Can the Right Tool Unlock Green Building Investment?

Decision Aiding Tool for Profitable Energy Efficiency Investments in the Commercial Real Estate Industry

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Introduction

Office buildings within the U.S. Commercial Real Estate (CRE) sector spend more than $32 billion annually on energy[1] and contribute 18% of US carbon dioxide emissions.[2] For building owners, energy costs directly impact net operating income which is a key metric for their profitability. For tenants, who are often responsible for the cost of the energy consumption, efficiency improvements are tied to their bottom line. For the environment, a meaningful reduction in CO2 emissions from commercial buildings would help move the needle in the fight against climate change. All the major stakeholders involved have something to gain from reducing energy consumption, and yet the CRE market has been slow to make large-scale changes. Building owners and management firms must weigh many factors before deciding to make an investment in energy efficiency. For example, they must estimate their potential return and the timeframe within which they will receive it. They must also consider the upfront cost and to whom the benefit will accrue as well as how the investment will be received by tenants. This process takes time and requires an understanding of the benefits and tradeoffs of available technologies and many firms in the CRE industry do not have this additional time and expertise. However, with the right decision making framework, firms in CRE industry can more efficiently explore and evaluate potential investments that will both increase their profitability and benefit the environment. For this project, we partnered with the Grand Rapids based property management firm CWD to develop a system by which property managers can more efficiently identify potential opportunities for investments in energy efficiency that will yield both a financial return and reduce CO2 emissions

Background

Business Case & Green Building Trends in the Commercial Real Estate (CRE) Sector

Green building trends have been increasing in the US and globally. In 2013, the global market for green building was estimated at $280 billion[3] and account for 20% of all new construction[4]. The US Green Building Council identifies many reasons why new builds and retrofits alike are taking sustainability into consideration. The two biggest factors were client and market demand[5].

As a result of meeting this demand, building owners have reported a range of financial benefits as seen in Table 1. Other reasons for investing in green building included: increased productivity and worker satisfaction, better health standards and increased rents[6]. The LEED certification continues to serve as the industry standard although other certifications exist. However, not all firms will choose to pay for an

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[1] U.S. Energy Information Administration. (2012). Commercial Buildings Energy Consumption Survey (CBECS). Table C2. Total Energy Expenditures by Major Fuel. http://www.eia.gov/consumption/commercial/data/archive/cbecs/cbecs2003/detailed_tables_2003/2003set9/2003html/c2.html

[2] https://www.bomaorlando.org/Green-Resources/

[3] US Green Building Council. (2015). The Business Case for Green Building. Retrieved from http://www.usgbc.org/articles/business-case-green-building

[4] Lux Research, "Driven by Higher Rents and Values, Green Buildings Market Grows to $260 Billion," 2014. http://www.luxresearchinc.com/news-and-events/press-releases/read/driven...

[5] US Green Building Council. (2015). The Business Case for Green Building. Retrieved from http://www.usgbc.org/articles/business-case-green-building

[6] US Green Building Council. (2015). *The Business Case for Green Building*. Retrieved from http://www.usgbc.org/articles/business-case-green-building

official certification. Green building incorporates a wide range of projects from renewable energy, to material selection, to water management. Common energy efficiency projects include: HVAC optimization, efficient lighting and weatherization.

Table 1	Retrofit	New Construction
ROI	19.2 %	9.9%
Operating Cost Improvement	8.5%	13.6%
Building Value Increase	6.8%	10.9%
Source: McGraw Hill[7]		

Green Building in Grand Rapids, MI

Grand Rapids, the second largest city in Michigan, has seen tremendous growth in green building projects over the last decade. Grand Rapids, historically built on the furniture industry, continues to have the business community as its backbone. The city has leveraged its strong relationships with the private sector to develop a "triple-bottom line" approach to sustainability. These can be seen as early as the 1980's when there was a broad support for investment in major stormwater infrastructure[8] In 2006, the city developed its first cohesive sustainability plan which was designed to work in close partnership with the business community[9]. This plan also launched the Office of Energy and Sustainability, which manages the city's sustainability efforts. In 2009, Grand Rapids joined U.S. Conference of Mayors Climate Change Protection Agreement and in 2012 was named the top large US city (over 100,000) to implement the agreement[10]. These sustainability efforts certainly apply to the built environment; and by 2009 Grand Rapids had the most LEED certified buildings per capita in the US[11]. Recently, Grand Rapids joined the 2030 District initiative, which pledges to cut building energy consumption in half by 2030[12].

CWD Real Estate

CWD is a real estate investment firm based in Grand Rapids, Michigan. CWD is owned by three partners: Sam Cummings, Scott Wierda and Dan Devos. CWD owns and manages over 30 properties including several of the most iconic office buildings in downtown Grand Rapids. They also manage some retail and residential properties within the greater Grand Rapids area. CWD has a reputation for world class quality and customer service while keeping a laser focus on profitability. They are willing to invest in their properties if they believe they can improve the tenant experience or reduce operational expenses.

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[7] McGraw Hill Construction. (2011). *Green Outlook 2011: Green Trends Driving Growth*. http://aiacc.org/wp-content/uploads/2011/06/greenoutlook2011.pdf

[8] National Academies of Sciences, Engineering, and Medicine. (2016). *Pathways to Urban Sustainability: Challenges and Opportunities for the United States*

[9] National Academies of Sciences, Engineering, and Medicine. (2016). *Pathways to Urban Sustainability: Challenges and Opportunities for the United States*

[10] US Conference of Mayors. (2012). *MAYORS OF GRAND RAPIDS (MI) AND BEAVERTON (OR) WIN FIRST PLACE HONORS FOR LOCAL CLIMATE PROTECTION EFFORTS* http://grcity.us/enterprise-services/officeofenergyandsustainability/Documents/6-13-12%20RELEASE%20-%20CLIMATE%20PROTECTION%20AWARDS%202012%20-%20FINAL.pdf

[11] The Grand Rapids Press. (2009). *Grand Rapids has most LEED buildings per capita in U.S*. http://www.mlive.com/news/grand-rapids/index.ssf/2009/11/grand_rapids_has_most_leed_bui.html

[12] US Green Building Council West Michigan. http://www.usgbcwm.org/grand-rapids-2030-district/

However, at the end of the day, profit is always the driving force behind any capital allocation decisions. One of the aspects that makes CWD unique is that they have a "buy and hold" strategy. Many CRE firms will target selling a property after 5-7 years. As a result, the need for a quick payback will often constrain investment possibilities. CWD is open to hold a property much longer. Therefore, CWD's ownership structure allows for a longer horizon to recoup investment capital. This strategy of longer ownership also aligns with CWD's publicly stated commitments to the success of Grand Rapids. The firm's mission statement and value system sees their work as an important piece of making the city a wonderful place to live and work.

