

Drivers of Environmental Performance Among Green Buildings

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Opening Worlds

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1.0 EXECUTIVE SUMMARY

The building sector has an enormous environmental impact. In Canada, the operation of buildings draws 50% of energy produced, and buildings emit 35% of total CO₂ emissions (CanmetENERGY, 2011; Lucuik et al., 2005). The large environmental impact of the building sector makes it a critical area for mitigating climate change, preserving scarce resources, and reducing the environmental impact of cities (Lucuik et al., 2005). Innovations to reduce the environmental impact of the building sector have led to the development of certification programs for green buildings. In Canada, the two largest organizations that evaluate and certify green buildings are the Building Owners and Managers Association (BOMA) and the Canadian Green Building Council (CaGBC). BOMA awards the Building Environment Standards (BOMA BEST) certification, and the CaGBC awards the Leadership in Energy and Environmental Design (LEED) certification (BOMA BEST, 2011; CaGBC, 2011).

BOMA BEST and LEED certifications signal the environment performance of a building, and a building with superior environmental performance may earn higher levels of certification to reflect this. Since BOMA BEST and LEED certification programs were introduced to Canadian markets, there has been a steady increase in the average level of certification for both certification programs (See Figure 3 on page 8). If the observed increase in certification levels means an overall improvement in environmental performance within the building sector, then this may be good news for the environment. This then raises the question: what is driving the improvement in environmental performance of buildings.

One possible driver for improved environmental performance is a building's operating expense, such as the costs to maintain a comfortable working environment including heating and lighting expenses. By improving the environmental performance of a building the amount of resources required to operate a building may be reduced. Using fewer resources may amount to lower operating costs, and it is possible this incentive is strong enough for building owners and managers to make the extra effort and investment necessary to attain higher levels of environmental performance within the building sector. All things held equal, a building in a region with lower operating costs may require more incentive to reach the same level of environmental performance as a building in a region with higher operating costs.

The purpose of this report is to examine the relationship between operating costs, incentives, and environmental performance. Drivers of operating costs - such as climate or the price of electricity and natural gas - are compared to the level of certification attained by non-residential green buildings across Canada. The results reveal that the environmental performance of non-residential green buildings is related to drivers of operating costs; however not always in the way anticipated. The main findings of the report are:

- Building owners and managers may be responding to higher energy costs by increasing the energy efficiency of their building. Regions with higher electricity prices had higher average levels for BOMA BEST certified buildings, but not for LEED certified buildings. The weighting of energy within the BOMA BEST certification may explain its strong relationship with electricity prices.

- Buildings in regions where electricity prices had increased the most prior to certification had lower levels of BOMA BEST certified buildings.
- Buildings in colder climates, with greater heating requirements, are less likely to exhibit higher levels of eco-certification.
- There was no relationship between the price of natural gas and the level of certification for BOMA BEST or LEED certified buildings.
- Despite an almost six year head start, there are over three times as many BOMA BEST certifications in Canada than LEED certifications. Differences in certification processes and costs may explain the faster adoption of BOMA BEST buildings in Canada.
- Despite strong relationships found between the level of environmental performance and certain variables, the drivers of operational costs tested here explain only a small fraction of the total variation in certification level of environmental performance.

2.0 GREEN BUILDINGS IN CANADA

2.1 RAPID GROWTH

In Canada, the two largest organizations that evaluate and certify green buildings are the Building Owners and Managers Association (BOMA) and the Canadian Green Building Council (CaGBC).¹ They encourage the development of sustainable buildings by awarding eco-certifications to buildings with superior environmental performance. BOMA awards the Building Environment Standards (BOMA BEST) certification, and LEED awards the Leadership in Energy and Environmental Design (LEED) certification.

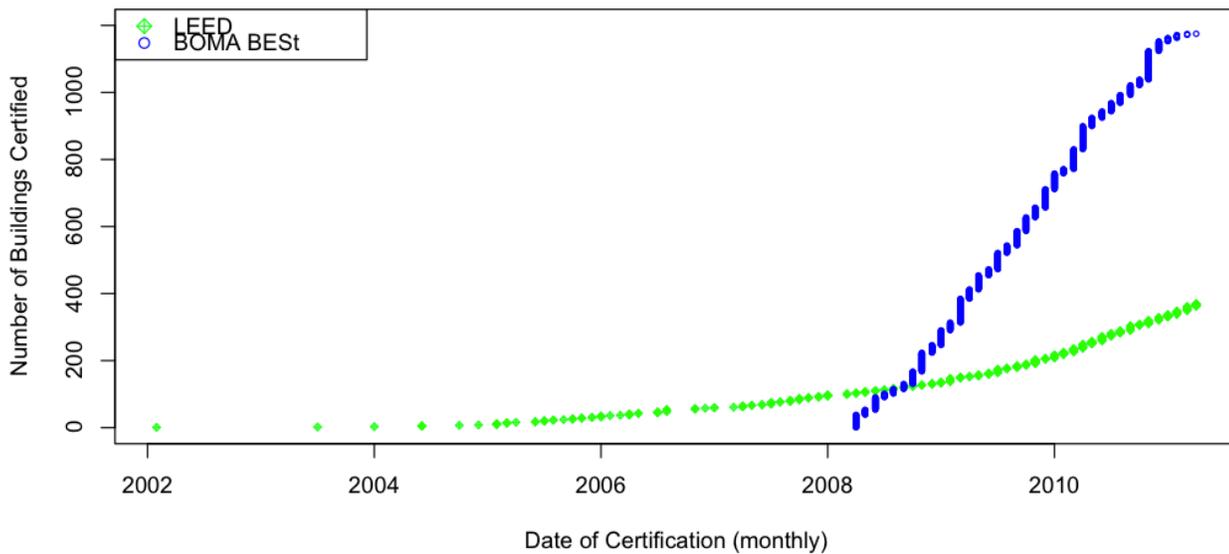
Figure 1: Top 10 cites by number of LEED and BOMA BEST certifications, May 2011

