Show Me the Value: Understanding the Financial Impacts of High-Performing Buildings

Thursday, July 11th, 2019
9:00 – 10:30 AM
Speakers

Cindy Zhu
Moderator, DOE

Dr. Rogier Holtermans,
University of Guelph

Dr. Avis Devine,
York University

Dr. Sofia Dermisi,
University of Washington
First, some good news: In 2017, over 40% of commercial office space in the top 30 U.S. markets was certified as “green” or “efficient” showing significant growth from 5% in 2005. Ranking: Chicago, SF, Atlanta.

The challenge: Real estate investors and other stakeholders want to know:

*Do energy efficiency and “green features” actually improve the financial value of buildings? By how much? Where? In what types of buildings?*

Empirical evidence of financial value is key to sustain and increase demand for and investment in green buildings, beyond just ESG motivations.
Framing the Research Question

<table>
<thead>
<tr>
<th>Energy/Green Metric</th>
<th>Financial Value Metric</th>
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<tbody>
<tr>
<td>Site energy use or EUI</td>
<td>Vacancy/Occupancy</td>
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<td>Source energy use or EUI</td>
<td>Sales Price</td>
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<td>Energy cost or cost/sf</td>
<td>Leasing Velocity (absorption, speed of sales, leasing)</td>
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<td>ENERGY STAR score</td>
<td>Regulatory &amp; Compliance Risk</td>
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<td>ENERGY STAR label</td>
<td>Tenant Renewals</td>
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<td>Green Building Certification (LEED, BOMA 360...)</td>
<td>Insurance (rates, ability)</td>
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<td>Green Building Certification level (e.g., LEED Silver, Gold)</td>
<td>Tenant Satisfaction</td>
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<td>Default Risk</td>
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<td>Rental Income and Rent Concessions</td>
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<td>Debt Service Coverage Ratio</td>
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<td>Marketing Costs</td>
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<td>Access to Funding</td>
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<td>Utility Costs, Maintenance, OpEx</td>
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<td>Interest Rates</td>
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<td>Obsolescence</td>
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<td>Reserves</td>
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<td>Capitalization Rates</td>
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Real Estate Research Institute Special Sustainability RFP

- 12 proposals received, 5 projects selected
- Criteria:
  - Alignment with DOE goals
  - Impact on Commercial Real Estate Industry
  - Feasibility and Interest
  - Quality and Validity
## RERI RFP: Five diverse projects

<table>
<thead>
<tr>
<th>Title</th>
<th>Institutions</th>
<th>Key Metrics</th>
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</thead>
<tbody>
<tr>
<td>The Impact of Environmental Interventions on CRE Operations</td>
<td>York University Univ. of Guelph</td>
<td>EnergyStar, LEED NOI, OpEx</td>
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<tr>
<td>The Dynamics of Energy Consumption in Commercial Real Estate</td>
<td>Maastricht U. Univ. of Guelph</td>
<td>Bldg. cert., Energy use, EE CapEx,</td>
</tr>
<tr>
<td>Effect of Energy Benchmarking and Disclosure on Office Bldg. Marketability</td>
<td>Univ. of Washington</td>
<td>EnergyStar, EUI, occupancy rates</td>
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<tr>
<td>Estimating Office and Residential Building Energy Retrofit Hurdle Rates</td>
<td>NYU, U of Arizona, UNC Chapel Hill, Cambridge Univ.</td>
<td>Energy savings, CapEx IRR</td>
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<tr>
<td>ESG Insights in Public Real Estate Performance</td>
<td>Tilburg Univ, Univ. Of Reading</td>
<td>ESG ratings, REIT returns</td>
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### Effect of Energy Benchmarking and Disclosure on Office Building Marketability

<table>
<thead>
<tr>
<th>Hyun Woo “Chris” Lee</th>
<th>Sofia Dermisi</th>
<th>Youngjun Choe</th>
<th>Luming Shang</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assistant Professor of Construction Management</td>
<td>Professor of Real Estate and Urban Design and Planning</td>
<td>Assistant Professor of Industrial &amp; Systems Engineering</td>
<td>PhD candidate Construction Management</td>
</tr>
</tbody>
</table>

Funded by: Real Estate Research Institute and Lawrence Berkeley National Laboratory (LBNL)
Building Energy Use/Benchmarking and Disclosure

- **Energy Benchmarking?**
  1. Buildings track their energy use/emissions
     - Energy Star score (1-100)
     - Energy (Kbtu)
     - GHG Emission (kg of CO2e per sft)
  2. Report to city or state entity
  3. Some information is shared with the public

- **When did it begin?**
  - First enacted in Washington DC in 2008
  - New York since 2009
  - San Francisco since 2011
  - Chicago since 2013