This report and the recommendations provided allow the necessary first steps to accelerate adoption towards greater investment in green building strategies. However, through providing short-term strategies that create immediate value to CWD, an additional intent of this report is to engage internal discussion towards a comprehensive long-term plan based on CWD's ownership structure that uniquely aligns with reaping the benefits of green buildings. Competitors within the commercial office-building sector that CWD occupies have shown measurable benefits in market differentiation, public sector engagement, tenant satisfaction, and portfolio wide improvements in capitalization rate percentages, among others. [13]

Barriers to Adoption Communicated Through Stakeholder Engagement

Numerous conversations were held with CWD to fully understand the firm's constraints and prioritize opportunities according to the firm's stated preferences. The barriers communicated throughout this stakeholder engagement process are similar to those experienced throughout the commercial real estate sector and summarized below:

Age & Original Design Considerations of CWD's Downtown Properties

The majority of CWD's downtown properties were originally built over 100 years ago, and similar to most developed societies at the time, these offices were traditionally constructed with load-bearing exterior walls of masonry which feature openings for windows and door entry areas.[14] Despite the fact that these buildings are among the most profitable within its portfolio, barriers to investment adoption result because any energy efficiency measures considered require circumventing the original design of the building. When acquired by firms such as CWD, the building's original primary equipment (i.e. chilled water systems or central plant) often remains due to the cost of full replacement. These aged equipment systems create significant building inefficiencies, cause headaches for building operators throughout the industry, and contribute to the fact that nationwide 30% of the energy used in U.S. commercial buildings is wasted.[15]

Existing Lease Structure create 'Split Incentive' & Need for Tenant Engagement

Traditional forms of leases (gross or net) create asymmetries in the relationship between landlords and tenants, therefore generating '"split incentives" that do not set the ground for energy efficiency

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[13] Urban Land Institute: *Retrofitting Office Buildings to Be Green and Energy-Efficient*. (2009). Independent Publishers Group.
[14] Urban Land Institute: *Retrofitting Office Buildings to Be Green and Energy-Efficient*. (2009). Independent Publishers Group.
[15] Better Buildings Challenge (BBC) Overview.
https://www4.eere.energy.gov/challenge/sites/default/files/docs/BB_Challenge_Program_Overview.pdf

investments. [16] In addition to the two other lease structures CWD utilizes (gross and modified gross), its triple net lease particularly highlights the obstacles faced by landlords. Under the triple net lease CWD utilizes, the tenant pays for rent plus property taxes, insurance and maintenance. Due to the fact that the tenants are directly responsible for their utility bills in a triple-net lease, the office space's rent operating costs and thereby risks are passed through to tenants and landlords have no incentive in carrying out energy efficiency upgrades in the property. Building operators holding similar barriers in lease structure are thereby incentivized to only target investment towards the building's common area space where the landlord still maintains control and reaps the investment benefits. There is also a need to empower tenants through communicating various ways of incorporating energy reduction measures within their lease line and educating them of the potential benefits.

Limited Data Availability to Locate Low Hanging Fruit Investment Opportunities

Two of the investment priorities communicated through stakeholder engagement were CWD's preference towards technologies that have short payback periods and minimal price premiums in terms of upfront cost. Opportunities that meet this objective are plentiful. An international study of over 200 office buildings in ten nations conducted by Good Energies, a global investor in renewable energy and energy efficiency technologies, concluded that the greatest cost premiums for most technologies is between 0 and 1 percent. [17]

However even if investment opportunities are viable, building owners and operators often have inadequate information about the performance of high-efficiency technologies and energy-efficient operations. Stakeholders lack robust ways to assess, compare, and validate building energy performance. At CWD, lease structure issues often diminish the desire to enhance real-time data capture of the buildings consumption or sub-metering which could distinguish tenant usage and the common area which is within its control. One consequence of CWD's limited data capabilities and uncoordinated control of the aged building systems is that investment cannot be target at areas effected by peak heating and cooling seasons. These high demand rates impact their monthly utility bills. For commercial building operators, this is undesirable because the high demand rates result in peak power charges which can account for 50% of the total electricity bill. [18]

Limited Employee Bandwidth to Troubleshoot Equipment Issues

The value proposition of improving the overall productivity of building operators and limiting the time requirements for employees to troubleshoot or plan ahead is significant. Viewed over a 30-year period, initial building costs account for approximately two percent of the total, while operations and maintenance costs equal six percent, and personnel costs account for the remaining 92 percent. However, limited bandwidth is common and this sentiment was conveyed through conversations with CWD. One

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[16] Urban Land Institute: *Retrofitting Office Buildings to Be Green and Energy-Efficient*. (2009). Independent Publishers Group.
[17] Good Energies, "Landmark International Green Building Study Finds Benefits of Buildings Green Outweigh Cost Premiums,"Nomember 19, 2008. www.goodenergies.com/new/-pdfs/Green%20buildings%20Study%20Press%20Release%20FINAL_5.pdf
[18] Oak Ridge National Laboratory (ORNL): *Cost-effective retrofit technology for reducing peak power demand in small and medium commercial buildings*. May 27th, 2015. Science and Technology for the Built Environment. Journal Volume: 21; Issue: 6. https://www.osti.gov/scitech/servlets/purl/1265489

priority vocalized was the desire to limit the time required to locate issues and access investment opportunities. This has proven to be a barrier to CWD's further adoption of energy efficiency technology.

When building occupants are uncomfortable it leads to building maintenance engineers spending unnecessary labor hours dealing with complaints. This has real financial implications. One study estimated that simple efforts to increase comfort could result in a 12 percent decrease in labor costs attributed to responding to complaints and reduce complaints to as low as 10 calls per 1,000 employees per year.[19] Less time dealing with complaints leads to more time to complete preventative maintenance, better equipment longevity, and lower operating costs overall.

Project Objectives Identified Based on Stakeholder Priorities

CWD approaches energy savings primarily as an opportunity to create economic value rather than an avenue for environmental impact. With that goal in mind they are interested in expanding their investments in energy-saving technology. Their investments to date have been limited due to inadequate bandwidth amongst their staff to evaluate potential projects. Therefore, a key need identified during our initial meetings was to develop a process by which the evaluation of new energy savings opportunities could be accelerated. In order to get final approval for a major investment CWD must get contractors to do an inspection and submit a formal bid. This process is time consuming and therefore CWD must be selective on which projects they investigate. With this problem in mind our project focused on the following:

1. **Identify ten high potential energy efficiency enhancing technologies:** There are many ways to save energy within a building. However, not all are appropriate for every region and some will struggle to yield a positive ROI. With these considerations in mind, and with some stated interests and preferences of CWD, we selected 10 technologies which we believe can both cut total energy expenditures as well as create a positive economic return.

2. **Creating a decision-aiding tool to identify which technologies to investigate for a particular property:** Using the ten technologies we selected, we created a dynamic tool that provides property specific recommendations for which technologies should be considered for further investigation. These recommendations are based on three components which are explained in detail below 1.) Energy Star Benchmarking Score 2.) Property Specific Score 3.) Investment Criteria Weighted Score. These are combined to quickly generate a profile for a given property and show where it stands compared to national averages and ranks the technologies by attractiveness for a that location. Decision-aiding tools utilizing a similar Analytical Hierarchal Process (AHP) have been created by the U.S. DoE, prioritizing projects based on stakeholder feedback payback, time and impact.[20] A case study of its effectiveness can be found in Exhibit 1.

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[19] Federspiel, C. 2000. "Costs of Responding to Complaints." *Indoor Air Quality Handbook*. Spengler, J.D., Samet, J.M., And McCarthy, J.F. Eds. New York: McGraw-Hill.
[20] U.S. DoE. (2013). "The Business Case for Energy Efficiency." Page 56.
https://energy.gov/sites/prod/files/2013/12/f5/business_case_for_energy_efficiency_retrofit_renovation_smr_2011.pdf

3. **Provide materials to better engager tenants regarding energy efficiency:** Many of CWDs leases are structured in a way that tenants are at least partially responsible for their own energy usage. While advantageous in many ways, it means that the savings from increased energy efficiency are passed on to the tenant. It is ideal for CWD if its tenants are willing to make these investments. Therefore, we have developed some materials to improve CWDs ability to communicate the value of energy efficiency to its tenants.