BOMA BEST	LEED
Toronto (138)	Toronto (39)
Calgary (99)	Vancouver (31)
Mississauga (68)	Calgary (25)
Vancouver (64)	Montreal (25)
Montréal (61)	Victoria (16)
Ottawa (60)	Ottawa (12)
Edmonton (31)	Edmonton (10)
Burnaby (31)	Mississauga (10)
Richmond (29)	Winnipeg (9)
Québec (26)	Hamilton (8)

The BOMA BEST and LEED certifications have grown quickly in number across Canada. As of May 2011, the number of BOMA BEST certified buildings have grown from 246 in 2008 to 1175 in May of 2011, and the number of LEED certified buildings from 133 in 2008 to 370 in May of 2011 (BOMA BEST, 2011; CaGBC, 2011). The green buildings are concentrated in Canada’s population centers (see Figure 1), and each province contains at least one green building of each type, excluding the territories.

¹ There are most likely other buildings exhibiting superior environmental performance without a certification from either BOMA or the CaGBC, in Canada. However, without an eco-certification these buildings are difficult to find. For the purposes of this study, LEED and BOMA BEST certified buildings represent green buildings in Canada.

Figure 2: Number of BOMA BEST and LEED buildings over time



2.2 INCENTIVES FOR ENVIRONMENTAL PERFORMANCE

The key premise being explored in this paper is the relationship between incentives, operating costs, and environmental performance. Buildings use resources throughout their operational life, and energy expenses can amount to 30% of a building’s operating costs (Eichholtz, Kok, and Quigley, 2010). One way green buildings benefit the environment is by using fewer resources for their operation than their peers. Using fewer resources may amount to lower operating costs, and it is possible this incentive is strong enough for building owners and managers to make extra effort and attain higher levels of environmental performance.

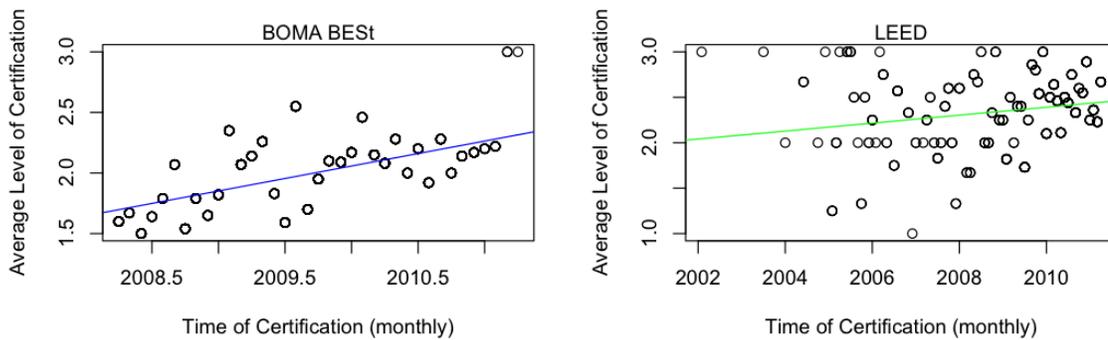
The ability to signal the environmental performance of a building is an important feature of a BOMA BEST or LEED certificate. Within each certification program, buildings can attain more prestigious certificates if they achieve higher levels of environmental performance. A BOMA BEST certified building might earn a certification of BOMA Level 1-4, with BOMA Level 4 signaling the highest level of environmental performance. A LEED certified building may earn a level of LEED Certified, Silver, Gold, or Platinum, with LEED Platinum signaling the highest level of environmental performance.

The question then, is do regions with higher operating costs exhibit higher levels of environmental performance? If so, then operating costs are drivers of environmental performance amongst green buildings. All things equal, to reach the same level of environmental performance, a building in a region with lower operating costs would require more added incentives than a building in a region with higher operating costs. Knowing what matters to building owners and managers is of use to policy makers seeking to reduce the impact of building sector on the environment through the proliferation of green buildings.

2.3 IMPROVEMENT IN ENVIRONMENTAL PERFORMANCE OVER TIME

The rapid growth in the cumulative number of green buildings in Canada also runs in parallel to an increase in the average level of certification achieved over time (see Figure 3). Since LEED's introduction to Canadian markets in 2002 and BOMA's in 2008, there has been a steady improvement in the average level of certification. Higher levels of certification may mean more conservation of scarce resources, less emissions, and a more sustainable building sector. The goal of this report is to explain the improvement in environmental performance, using drivers of operating costs such as climate, and the price of electricity or natural gas.

Figure 3: Bivariate Relationship of Average Level Over Time²



² Originally, the non-continuous ranking of certification level from 1-4 made the trends in the scatter plots difficult to observe. Instead the average level of certification was used to build the scatter plots. To calculate the average level, the data was ranked by each independent variable then split into 20 groups. The average level of certification was then calculated for each group. Average levels were not used in calculating the bivariate line in the scatter plots or for the multivariate regression.

3.0 RELATED RESEARCH

What motivates building owners and managers to adapt technologies and practices necessary to improve the environmental performance of their building? Related research in the United States has compared building standards and the diffusion of eco-certifications to attempt and answer this question. As further detailed below, energy efficient building standards in residential homes and the market share of green buildings increase with certain drivers of operating costs.