Source: [https://www.buildingrating.org/graphic/us-commercial-building-policy-comparison-matrix](https://www.buildingrating.org/graphic/us-commercial-building-policy-comparison-matrix)
Effect of Energy Benchmarking and Disclosure on Office Building Marketability

Research Objectives:

- Assess the effectiveness of benchmarking policy
- Examine if the policy affects the real estate performance of sustainable and less sustainable buildings differently
Effect of Energy Benchmarking and Disclosure on Office Building Marketability

Research Data:
• Three databases (real estate, energy consumption, and energy star label)
• Four target cities (NYC, Washington DC, San Francisco, Chicago)

- Real Estate Data (CoStar Group) (Office Building larger than 10,000 sf)
  - NYC: 2901 observations; SF: 1196 observations; D.C.: 1079 observations; Chicago: 301 observations

- Energy Consumption Data (after internal merging and data cleaning)
  - NYC: 1539 observations; SF: 643 observations; D.C.: 708 observations; Chicago: 349 observations

- Sustainability Labeling Data (Energy Star labeled buildings)
  - NYC: 405 observations; SF: 297 observations; D.C.: 368 observations; Chicago: 156 observations

The Integrated Database (merged based on building address)
  - NYC: 556 observations; SF: 450 observations; D.C.: 442 observations; Chicago: 292 observations

* Office Buildings >10,000 square feet
Effect of Energy Benchmarking and Disclosure on Office Building Marketability

**Approach:**

- Did the benchmarking policy affect the real estate performance of office buildings?

  **Interrupted Time Series (ITS) Analysis**

- Do energy efficient buildings cluster spatially?

  **Hot Spot Analysis**
Effect of Energy Benchmarking and Disclosure on Office Building Marketability

Table 1. The summary of the integrated database

<table>
<thead>
<tr>
<th>City</th>
<th>Time Frame of Real Estate Data</th>
<th>Year of the Policy Implementation</th>
<th>Number of the ES Buildings</th>
<th>Number of non-ES Buildings</th>
<th>Total Number of Buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>NYC</td>
<td>1994 - 2017</td>
<td>2009</td>
<td>160</td>
<td>396</td>
<td>556</td>
</tr>
<tr>
<td>D.C.</td>
<td>1993 - 2017</td>
<td>2008</td>
<td>254</td>
<td>188</td>
<td>442</td>
</tr>
<tr>
<td>SF</td>
<td>1997 - 2017</td>
<td>2011</td>
<td>144</td>
<td>306</td>
<td>450</td>
</tr>
</tbody>
</table>
| Chicago  | 1996 - 2017                    | 2013                              | 145                         | 147                         | 292                      

The number of buildings under each class level

- Class A
- Class B
- Class C

NYC: 169, 256
DC: 130, 185
SF: 90, 260
Chicago: 102, 142, 47
Spatial distribution of matched buildings
Spatial distribution of matched buildings

Legend - New York City
Stories
- 3 - 14
- 15 - 23
- 24 - 36
- 37 - 72
Yr Bld
- <1915
- 1916 - 1936
- 1937 - 1973
- 1974 - 2013

Legend - Washington DC
Stories
- 1 - 4
- 5 - 7
- 8 - 16
- 17 - 15
Yr Bld
- 1927 - 1928
- 1929 - 1977
- 1978 - 1992
- 1993 - 2008
Effect of Energy Benchmarking and Disclosure on Office Building Marketability

Occupancy trend of ES group vs. non-ES group – Class A & B

Effect of Energy Benchmarking and Disclosure on Office Building Marketability

Occupancy trend of ES group vs. non-ES group – Class A & B

Effect of Energy Benchmarking and Disclosure on Office Building Marketability

Key findings (based on mean occupancy)

New York City

- An immediate decline of occupancy after the policy for the ES group in contrast to an immediate increase for the non-ES group.
- A slightly increasing trend of the ES group in contrast to a decreasing trend for the non-ES group occupancy.

DC:

- An immediate decline of occupancy after the policy for both groups.
- After implementation, the ES group shows an increasing trend, but the non-ES group shows a slightly decreasing trend.

Effect of Energy Benchmarking and Disclosure on Office Building Marketability

Key findings (based on mean occupancy)

San Francisco

![Graph showing occupancy trends in San Francisco.]

**SF:**
- After implementation, both groups exhibited an increasing trend of occupancy.
- There is no difference in the trend between two groups, which implies the policy impact on the two group is at the same level.

Chicago

![Graph showing occupancy trends in Chicago.]

**Chicago:**
- An immediate increase of occupancy after implementation for both groups
- The ES group shows a continuous increase, but the non-ES group does not.