Methods

Technology Selection Criteria

According to CWD's constraints, priorities and preferences detailed above, significant research was conducted and over 20 potential technologies were assessed and screened. In addition to CWD's three main priorities of minimizing upfront cost, payback period and potential time savings, reports from the U.S. DoE's Building Technologies Integration (BTI) program were useful to gauge the applicability of various technologies based on local climate zones. **(Exhibit 2)** These reports were also beneficial in formulating assumptions around energy savings potential and price per square foot basis comparisons. For example, the specifications of the appropriate R-Factor assigned for insulation or solar reflectance of various roofing materials needed to be compared by building type (office), occupancy and age. **(Exhibit 3)**[21]

In addition to these assumptions, external research looked at which building systems likely account for the largest proportional share of energy usage within CWD's building portfolio. For example, over 33% of the energy used by small and medium commercial office buildings is dedicated to HVAC units[22] and 25% is used by lighting.[23] Most of these HVAC units or lighting systems rely on uncoordinated controls which accelerate maintenance issues from deteriorated equipment and cause high rates in the demand rates charged on their monthly utility bills. By evaluating technologies that improve the controllability of its largest proportional building systems, external research found significant potential to address CWD's barriers of limited employee bandwidth, the age of its building stock or the high demand rates found in monthly utility bills. [24] Finally, applicable rebates were considered for each technology and 10 were selected for further analysis in our decision-aiding tool:

Interior LED Lighting (common area)	**Variable Air Volume (VAVs)**
Ground sourced geothermal heat pumps	**Building Management Systems (BMS)**
Building envelope (weatherization)	**Occupancy Sensors & Controls**
Cool roof retrofits	**HVAC Economizer**
Variable Frequency Drives (VFDs)	**Old Boiler Replacement**

(A full description of each technology, case studies, and the assumptions used can be found in **Exhibit 4**)

[21] U.S. DoE's Office of Energy Efficiency & Renewable Electricity: Evaluating an Exteror Insulation and Finish System for Deep Energy Retrofits. Building Technology Office. January, 2014. http://www.nrel.gov/docs/fy14osti/61005.pdf
[22] (EIA, 2003)
[23] Energy Information Administration, "Commercial Buildings Energy Consumption Survey (CBECS): Table EIA. Major Fuel Consumption (BTU) by End Use for All Buildings," September 2008. Accessible at http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/detailed_tables_2003.html
[24] Griffith, B.; Long, N.; Torcellini, P.; Judkoff, R.; Crawley, D.; Ryan, J. (2007). *Assessment of the Technical Potential for Achieving Net-Zero-Energy Buildings in the Commercsial Sector*. NREL Report No. TP-550-41957. Golden, CO: NREL.

Energy Star Benchmarking

Conversations with industry experts within the commercial office building industry were conducted in addition to prescreening through secondary research. A byproduct of such interviews was the recommendation to generate EnergyStar Portfolio Manager accounts for CWD's properties and benchmark each building's usage and performance to that of its peers. EnergyStar's Portfolio Manager is the most widely utilized benchmarking tool within the industry, comprising 34,000 buildings across the country representing over 4.2 billion square feet.**(Exhibit 5)**

In addition to enhancing reporting capabilities, benchmarking is viewed as the initial means of locating opportunities to adopt cost-effective upgrades and solutions to help companies dramatically cut waste in their operational expenditures. Portfolio Manager's office building users with an 8% capitalization rate and who spend $400,000 per year on energy have utilized benchmarking to reduce their energy use by 10% and add $500,000 to the asset's value.[25]

For CWD, generating profiles proved valuable in enhancing its data capabilities as well as locating opportunities within its portfolio and flagging the properties that reported a high percentage of demand rates shown on monthly utility bills. The results of benchmarking CWD's portfolio showed that no CWD properties currently achieve the score of 75 needed to attain ENERGY STAR certification, indicating significant investment potential. Five properties within CWD's downtown portfolio were selected for further analysis based on their benchmarking score and investment potential to improve the building's cap rate. The pre-screened properties and their respective ENERGYSTAR score are shown below:

1. The Trust Building (40 Pearl St.): **65**
2. 180 Monroe Ave: **62**
3. PNC Bank Building (171 Monroe Ave.): **63**
4. Ledyard Building (125 Ottawa Ave.): **71**
5. The CWD Building (50 Louis St.): **69**

Investment Criteria Weighted Score

In conversations with CWD three important investment criteria were identified: upfront cost, payback period, and time savings. Each one of the ten technologies that we selected is different across these dimensions. To systematically evaluate the relative attractiveness for each criterion we used analytical hierarchy process (AHP). In AHP each possible alternative is compared to every other alternative and scored by the magnitude of its relative attractiveness or unattractiveness. Every building and project is unique. Therefore, to get an estimate of upfront cost and payback period for each technology we used national averages and case studies. The fact that these values are not exact predictions has limited impact on the analysis because we only needed enough accuracy to make a comparison between alternatives. Since time savings is an even harder value to estimate in the abstract, we developed a framework for

[25] Building Owners and Managers Association International (BOMA). 2008. BOMA Experience Exchange Report. Print.

comparing the impact a certain technology has on time savings. First, we asked whether the technology had a major, minor, or limited impact on time compared to the status quo. Next, we acknowledged that not all maintenance requirements have the same impact on building operations. Therefore, we built the matrixes below to rate the nature of the maintenance required by the status quo. Therefore, technologies that have a "major" advantage over the status quo and status quo technologies whose time requirements have a "high" impact building operations scored the highest in the AHP.

Matrix A: Maintenance is…	**Infrequent**	**Frequent**
Predictable	Low	Medium
Unpredictable	Medium	High

Matrix B: Maintenance is…	**Quick Fix**	**Delayed Fix**
In-House	Low	Medium
Contracted	Medium	High

When comparing technologies, we used the following nine-point scale where preference equals the degree to which a technology meets the criteria (i.e. has a lower upfront cost, shorter payback period, or greater time savings). When A is less preferred than B the inverse score of the appropriate magnitude is given.

1-A and B are equal
3-A is thought to be moderately more preferred than B
5-A is thought to be strongly more preferred than B
7-A is thought to be or has demonstrated that it is much more preferred than B
9-A can be empirically shown to be much more preferred than B

The scores for each technology are then normalized to a 0-1 scale. To ensure that we were being consistent in our comparisons we conducted a consistency analysis and calculated consistency ratios of 0.089-0.105. The weights or ranks for each technology for each of the three criteria categories can be found below:

AHP Derived Relative Weights

Upfront Cost

Occupancy Sensors	29%
Building Envelope	16%
Building Management System	14%
Variable Frequency Drives	13%
HVAC Economizer	10%
LED Lighting	5%
Variable Air Volume	5%
Geothermal	3%
Cool Roof	3%
Old Boiler Replacement	2%
Consistancy Ratio	10.4%

Payback Period

Variable Frequency Drives	25%
HVAC Economizer	24%
Variable Air Volume	14%
Occupancy Sensors	12%
Building Management System	9%
LED Lighting	7%
Building Envelope	5%
Old Boiler Replacement	2%
Geothermal	2%
Cool Roof	2%
Consistancy Ratio	8.9%

Time Savings

Building Management System	28%
Geothermal	19%
Old Boiler Replacement	19%
LED Lighting	14%
Variable Frequency Drives	6%
Occupancy Sensors	5%
HVAC Economizer	3%
Cool Roof	3%
Variable Air Volume	2%
Building Envelope	2%
Consistancy Ratio	10.5%

The Investment Criteria Weighted Score is a weighted average of the three different scores. The amount of weight placed on each criterion can be dynamically set within the tool. For example, a user could place an equal 33% weight for all criteria. However, if capital is constrained or their maintenance staff was reduced the user may want to rate upfront cost or time savings higher. The ability to dynamically set these weights recognizes the fact that the factors influencing an investment decision will vary at different points in time. *(The full AHP can be found in the Appendix in Exhibits 6*)

Property Specific Score

No two properties are identical and therefore the relative "fit" of energy savings technology will vary depending on the history and characteristics of a given building. Therefore, our decision-aiding tool will assign different scores based on the answers to nine questions. Given the fact that this tool is meant to accelerate decision making, we strove to minimize the number of questions and only choose those that could be answered with minimal research. Each question, listed below, was chosen to highlight a specific opportunity or challenge the technologies could address. For example, the question, "Is the HVAC system inefficient but not slated for replacement?" highlights the opportunity for any technology that helps extend the life or improve the functioning of an old HVAC system. If the answer is "Yes", then variable frequency drives directly address the opportunity while a cool roof has only a moderate and indirect impact via reduced loading. For each question the technology was scored as follows:

High (9 Points)-The technology directly and strongly addresses the opportunity or challenge
Med (5 Points)-The technology indirectly or moderately addresses the opportunity or challenge
Low (1 Point)-The technology has limited impact on the opportunity or challenge
NA (0 Points)- The technology is unrelated to the opportunity or challenge

Below is a list of each question, the potential answers and the scoring criteria. A more detailed exhibit which shows the potential scores for each technology can be found in the Appendix in Exhibit 7.