Dora L. Costa and Mathew E. Kahn (2011) investigated the effect of electricity prices on the electricity consumption of residential homes in California over a forty-year period. They found that price of electricity at the time of construction is an important determinant in the buildings future electricity consumption. Homes built during periods of high electricity prices consumed less electricity over the buildings' life, compared to homes built during low electricity prices. In California, electricity prices may be drivers of environmental performance, as the authors predicted that consumers demand more energy-efficient homes during periods of high electricity prices (Costa and Kahn, 2011).

Kok, *et al.* (2011) compared the diffusion of energy efficient and sustainable technologies in commercial buildings to drivers that might increase incentives for building owners to adopt new technologies. The market share of LEED and Energy-Star-certified office space across 48 metropolitan regions were used to estimate the adoption of sustainable and energy efficient technologies, respectively. They compared the market share of LEED and Energy-Star-certified office space to a variety of drivers including electricity prices, and the local climate. They anticipated that buildings faced with more adverse climactic conditions, or higher electricity prices would have a greater incentive to adopt energy efficient or sustainable technologies. They found that while climate had no effect on the market share of LEED or Energy Star; electricity prices did. With higher electricity prices the market share of Energy-Star-certified office space increased. This indicates that future energy consumption may impact the investment decisions of commercial building owners (Costa and Kahn, 2011). However, no independent variable for time was used in the analysis and the explanatory power of the regression was not reported.

This report investigates whether the incentive to reduce operating costs are driving improved environmental performance for non-residential buildings in Canada. Compared to related studies in the United States this report has had to overcome certain obstacles, such as a shorter time horizon, with the first building being certified in 2002 and a median certification date of August 2009. The ranges of climate and electricity prices are also narrower than those in the United States, and the sample size of non-residential buildings is considerably smaller. Despite these challenges, this preliminary research will provide insight into what drives Canadian building owners and managers to improve the environmental performance of their building.

4.0 DRIVERS OF OPERATING COSTS & ENVIRONMENTAL PERFORMANCE

Before discussing the results of the study, the relationship between each potential driver of operating cost and the level of environmental performance is described below. The potential drivers include: climate, the price of electricity, the change in the price of electricity over the past three years, and the price of natural gas.

4.1 CLIMATE

Buildings in regions with more extreme temperatures may exhibit higher levels of certification. Climate has an impact on the operational costs of a building by increasing the heating and cooling requirements. Climactic conditions are key drivers of energy expenditures in regions and are relatively constant over time. The annual heating and cooling-degree days in a region are used as a proxy for cold and warm climactic conditions, respectively. Heating-degree days (HDD's) are the total number of degrees below 18 degrees Celsius, multiplied by the fraction of days at that temperature. Cooling degree-days (CDD's) are the total number of degrees above 18 degrees Celsius, multiplied again by the fraction of days. Heating and cooling-degree days were taken from Natural Resource Canada's RETScreen Clean Energy Analysis Software RETScreen International, 2011.

Investing in Energy

Some investments are more difficult to justify than others on operational savings alone. Consider that, in two recent surveys, the LEED category for Energy & Atmosphere for LEED New Construction – including renewable energy categories – scored the lowest percentage out of points earned compared to all other categories, and none of the common energy efficiency measures for BOMA BEST buildings included the adoption of onsite renewable energy. Centralized energy production can create a barrier towards the adoption of renewable energy or energy efficiency investments by providing electricity at low prices and thus reducing the operational savings – particularly regions with cheap and abundant hydropower such as in British Columbia or Quebec.

2010 BOMA BEST Energy and Environmental Report

(<http://www.bomacanada.ca/>)

Average Scorecard for LEED Canada-NC 1.0.

(<http://www.cagbc.org/Content/NavigationMenu/Programs/LEED/ProjectProfilesandStats/default.htm>)

4.2 ELECTRICITY

Buildings in regions with higher or volatile electricity prices may also exhibit higher levels of certification. Energy has the greatest weighting of any environmental performance category for both BOMA BEST and LEED certifications, therefore effort to conserve energy may be observed through a higher level of certification. Average annual electricity prices in ¢/kWh were taken from Hydro Québec's annual Comparison of Electricity Prices in Major North American Cities, (Quebec Hydro 2011). Prices were available from 2006-2010. Electricity prices for 2006 were used for the LEED certified buildings constructed prior to 2006, and 2010 prices were used for buildings certified in 2011. Prices were only available for major cities, so the capital of each province was used with the exception of Moncton for New Brunswick. To capture changes in the price of electricity, the non-residential electricity price index was used from Statistics Canada (Statistics Canada, 2011). The monthly change of the electricity price index was used to calculate the 3 Year trailing monthly average for a region.

4.3 NATURAL GAS

Buildings certified during periods of high natural gas prices may have a higher level of certification. Natural gas is a source of heating for commercial buildings in Canada. A building that spends more on natural gas for heat would benefit from a higher level of certification. To compare the level of certification to natural gas prices, the spot price of natural gas during the month of certification was used. For buildings in British Columbia, Alberta, Saskatchewan and Manitoba, prices were taken from the NGX AB-NIT Yesterday Index (TMX Natural Gas Exchange, 2011a). For Ontario, Quebec and the Maritimes, prices were taken from the NGL Union-Dawn Day Ahead Index (TMX Natural Gas Exchange, 2011b). The effects of natural gas prices are somewhat ambiguous. The spot price of natural gas varies substantially, while the consumption price may not. Regulation, or long term contracting, may drive a wedge between the spot price and the consumption price of natural gas.