Effect of Energy Benchmarking and Disclosure on Office Building Marketability

Key findings – single group ITS (based on each building instead of on the aggregated data)

50% of ES buildings experience an occupancy increase after the policy implementation for class A & 40% for class B

44% of ES buildings experience an occupancy increase after the policy implementation for class A & 44% for class B

Overall class A and B trends:

- Class A: The groupings of NYC with DC as well as SF with Chicago are maintained with the former showing a slower occupancy increase than the latter.
- Class B: In contrast to all cities, DC maintain a small ratio of occupancy increases.
Hot spot analysis
Conclusion

• The energy policies may not immediately affect the real estate performance of office buildings. However, after the energy policy implementation, the real estate performance of energy-efficient buildings exhibits continuously increasing trends (evidence from the ITSA result of all of the four cities).

• The results, are mixed with NYC’s and Chicago’s, showing a statistically significant difference in the trends of real estate performance between ES buildings and non-ES buildings after the policy implementation, which implies that the policy may affect the two types of buildings differently.

• The results of Washington DC and NYC exhibited a decline after the policy implementation. This effect can also have its roots in the financial crisis as the implementation happened in 2008 and 2009. More analyses are needed to account for the confounding effects (e.g., including control-group cities without disclosure policies in the analyses).

Professor Rogier Holtermans

University of Guelph
Environmental Performance of Commercial Real Estate: New Insights into Energy Efficiency Improvements

Piet Eichholtz\textsuperscript{a}, Rogier Holtermans\textsuperscript{b} and Nils Kok\textsuperscript{a}

\textsuperscript{a}Maastricht University, the Netherlands
\textsuperscript{b}University of Guelph, Canada
Built environment consumes 40% of energy in the United States (source: EIA)
Big Buildings Hurt the Climate. New York City Hopes to Change That.

To fight climate change, the city is forcing the buildings, like the Empire State Building and Trump Tower, to reduce greenhouse gas emissions.

Buildings like the Freedom Tower and the Empire State Building could face fines of up to millions of dollars per year if they do not significantly reduce emissions by 2030.

Karsten Moran for The New York Times
Uptake of LEED and Energy Star increased significantly since 2005
But research is scant...

Previous research has mostly focused on single-family housing
- Aggregate energy consumption of CRE is comparable
- CRE is more lumpy – small effects may have large implications

Main interest is threefold:
1. To understand the general determinants and dynamics of the energy performance of commercial real estate
2. To understand how environmental building certification is related to commercial building energy consumption
3. To understand how specific energy efficiency investments affect commercial building’s energy consumption
Data and approach

**Information on energy consumption in CRE is hard to obtain**
- Partner with Measurabl: proprietary set of longitudinal data on some 26,000 buildings, covering the 2009-2018 period
- Information on monthly energy consumption
- U.S. Green Building Council’s LEED certification program
- Interventions aimed at improving the environmental performance (GRESB and CDP)

**Explaining building energy consumption over time**
- How do certification and interventions affect energy consumption?
- Fixed effects to control for quality differences (building and month)
- Control for climatic conditions (heating and cooling degree days)
Median energy consumption in commercial real estate decreased by 42%
<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
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<tbody>
<tr>
<td>LEED (1=yes)</td>
<td>-0.082***</td>
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<td></td>
<td>[0.014]</td>
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<tr>
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<tr>
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<td>Gold</td>
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<td>Platinum</td>
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<td>-0.123*</td>
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<td>Building Design and Construction (BDC)</td>
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<td>Core and Shell (CS)</td>
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<tr>
<td>Cooling degree days (monthly in thousands)</td>
<td>0.430***</td>
<td>0.430***</td>
<td>0.431***</td>
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<td>Heating degree days (monthly in thousands)</td>
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<td>[0.012]</td>
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**LEED certification and energy consumption (office only)**
LEED certification tenure (in months)
Building improvements aimed at energy efficiency reduce energy consumption by 8 to 11%, combined effect more than 15%

<table>
<thead>
<tr>
<th>Intervention category (1=yes)</th>
<th>(1)</th>
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<th>(6)</th>
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<tbody>
<tr>
<td>CDP – Energy-efficiency: Building Services</td>
<td>-0.081*** [0.017]</td>
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<td>GRESB – HE Equipment and Appliances</td>
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<td>-0.084*** [0.018]</td>
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<td>Lighting</td>
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<td>Building Controls</td>
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<td>-0.114*** [0.038]</td>
<td>-0.083** [0.039]</td>
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<td>0.419*** [0.018]</td>
<td>0.419*** [0.018]</td>
<td>0.418*** [0.018]</td>
<td>0.418*** [0.018]</td>
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<tr>
<td>Heating degree days</td>
<td>0.497*** [0.013]</td>
<td>0.497*** [0.013]</td>
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<td>0.498*** [0.013]</td>
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Monthly median energy consumption for U.S. offices (kWh per sq. ft.)
Summary and implications