Questions	Measurement	Criteria
Most common lease structure	Gross Mod Gross Triple Net	High: Gross Med: Mod Gross Low: Triple Net
Amount of Common Space (Common SQFT/Total SQFT)	Above Average (40-50%) Average (20-50%) Below Average (Less than 20%)	High: (Above) Technology installed IN common space Med: (Above) Technology shares energy savings building-wide (Average) Technology installed IN common space Low: (Average) Technology shares energy
Is the existing HVAC system inefficient but not not slated for replacement?	Y/N	High: Improves the functionality of the HVAC system Med: Reduces heating and cooling demand with no effect on HVAC functionality Low: Would require new HVAC system, or
Is the HVAC system nearing end of life	Yes:System over 20 year old/planning to replace within 5 years No:System has at least 5 years of useabe life	High: (Yes) Viable HVAC replacement Med: (Yes) Reduces Heating and Cooling loads with no effect on HVAC functionality Low: (No) Applicable to HVAC even with replacement pending (No) Requirees HVAC replacement
Do you have any of the following lighting: Incandescent, halogen, standard metal halide, metal halide, T-12, mercury vapor?	Y/N	High: Lighting replacement Med: Helps optimimize lighting useage NA: Not related to lights
Was here a major renovation in the last 10 years?	Y/N	High: (No) Technology requires major rennovation Med: (No) Technology requires only modertate rennovation (Yes/No) Technology does not require property renovation Low: (Yes) Technology requires only
Was the latest commissioning within 5 years?	Y/N	High: (No) Condition of technology can diminish significantly and unpredictably within 5 years Low: (No) Technology condition changes slowly and predictably or technology unlikely to have been recommended over 5
Does demand rate account for over 20%-55% of monthly utility bill?	Y/N	High: (Yes) Technologly enhances data capturing, energy optimization and/or shows where within building high consumption is occuring (i.e. hotspots) Low: (Yes) Technology reduces energy
Is the roof nearing replacement	Y/N	High: (Yes) Techology is a roof Low: (No) Technology applies to an existing roof

Downtown Property Profiles

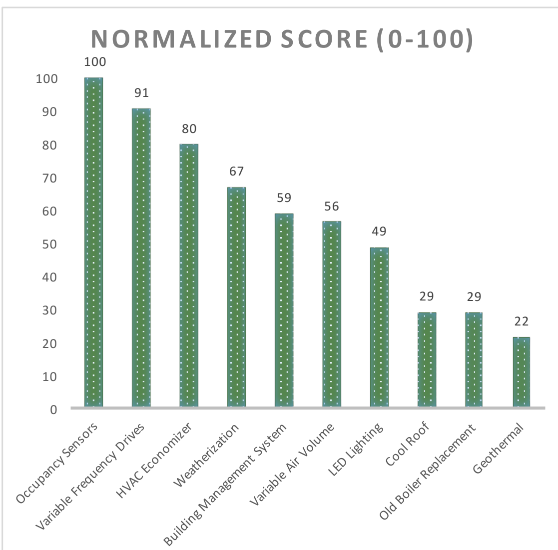
The Trust Building

40 Pearl Street NW

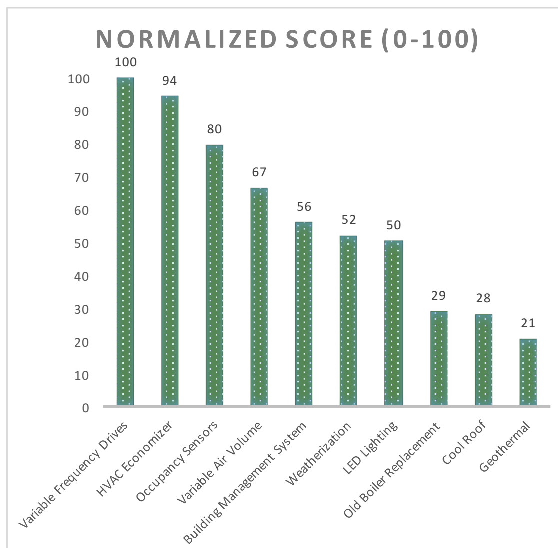
Energy Star Score:

65

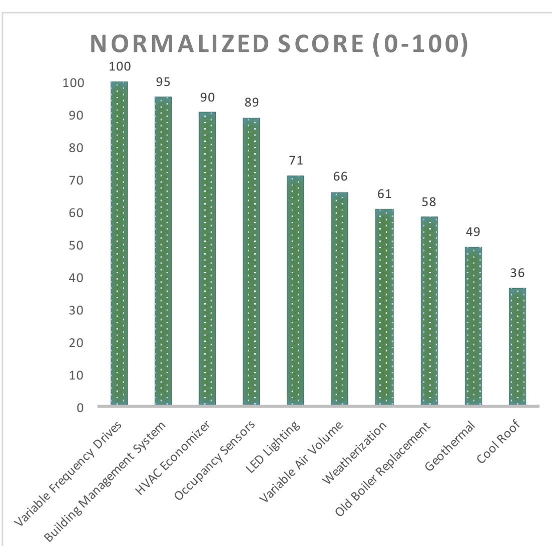
Upfront Cost Focus



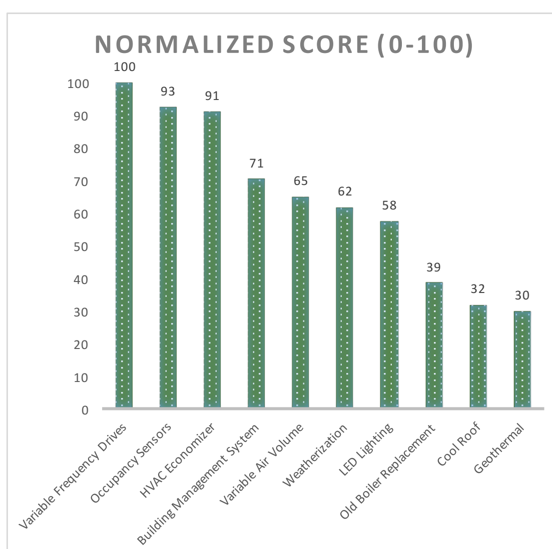
Payback Focus



Time Savings Focus



Balanced Focus

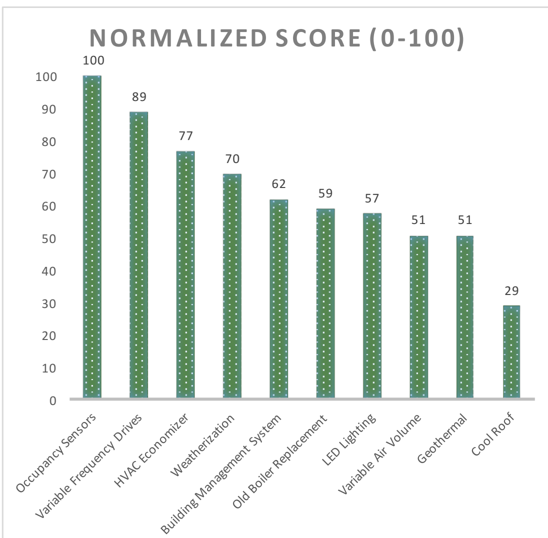


180 Monroe

Energy Star Score:

62

Upfront Cost Focus



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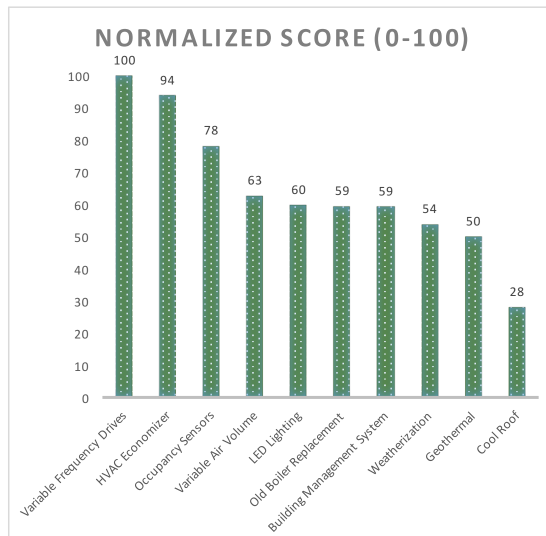

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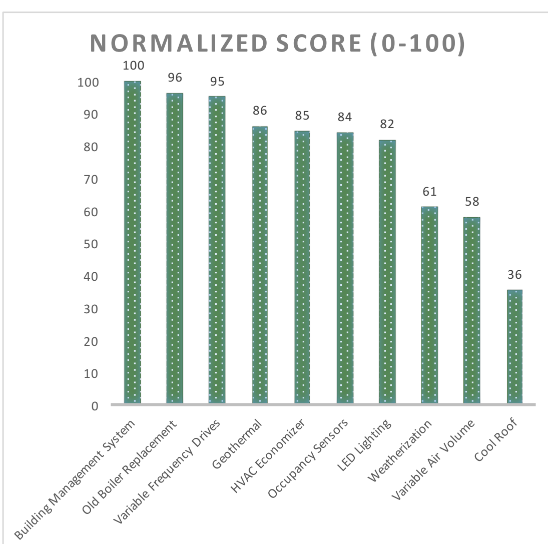
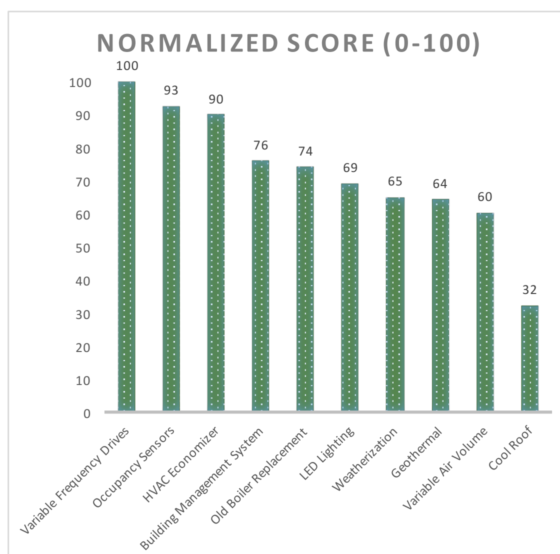


Balanced Focus



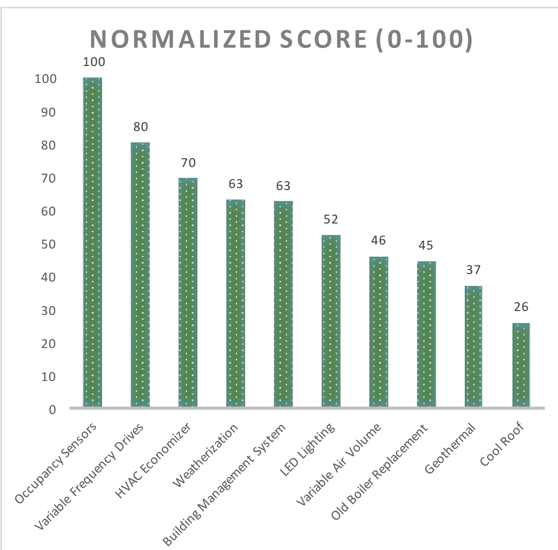
PNC Bank

171 Monroe

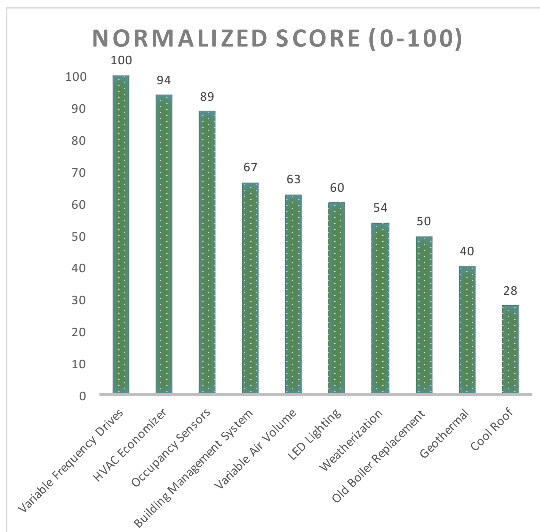
Energy Star Score:

63

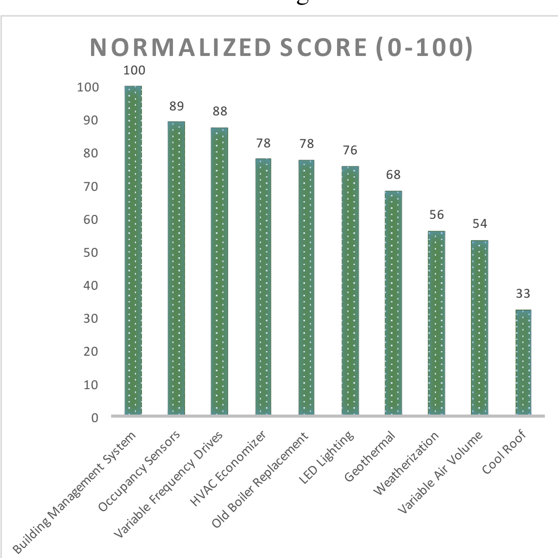
Upfront Cost Focus



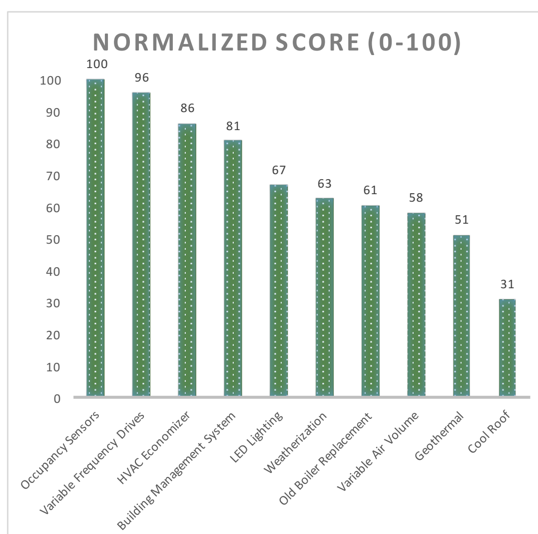
Payback Focus



Time Savings Focus



Balanced Focus



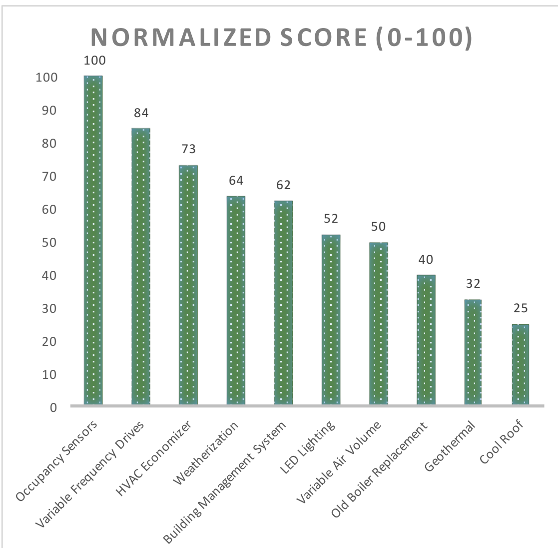
Ledyard Building

125 Ottawa Ave

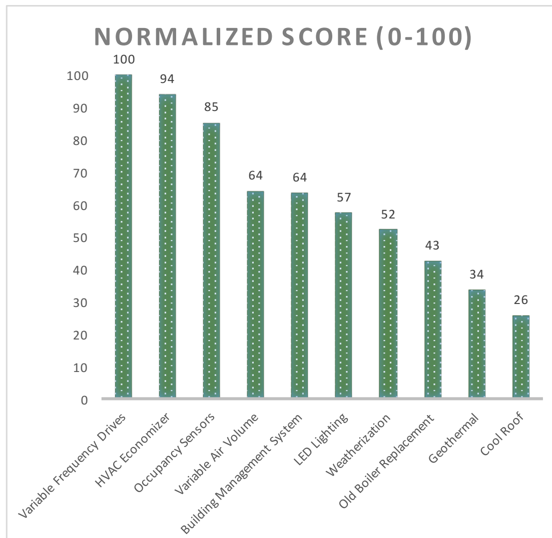
Energy Star Score:

71

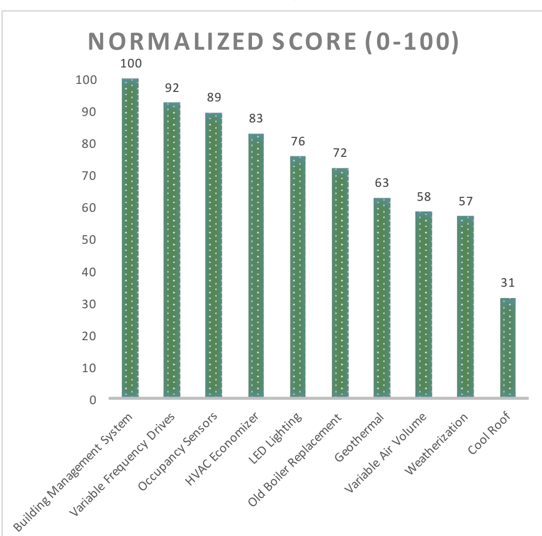
Upfront Cost Focus



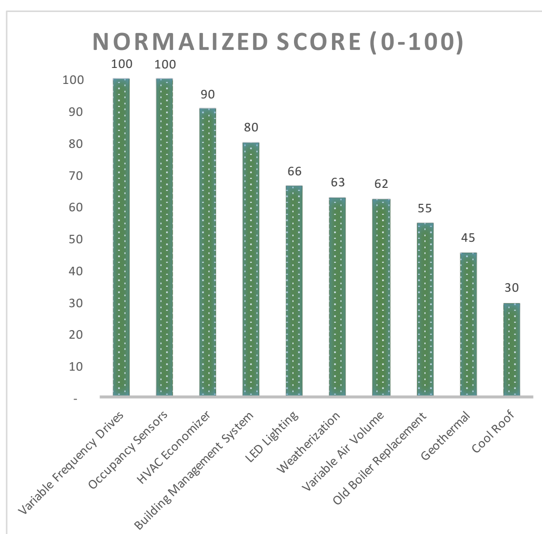
Payback Focus



Time Savings Focus



Balanced Focus



Ledyard

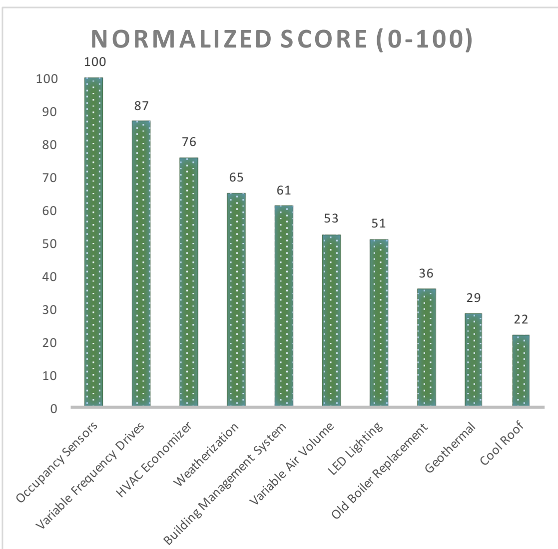
CWD Building

50 Louis St.

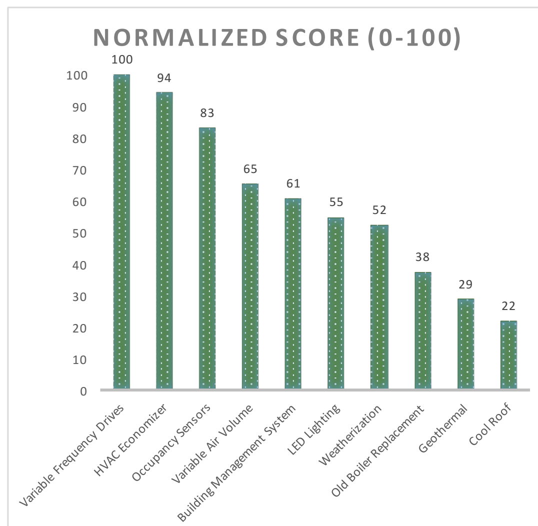
Energy Star Score:

69

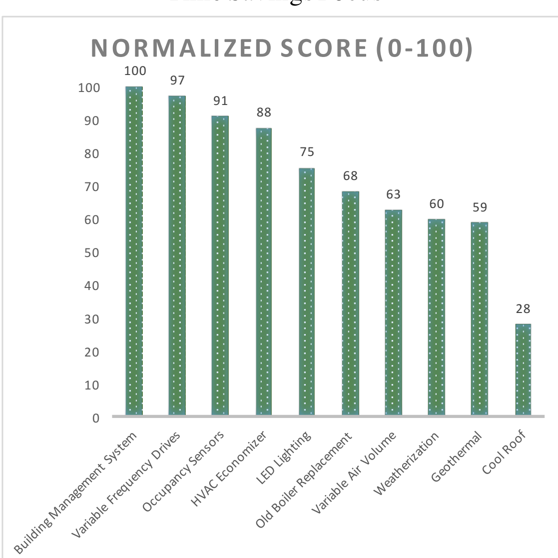
Upfront Cost Focus



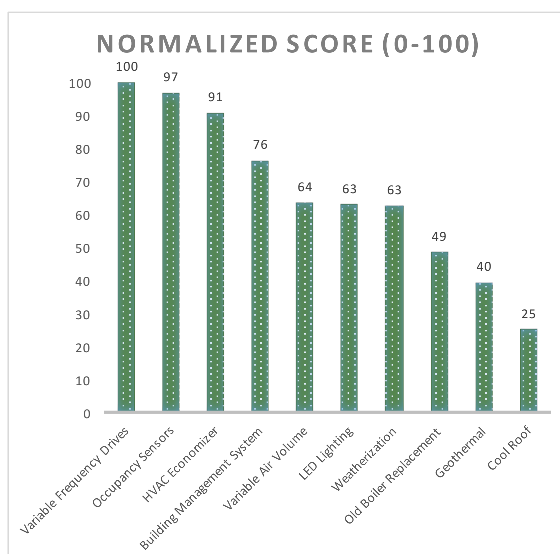
Payback Focus



Time Savings Focus



Balanced Focus



Recommendations

The decision-aiding tool is designed to be dynamic and therefore the recommendations will change depending the preferences and all the technologies explored could be profitable investments. However, when we looked at the downtown properties across our various scenarios four technologies consistently performed well: occupancy sensors, variable frequency drives, HVAC economizers and building management systems. Furthermore, occupancy sensors performed the best of the four. Therefore, we recommend that CWD investigate these technologies further with special emphasis on occupancy sensors.