There are other factors that affect how external factors impact operating costs of a building that are not controlled for here. For example, buildings are built to suit their environment with passive features such as insulation, which may make climate differences less important. It is also common to have a net lease, where tenants pay for the utility bills. This may lead to an agency problem, as the investment for improving the efficiency of the building would not reside with the building owner or manager.

5.0 METHODOLOGY

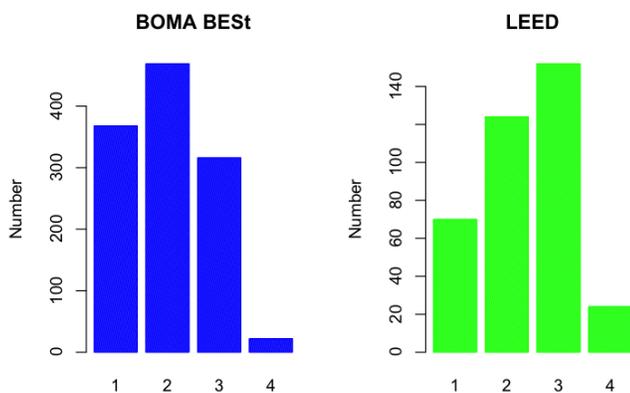
Ordinary least squares techniques were used in a time series analysis of non-residential buildings across Canada. The dependent variable, of level of certification attained, is compared to the independent variables including: heating and cooling-degree days, the spot price of natural gas, the month of certification, and the change in the price of electricity over the last three years. The data set included 370 LEED certified and 1175 BOMA BEST certified buildings taken from the CAGBC and BOMA BEST websites, respectively (BOMA BEST, 2011; CaGBC, 2011). The level of certification for each building is non-continuous, having an ordinal ranking of 1-4. Related studies in the U.S. compare the market share of eco-certified buildings in an area, which allows for continuous data (Kok, McGraw, and Quigley, 2011). At the time of publication no reliable estimate of the total area of commercial office space in Canada was found to estimate market share.

Figure 4: Data description for Independent Variables

	MAX	MIN	MEAN	MEDIAN	STD. DEV.	NO.
BOMA BEST Level of Certification	4.00	1.00	1.99	2.00	0.81	1175
LEED Level of Certification	4.00	1.00	2.35	2.00	0.86	370
Time of Certification	Apr 2011	Feb 2008	Jun 2009	Oct 2009	1.15 yrs	1545
HDD (1000's)	8.64	2.50	4.23	4.36	0.92	1356
CDD (1000's)	1.29	0.04	0.92	1.06	0.23	1356
Electricity Price (¢/kWh)	10.78	2.53	5.18	4.45	2.08	1543
Change in price of electricity over prior 3 years, (monthly) ³	0.20	-0.16	0.02	0.02	0.07	1545
Natural Gas (\$US/MMBtu)	13.12	2.53	5.18	4.45	2.08	1545

The LEED and BOMA BEST data sets are used separately as they have different average levels of certification and certification processes. For LEED, the most common level of certification is 3 or LEED Gold, and for BOMA BEST the most common level is 2, or BOMA Level 2.

Figure 5: Mode Histogram for LEED and BOMA BEST Certified Buildings



³ A 3-year period was used to allow building owners and managers to make informed decisions and allow for renovations or new development.

6.0 FINDINGS

Using regression techniques, strong relationships were found between certain drivers of operating costs and environmental performance. In this section, the relationship between each driver tested and environmental performance is discussed, and an explanation for the faster growth of BOMA BEST certifications relative to LEED certifications is also proposed. To review, the dependent variable is the level of certification achieved, and the independent variables are the date of certification, the change in price of electricity over a three year period, the average annual price of electricity in Canadian ¢/kWh, the spot price of natural gas in \$US/MMBtu, and the heating and cooling-degree days for the region. Figures 6 and 7 display the results for the multivariate regression.

Figure 6: BOMA BEST regression results

BOMA	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6
Cert. Date	0.209 ***	0.220***	0.257***	0.241***	0.193***	0.192***
Electricity		0.069***	0.043***	0.045***	0.050***	0.048***
3YR Index			- 2.85***	- 2.85***	- 2.15***	- 2.08***
Natural Gas				- 0.009	- 0.025'.'	- 0.025'.'
CDD					0.416***	0.471***
HDD						0.025
<i>Adj. R²</i>	0.03939	0.06822	0.1291	0.1288	0.1364	0.1361
<i>n</i>	1175	1175	1174	1174	1012	1012

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Constant estimate not reported

Figure 7: LEED Regression Results

LEED	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6
Cert. Date	0.043'.'	0.042'.'	0.041	0.020	0.018	0.032
Electricity		0.011	0.013	0.017	0.028	0.050
3YR Index			0.183	0.096	- 0.106	- 0.627
Natural Gas				- 0.029	- 0.034	- 0.021
HDD					- 0.114*	- 0.187**
CDD						- 0.60*
<i>Adj. R²</i>	0.006	0.004	0.002	0.002	0.015	0.029
<i>n</i>	370	370	369	369	320	320