Findings:
- We observe a 42% reduction in energy use over the past decade
- On average, energy consumption is reduced by 6% post-certification
- Interventions improve the energy efficiency of buildings by 8 to 12%

Implications:
- Commercial real estate has been responsive to policy efforts and scrutiny of investment community
- Environmental building certification seems to lead to actual reductions in energy consumption
- Investments in environmental building improvements have the desired supply-side effect, leading to increased energy efficiency
Professor Avis Devine
York University
Beyond Building Certification: The Impact of Environmental Interventions on CRE Operations

Jim Clayton, Avis Devine & Rogier Holtermans
Motivation & Research Question

• Most research to-date targets the impact of environmental building certification
  • Rent and occupancy rate premiums; decreased risk, lower cost of debt
• Focus on the Building’s impact; what about the Users?

Research Question:

What is the impact of environmentally-focused building interventions on utility consumption?
Tenant Engagement: ForeverGreen

<table>
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<tr>
<th>Year</th>
<th>Jan</th>
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<th>Mar</th>
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Legend:
- Intro
- Health
- Community
- Waste

[Image of bar chart and text boxes with different colors and icons]
Data & Methods

The Sample
- Partnered with Bentall GreenOak
- 261 office buildings in the U.S. (145) and Canada (116)
- 15 years of monthly observations (25,704 building-months)
- Graphs: Intervention adoption over time

The Approach
- Stringent fixed effects modeling, with controls for external factors
Intervention Tenure Impact on Electricity Consumption

- Regression coefficients from fixed effects models
  - All results highly statistically significant except for dotted line

Findings

- Notable decrease in all categories
- ForeverGreen is a relatively static benefit
- EcoTracker has a “burn in” period
Cost Analysis: Dollars and Carbon Dioxide

- Graph: Cost estimates in local currency (upper), CO2 (lower)
  - Using significant regression results
  - Broken into terciles by cost
  - Based on 2018 actuals ($) & federal government estimates (CO2)

Example: ForeverGreen in Canada
- $3-6/occupied SF saving
- Offset up to 2.4 Kg CO2
- Cost: negligible
Environmental Capex Results: Subcategory Analysis

Dependent variable electricity consumption in natural log form, scaled by occupied square foot

Restricted to buildings that report in the system (smaller sample)

Example: Operational Change in Canada
- Average one-time cost: $0.02/occ SF
- Average savings: $1.69-$3.07/occ SF

<table>
<thead>
<tr>
<th>CAPEX Subcategory:</th>
<th>(1)</th>
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<tr>
<td>Operational Change</td>
<td>-0.082*</td>
<td>0.030</td>
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<tr>
<td>Lighting Retrofit</td>
<td>-0.082**</td>
<td>-0.076**</td>
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<tr>
<td>BOMA BEST only</td>
<td>0.003</td>
<td>0.013</td>
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<tr>
<td>LEED EBOM only</td>
<td>-0.097*</td>
<td>-0.104**</td>
<td>0.044</td>
<td>0.027</td>
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<td>BOMA BEST &amp; LEED EBOM</td>
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<td>-0.090*</td>
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<td>Energy Star only</td>
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<td>-0.064*</td>
<td>-0.082**</td>
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<td>Energy Star &amp; LEED EBOM</td>
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<td>-0.050**</td>
<td>-0.052**</td>
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<td>0.006</td>
<td>-0.171***</td>
<td>-0.181***</td>
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<td>EcoTracker</td>
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<td>-0.071**</td>
<td>0.027</td>
<td>0.026</td>
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<td>ForeverGreen</td>
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<td>-0.081**</td>
<td>-0.066**</td>
<td>-0.053**</td>
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<td>Occupancy &amp; Degree Days</td>
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<td>yes</td>
<td>yes</td>
<td>yes</td>
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<tr>
<td>Month &amp; Bldg fixed effects</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
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<tr>
<td>Number of bldg-months</td>
<td>3,872</td>
<td>3,872</td>
<td>2,393</td>
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<tr>
<td>Number of buildings</td>
<td>36</td>
<td>36</td>
<td>27</td>
<td>27</td>
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<tr>
<td>Adj. R-squared</td>
<td>0.683</td>
<td>0.685</td>
<td>0.928</td>
<td>0.922</td>
</tr>
</tbody>
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Summary

- All forms of interventions lower electricity consumptions, even when controlling for other interventions
  - Strong results in Canada, weaker in U.S. but with stronger model fit
- Environmentally-focused capex decreases electricity consumption, often at a far smaller cost than expected savings
  - Particularly for calibration of systems and adjustments to lighting
- Building certification remains key, but certification alone does not optimize savings

The collective impacts of design, operating efficiency, and maintenance of equipment, along with an effective strategy to engage and help tenants understand and reduce energy consumption, interact to shape a buildings' bottom line.
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Thank You

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