Additional Recommendations

Sub-metering

Sub-metering gives your organization control over your energy use and energy cost. It is largely considered the first step in measuring/knowing your building/portfolio energy inputs so that you can make good investment choices thereafter. A study by CB Richard Ellis found that U.S. office buildings with tenant sub-metering used 21% less energy than buildings with pro-rata allocation of energy cost.[26]

Best practices in New Construction Building in Design

Because CWD typically owns and operates commercial buildings within their portfolio, their ownership structure is tailored for long term thinking behind its green building investment decisions. We argue this should start in the building and design phase to mitigate operational costs down the road. It is surprising to many experts and professionals that design and construction expenditures, the so-called "first costs" of a facility, account for just 5 to 10 percent of the total expenditures an owner will make over the span of a building's service lifetime. In contrast, operations and maintenance account for 60 to 80 percent of the total lifecycle cost. [27] A 2011 report from the U.S. DoE provide a comprehensive list of design and construction strategies that CWD can use to reduce first costs of its new developments. Some of the recommended strategies applicable to CWD are optimizing site and southern facing orientation, passive and integrative design strategies to locate synergies in lowering cost, enhanced daylighting to minimize mechanical requirements of the building, and incorporating building envelope strategies that reduce life cycle impact. [28]

Commissioning/Recommissioning

With many of its properties within its portfolio originally built over one hundred years ago and holding deteriorating building equipment, we recommend CWD incorporates a biennial recommissioning program that tests the performance of building equipment systems to satisfy both the designers' intent and occupants' needs. Studies of commercial buildings estimate that recommissioning only requires an average cost of $\$0.17/ft^2$, holds O&M-related energy savings potential of 10 percent, and the minimal upfront cost can be made up in just 1.4 years on average. [29]

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[26] Source: CBRE, "Do Green Buildings Make Dollars and Sense?"2009. Pg. 5. http://buildingrating.org/file/1094/download Accessed June 15, 2016.

[27] U.S. Federal Facilities Council. *Sustainable Federal Facilities: A Guide to Integrating Value Engineering, Life Cycle Costing, and Sustainable Development*. Federal Facilities Technical Report No 142. National Academy Press. Washington, DC. 2001

[28] Charles J. Kibert. *Sustainable Construction: Green Building Design and Delivery*. Wiley. Fourth Edition, 2016.

[29] Portland Energy Conservation Inc., *What Can Commissioning Do For Your Building?* (Brochure from the Federal Energy Management Program, U.S. Department of Energy).

Tenant Toolkit

Finally, in order to empower tenants within CWD properties with difficult leasing structures, we have create a separate 10-page educational booklet that can be supplied to tenants. This tenant toolkit hopes to be the first step and kick-start a program comprehensive tenant engagement program within CWD, labeled "Flip The Switch." The toolkit covers numerous strategies tenants can utilize to lower operating expenses, the rationale or business case through adoption, ways to get started, as well as the average upfront cost and expected savings from adopting the energy reduction strategy. The strategies within the tenant toolkit range from no cost measures (i.e. preventive maintenance), to purchasing various ENERGYSTAR labeled office equipment as well as more comprehensive measures such as plug load reduction through enhance building controls.

Shown below is one page from the "Flip The Switch" Tenant Toolkit:

CWD
REAL ESTATE INVESTMENT

GREEN: MID LEVEL CHANGES

Category	Strategy	Rationale	Getting Started	Cost	Savings
Office Equipment POWER MANAGEMENT	Monitor Plug Loads - Install plug load controllers in cubicles to control multiple loads (i.e. monitors, fans and task lights). These devices use a motion detector to shut down equipment when the cubicle is not in use.	Reduces power requirements based on occupancy changes. It is estimated that plug loads account for 15-20% of a building's energy consumption.	EC	$90-$150	15%-20%
	Wireless Plug Load Controllers: Install plug-in outlet meters which can monitor plug load energy consumption of any device plugged into the outlet and control on and off times through the internet wirelessly.	According to the ENERGY STAR website, only 36% of office employees turn off their computers at night. If every monitor and computer in the US were turned off at night, the US could shut down up to 8 large power plants and save 7 million tons of CO2 annually.	EC	$60-$90/Outlet	30%-60%
LIGHTING CONTROLS	Dimming Controls- Install pre-set dimming controls to allow use of less light in a specific area (i.e. in conference/meeting rooms).	Controls allow a low cost measure that typically achieve payback between 1-2 years.(1) In addition, they do not require behavior modification.	LC/EC	$100-$200 per switch	30%-80%
	Occupancy Sensors- Install in open areas, conference rooms, restrooms, storage rooms, filing areas, pantries and private offices.	Occupancy Sensors typically hold a payback within the first year and hold considerable energy savings from day one. (Storage Closet- 45-80%, Corridors - 30-80%, Restroom- 30-90%, Conference Room- 22-65%, Private Office-13-50%) (2)	LC/EC/Arch	$60-$90/Outlet	22%-80%
DAYLIGHTING	Daylight Sensor Lighting Controls - Install daylight sensors to control specific lights. Wireless battery powered units can communicate with the light switch to control all lights on the switch. Fixtures do not need to be altered.	Using illumination provided by the sun (free) will reduce the amount of electricity needed for lighting. Sensors will maximize the use of daylight as they will not rely on manual adjustments made by individuals in the office.	LC/EC/Arch	$200-$500 per switch	up to 15%-20%
Getting Started Key: Arch = Architect	EPA = Environmental Protection Agency	EC = Electrical Contractor IT = Tenant's IT Department/Purchasing	LC = Lighting Consultant	MC = Mechanical Contractor	SRS Site = Sustainability Site

Acknowledgements

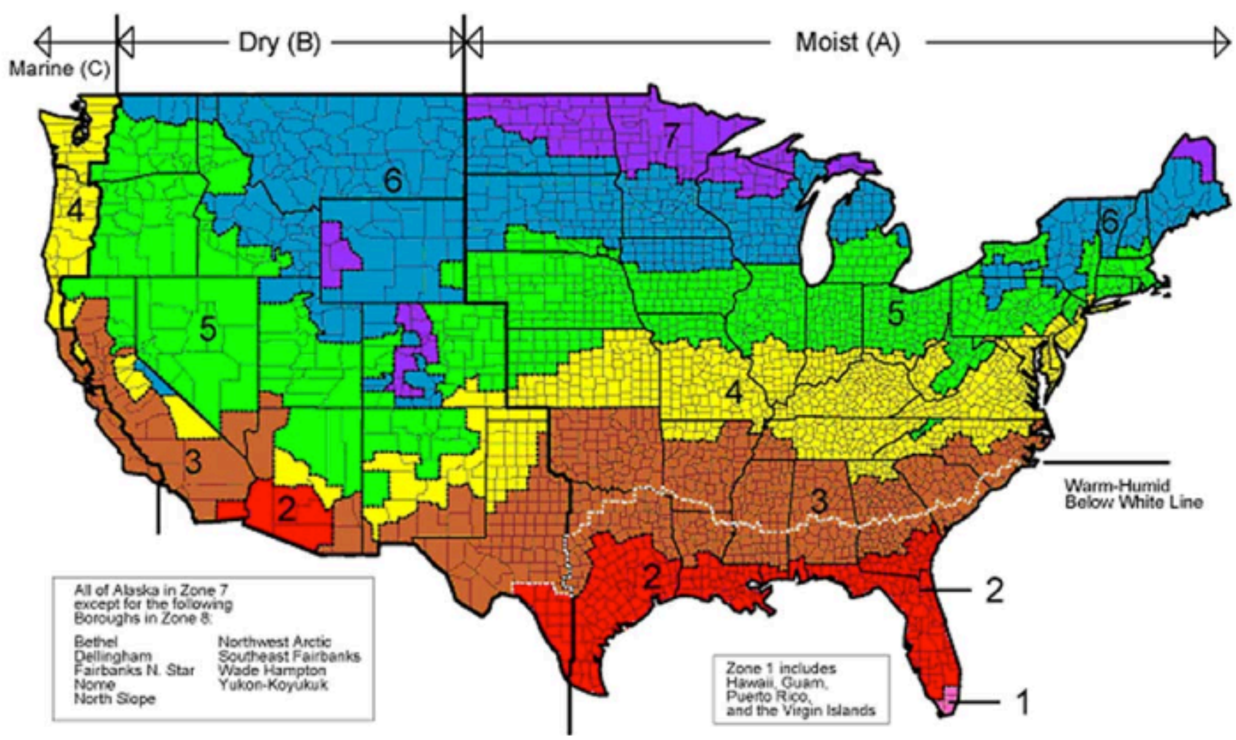
We would like to thank the staff at CWD very much for the opportunity to explore this project and learn more about their business. Also, we would like to thank Professor Andrew Hoffman for serving as our faculty advisor.