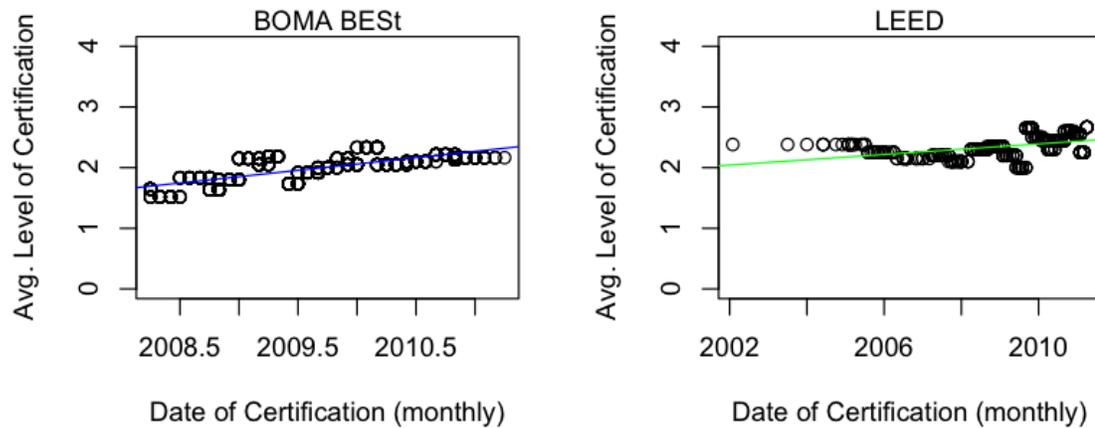
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Constant estimate not reported

6.1 TIME

There is a statistically significant increase in the average level of certification during the sample period. The level of improvement has been greater for BOMA BEST certified buildings with a slope coefficient of 0.25 compared to 0.05 for LEED certified buildings can be observed in Figure 8.

Figure 8: Bivariate relationship between time and average certification level

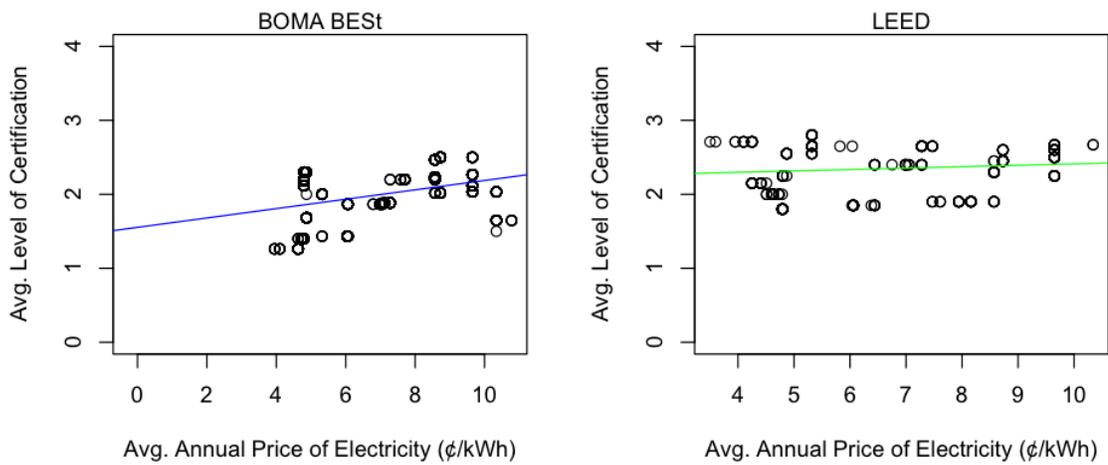


Organizational learning may help explain the improvement in average level of certification over time, as a few management corporations hold large clusters of the sample. Organizational learning can be defined as “the organization-wide activity of creating and using knowledge to enhance competitive advantage (Panayides, 2007, p.69)”. SNC Lavalin O&M Inc. and Bentall Kennedy LP each hold 142 and 137 of the BOMA BEST certified buildings, respectively. Together they manage 25% of the entire sample of BOMA BEST buildings. From 2008 to 2011 the average level of certification increased from 1.09 to 2.24 for Bentall Kennedy LP, and from 1.56 to 2.056 for SNC Lavalin O&M Inc. With such large clusters of the sample under management by the same corporations, the retention and communication of lessons from the certification process may have contributed to the overall improvement in attaining higher levels of certifications.

6.2 ELECTRICITY

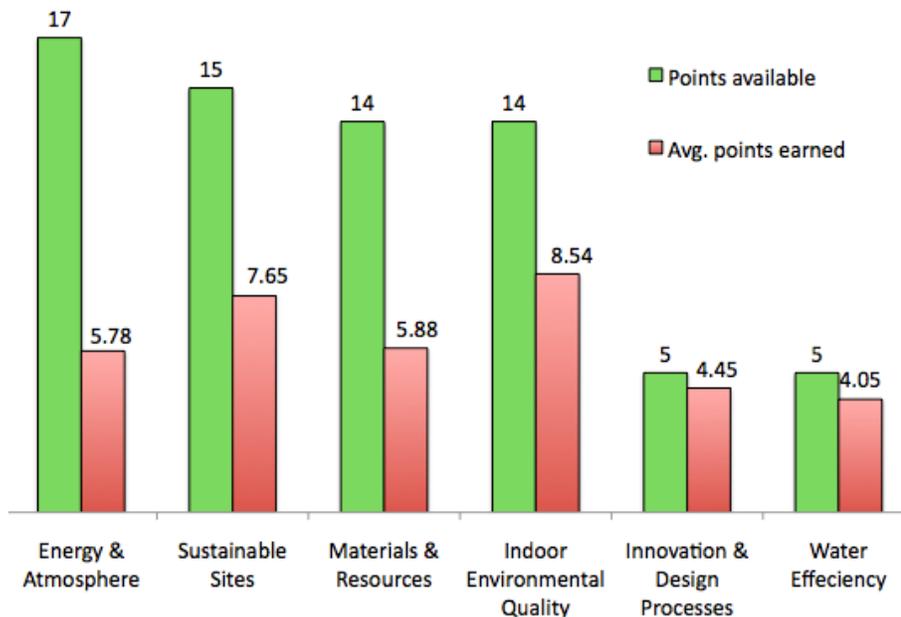
There was a positive and statistically significant relationship between the price of electricity and the level of certification for BOMA BEST buildings, however this was not the case for LEED. It is possible that building owners in Canada with higher energy costs may be responding by improving the energy efficiency of their building. The positive relationship between BOMA BEST buildings and the negligible relationship between LEED buildings can be seen in Figure 9.

