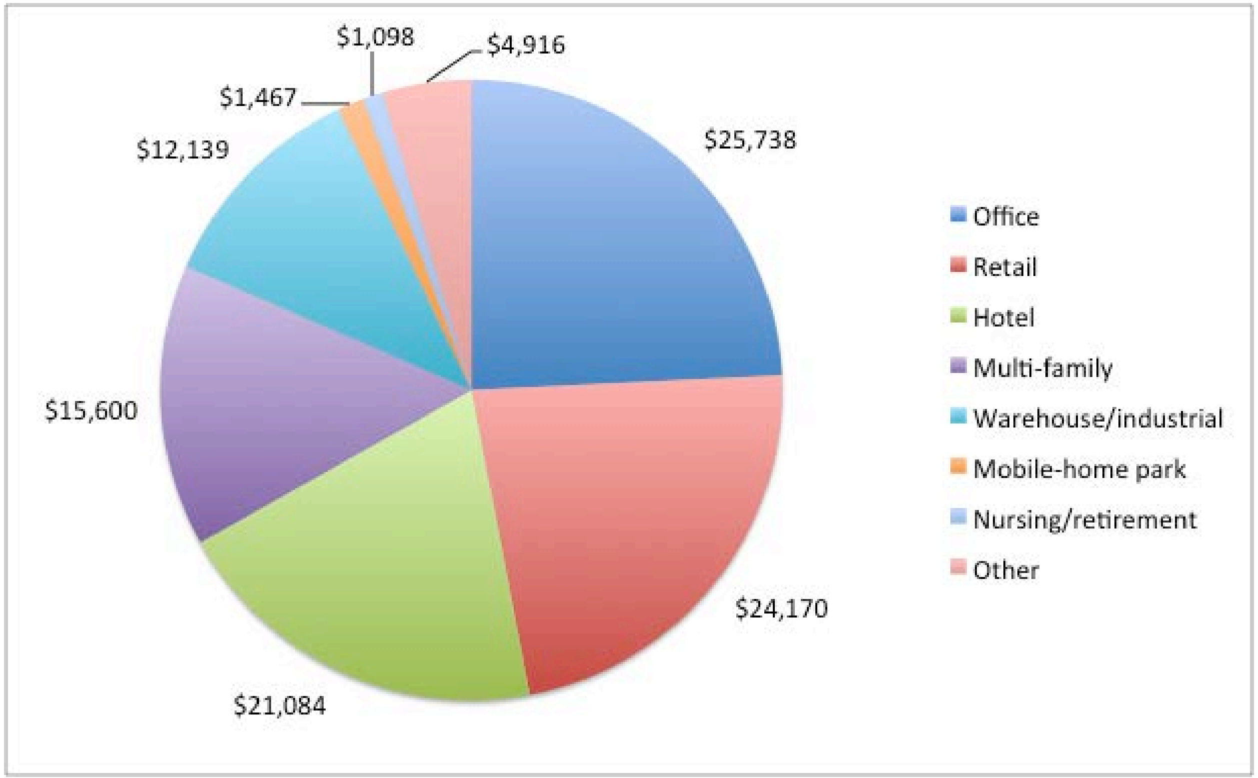
Appendix

$ 2.5 trillion market



Key CMBS sectors: Office, Retail, Hotel, Multi-family



Challenges and opportunities…1

- Energy efficiency is generally not a motivating factor for lenders.
- Very limited awareness and analysis of energy cost impacts in underwriting.
- Underwriting is not standardized across the industry.

Challenges and opportunities…2

- Property Condition Assessment (PCA) generally does not include energy efficiency information.

- Most appraisals do not consider energy efficiency features in property valuation.

Challenges and opportunities…3

- Many owners have not seen impact of energy factors on building value in their own portfolios.

- Context matters: all real estate is local. The impact of energy factors on valuation varies significantly by location, building type, quality, and market conditions.