Figure 9: Bivariate relationship between the average annual price of electricity (¢/kWh) and the average certification level



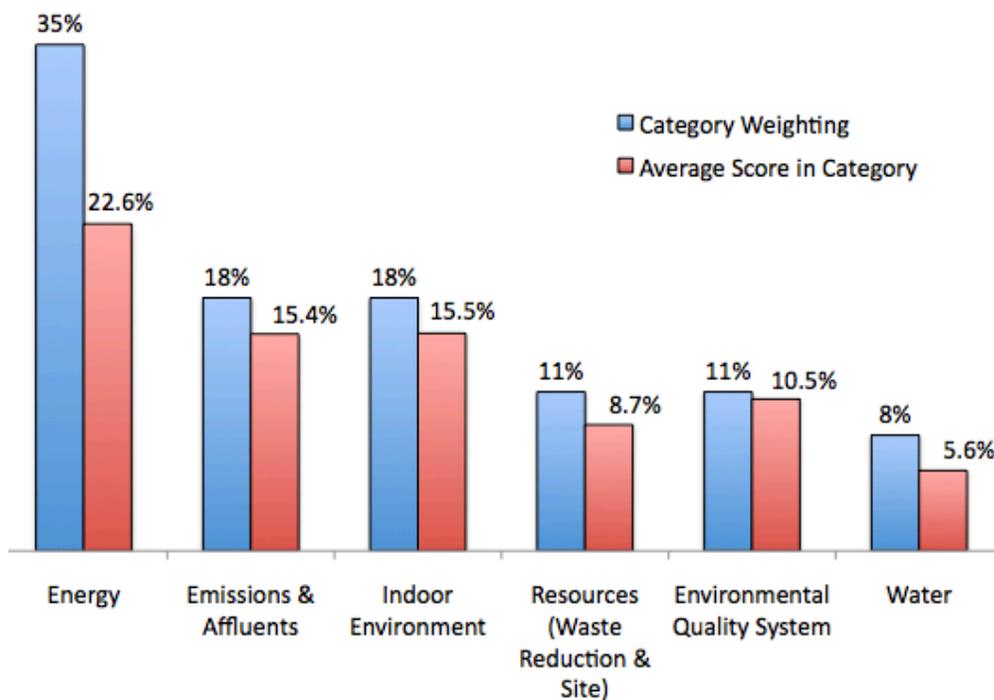
Differences in the weightings of environmental categories may explain why BOMA BEST buildings had a stronger relationship with electricity prices than LEED certified buildings. Each certification assigns a weight to each category of environmental performance, making certain categories such as energy worth more and water worth less. ‘Energy’ for BOMA BEST and ‘Energy and Atmosphere’ for LEED both receive the highest weighting of any environmental performance category (BOMA 2010; CaGBC, 2011b).

Figure 10: LEED Categories and Percentage of Points Earned



However, according to a recent survey of commercial and institutional buildings, the fraction of points earned to points available in these categories were the lowest of any environmental category for both BOMA BEST and LEED certified buildings. For the LEED buildings surveyed, of the 17 points available only 6 were earned on average (CaGBC, 2011b). For BOMA BEST buildings, 35% of the score for the certification depends on energy, but only 23% is tallied amongst actual buildings certified (BOMA, 2010). On average, energy is still the largest contributor of overall points for BOMA BEST certified buildings, and it is the third largest contributor of actual points for LEED certified buildings. For this reason, BOMA BEST buildings may have a stronger relationship than LEED when comparing electricity prices to the level of certification.

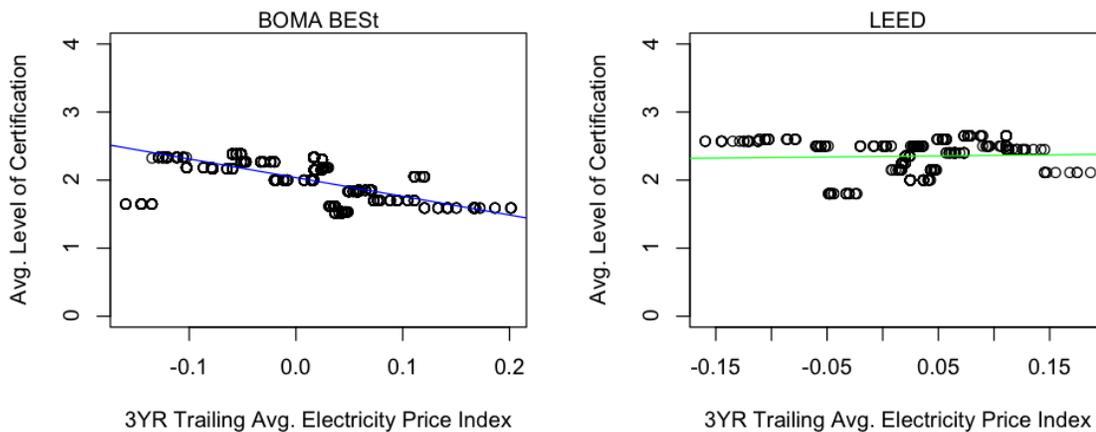
Figure 11: BOMA BEST Categories and Percentage of Points Earned



6.3 CHANGE IN ELECTRICITY PRICES

Buildings in regions where energy prices increased over a three-year period had on average lower levels of eco-certification amongst BOMA BEST certified buildings, and there was no affect on the average level attained amongst LEED certified buildings. Using the three-year trailing average meant that building owners exposed to electricity price increases three years in a row still did not achieve higher levels of certification.

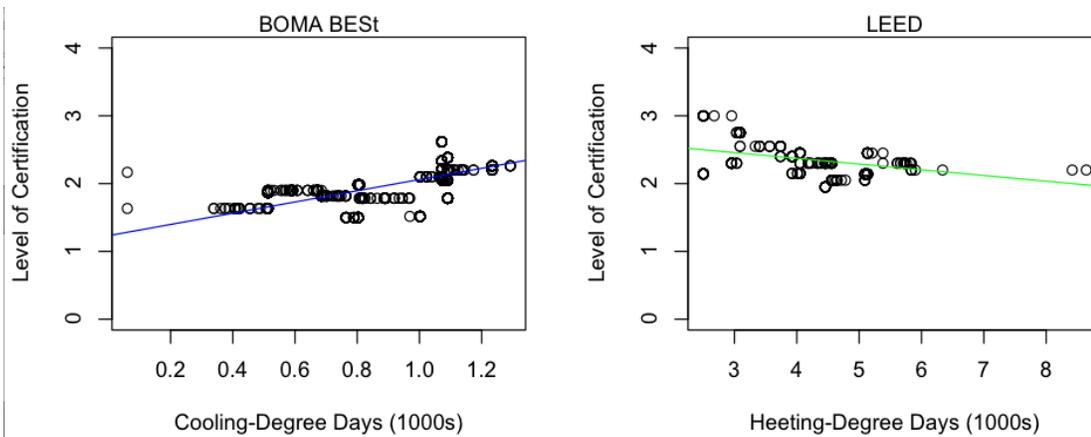
Figure 12: Bivariate relationship between 3YR trailing average of the industrial electricity price index the average certification level



6.4 CLIMATE

In Canada, buildings in the coldest climates are less likely to have higher levels of eco-certification. A building with a higher level of BOMA BEST certification is more likely to be found in a warmer region with more cooling-degree days, while a LEED certified building is more likely to have a higher level of certification in a region with fewer heating-degree days.

Figure 13: Bivariate relationship between climate and the average certification level



6.5 NATURAL GAS

The price of natural gas when the building was certified showed no significant relationship with the level of certification attained for either BOMA BEST or LEED certified buildings. The lack of relationship can partly be explained by the volatility of natural gas during the sample period (see Figure 15). Innovation in the extraction processes for

unconventional gas in Canada led to the collapse in natural gas prices in 2008 (Natural Resources Canada, 2010). This happened while the average level of certification was slowly increasing in Canada, making positive relationship with the price of natural gas very unlikely.

Figure 14: Bivariate relationship between the spot price of natural gas and the average certification level

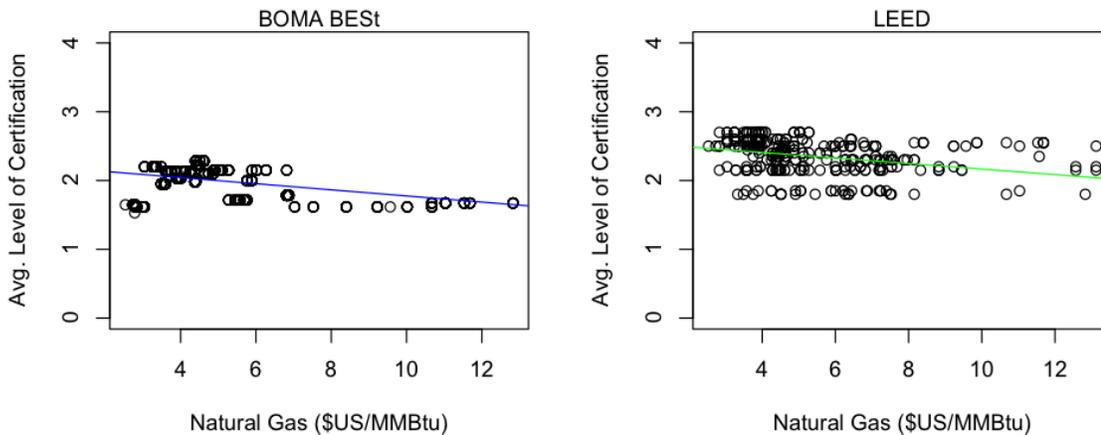
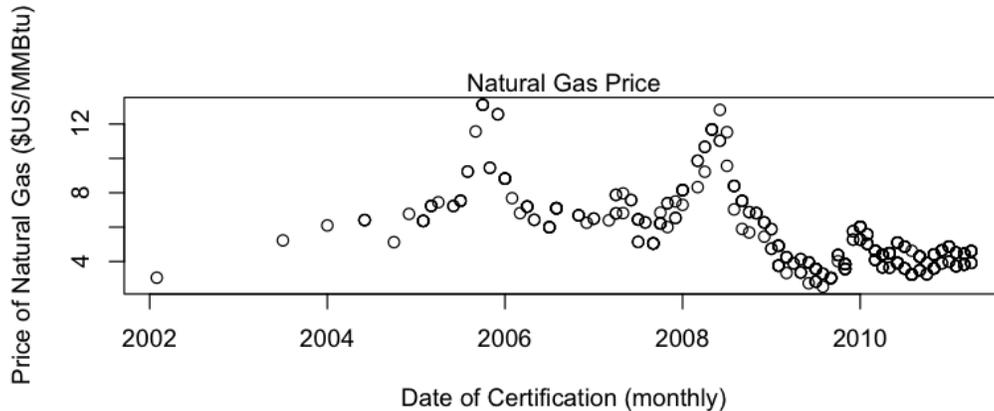


Figure 15: Natural gas prices during sample period



6.6 GROWTH OF BOMA BEST BUILDINGS RELATIVE TO LEED

Despite being introduced to the Canadian marketplace almost six years earlier, there are over three times as many BOMA BEST buildings than LEED. The different costs and processes of attaining a certification may explain the greater number of BOMA BEST certified buildings.

The costs for LEED certifications are much larger compared to BOMA BEST certifications (See Figure 16), although the two processes of certification are quite different. The substantial cost of LEED certification may narrow the field of building owners willing to commit to certification.

Figure 16: Cost of BOMA BEST and LEED certifications

	MEMBER PRICE ⁴	NON-MEMBER PRICE
LEED NC⁵		
< 2,500 m ²	\$4,200	\$6,300
> 25,000 m ²	\$21,500	\$32,200
BOMA BEST		
< 9,290 m ² ⁶	\$1,250	\$2,500
> 46,452 m ² ⁷	\$3,000	\$3,500

The more arduous certification process of LEED may also explain the slower growth of uptake. The certification process for BOMA BEST is closer to an evaluation and verification of the building's operational characteristics, while LEED certifications require more external involvement during the construction and certification processes. The differences in length and difficulty of the two-certification processes are contrasted below.

- BOMA BEST certifications are evaluated based on an online survey of 150 questions that requires 12 months of utility data. The total time depends on whether the information is readily available, and applicants have up to 90 days to complete the questionnaire. The certification is awarded following onsite verification by an external BOMA representative (BOMA, 2011b).
- LEED certifications include three main actors including the CaGBC, a review team, as well as the applicant. The applicant will submit three portfolios of progress, the CaGBC will perform three completeness checks and three quality assurances, and the review team will conduct three reviews before the final award of certification or optional appeal. This process requires at least 13 weeks, not counting preparation for preliminary meetings, which requires an equal amount of time (CaGBC 2011c, CaGBC 2011d).

6.7 OTHER FACTORS

Despite the statistically significant relationships found for certain variables, such as electricity prices and climate, the regression equation explains very little of the total variation in level of certification. The R-squared reported for BOMA BEST buildings never explains more than 14% of the total variation, while the LEED regression explains less than 3% of the total variation. Despite the incentives they provide to reduce operating costs, drivers of operating costs are not the critical factor in determining the environmental performance of green buildings in Canada.

⁴ Membership fees are a one time only cost.

⁵ The price includes both the registration and certification fees for LEED New Construction.

⁶ The price quote is for buildings less than 100,000 square feet.

⁷ The price quote is for buildings greater than 500,000 square feet.

The limited explanatory power of the drivers of operating costs is a positive finding for policy makers who would seek to encourage the development of green buildings in an area. This is beneficial for policy makers, as electricity prices, the cost of natural gas and climactic variables are difficult and in some cases impossible to control. Other drivers, which are more amenable to regulation, are probably explaining the vast majority of decisions regarding the level of environmental performance on a building. Demand for green space by environmentally conscious tenants may also be driving certification in Canada. Consider that, by 2013, all government offices in Canada must lease or occupy office space certified by an external verifier of green buildings, such as by BOMA or the CaGBC. It is also likely that building owners may be certifying their buildings to improve the value of their buildings. In the United States, studies have found 'green' office space commands higher rents, exhibits lower vacancies, and sells at market premiums compared to non-certified.

7.0 CONCLUSION

At the beginning of this paper, the question was posed: what motivates building owners and managers to adopt technologies and practices necessary to improve the environmental performance of their building? Related research in the United States has found that certain drivers of operating costs, such as the price of electricity, can increase the market share of green buildings in an area, or lead to buildings that use less energy throughout their operational life (Kok, McGraw, and Quigley, 2011; Costa and Kahn, 2011).

To answer this question, regression techniques compared the environmental performance of a building to drivers that may increase the operating costs of the building. The premise being that building owners in regions expected to have higher operating costs may benefit the most from improving the environmental performance of their building. Strong relationships were found for certain drivers of operating costs, which are described below.

- There was a constant improvement in the level of certification amongst both BOMA BEST and LEED certified buildings during the sample period. Organization learning may explain some of the improvement, as large clusters of the sample are owned and operated by the same companies.
- Building owners and managers may be responding to higher energy costs by increasing the energy efficiency of their building. Regions with higher electricity prices had higher average levels for BOMA BEST certified buildings, but not for LEED certified buildings. The weighting of energy within the BOMA BEST certification may explain its stronger relationship with electricity prices.
- Change in electricity prices were inversely related to environmental performance for BOMA BEST buildings, and had no affect of the level of LEED certification.
- Climate had the opposite affect on environmental performance than anticipated. Buildings in colder climates, with greater heating requirements, are less likely to exhibit higher levels environmental performance.

Contrary to what was found in the United States, the results interpreted in this report reveal that the environmental performance of non-residential green buildings in Canada are at best weakly related to some drivers of operating costs. Strong relationships between variables were found, although the regression used here never explained more than 14% of the variation in level of environmental performance amongst BOMA BEST buildings, and less than 3% for LEED. With the majority of variation in the level of environmental performance left unexplained, there are clearly other more important factors driving environmental performance among green buildings in Canada.

All things held equal, it is possible that a building in a region with lower operating costs may require more incentive to reach the same level of environmental performance as a building in a region with higher operating costs. However, based on the results interpreted here, drivers of operating costs do not supply sufficient incentives to explain differences in the level of environmental performance observed for non-residential green buildings in Canada.

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