Appendix

Exhibit 1: Case Study on Decision-Aiding Tools: *U.S.DoE's Building Technologies Integration (BTI) Program*

Prior research has been done outlining the potential benefits that CWD would reap through implementing our decision-aiding tool. To meet the competing priorities and objectives of multiple stakeholders within the commercial real estate sector, the Building Technologies Integration (BTI) subprogram within the U.S.DoE has utilized similar Six Sigma methodologies used in our decision-aiding tool, prioritizing projects based on payback, time and impact.[30] Gundersen Lutheran, a Wisconsin based and integrated Healthcare facility operator that incorporated the BTI's prioritization tool, reduced energy consumption by 10% within the first eight months of incorporating the program into their day-to-day operational decision making. By the end of the next year, portfolio wide energy consumption reduced to 25% and the company saved $1.25 million annually in operational expenditures. The significant success achieved from the tool led to praise from senior management within the company: "Most of these initial projects had a less than two-year payback period and were considered a better investment than some other things that we could have been doing with our capital." [31]As a result, the tool comprises approximately 40% of their investment projects.

Exhibit 2: Climate Zone Map used for Technology Selection Criteria : *(Briggs et al. 2003)*



[30] U.S. DoE. (2013). "The Business Case for Energy Efficiency." Page 56. https://energy.gov/sites/prod/files/2013/12/f5/business_case_for_energy_efficiency_retrofit_renovation_smr_2011.pdf

[31] U.S. DoE. (2013).

Exhibit 3: Wall & Roof R-Factor Assignments by Building Type, Activity, and Geography (Huang and Franconi 1999)

Building Type	Old Vintage (pre-1980)		New Vintage (post-1980)	
	North Btu/h·ft^{2}F (W/m^2·K)	South Btu/h·ft^2·F (W/m^2·K)	North Btu/h·ft^2·F (W/m^2·K)	South Btu/h·ft^2·F (W/m^2·K)
Small office	4.9 (1.158)	3.9 (1.456)	6.3 (0.901)	5.6 (1.014)
Large office	2.5 (2.271)	2.5 (2.271)	4.6 (1.234)	6.0 (0.946)
Small retail	3.4 (1.67)	2.5 (2.271)	6.6 (0.86)	4.8 (1.183)
Large retail	3.1 (1.832)	3.3 (1.721)	6.4 (0.887)	4.8 (1.183)
Small hotel	3.4 (1.67)	3.4 (1.67)	5.3 (1.071)	5.3 (1.071)
Large hotel	3.6 (1.577)	3.6 (1.577)	6.2 (0.916)	6.2 (0.916)
Fast food restaurant	10.9 (0.521)	10.9 (0.521)	13.2 (0.43)	13.2 (0.43)
Sit down restaurant	10.9 (0.521)	10.9 (0.521)	13.2 (0.43)	13.2 (0.43)
Hospital	4.3 (1.321)	4.3 (1.321)	6.9 (0.823)	6.9 (0.823)
School	2.7 (2.103)	3.4 (1.67)	5.3 (1.07)	5.7 (0.996)
Supermarket	3.3 (1.721)	3.3 (1.721)	5.8 (0.979)	5.8 (0.979)
Warehouse	3.2 (1.774)	2.4 (2.366)	4.6 (1.234)	4.0 (1.42)

Building Type	Old Vintage (pre-1980)		New Vintage (post-1980)	
	North Btu/h·ft^2·F (W/m^2·K)	South Btu/h·ft^2·F (W/m^2·K)	North Btu/h·ft^2·F (W/m^2·K)	South Btu/h·ft^2·F (W/m^2·K)
Small office	11.9 (0.477)	10.5 (0.541)	13.3 (0.427)	12.6 (0.451)
Large office	9.1 (0.624)	11.2 (0.507)	9.1 (0.624)	12.6 (0.451)
Small retail	10.2 (0.557)	9.5 (0.598)	13.2 (0.43)	12.0 (0.473)
Large retail	10.6 (0.536)	11.5 (0.494)	14.0 (0.406)	12.0 (0.473)
Small hotel	9.8 (0.579)	9.8 (0.579)	13.2 (0.43)	13.2 (0.43)
Large hotel	11.8 (0.481)	11.8 (0.481)	14.0 (0.406)	14.0 (0.406)
Fast food restaurant	10.9 (0.521)	10.9 (0.521)	13.2 (0.43)	13.2 (0.43)
Sit down restaurant	10.9 (0.521)	10.9 (0.521)	13.2 (0.43)	13.2 (0.43)
Hospital*	12.3 (0.462)	12.3 (0.462)	11.5 (0.494)	11.5 (0.494)
School	10.9 (0.521)	10.1 (0.562)	12.6 (0.451)	13.3 (0.427)
Supermarket	9.2 (0.617)	9.2 (0.617)	11.5 (0.494)	11.5 (0.494)
Warehouse	7.8 (0.728)	7.6 (0.747)	10.1 (0.562)	10.6 (0.536)

Exhibit 4: Technology Profiles

LED Lighting

Overview of how it works: Light-emitting diodes (LED's) are increasingly becoming the dominant type of bulb for nearly all lighting applications. LED's create light by running electric current through a semiconductor. This then illuminates small light sensors and creates light.[32] LED's have several advantages over incandescent and other existing lamps. One of the major factors is that they are far more efficient in managing heat which reduces their energy demand. Due to their many advantages, new LED products are being developed constantly and as their popularity increases their unit cost has been decreasing.[33]

Energy Savings Estimates: LED's offer significant energy savings relative to conventional lights. According to the Department of Energy, Energy Star Certified LED products are rated to use 75% less energy and last 25 times longer than incandescents. This is important because it is estimated that lighting accounts for 21% of all energy use in commercial buildings.[34]

Key Considerations for Attractiveness: The reduction in energy use is the primary driver of economic return when investing in LED lighting. However, LEDs also have a strong time-savings component. Changing a light bulb may seem trivial in terms of the time it requires. However, this is not the case in commercial properties. These buildings can have thousands of lights, many of which are hard to access. Furthermore, tenants expect a very quick response when a light is out. The long life of LEDs has a direct and significant impact on the amount of maintenance hours required to maintain a building's lighting.

Geothermal

Overview of how it works: Geothermal heating and cooling systems use heat transfer to convert constant subterranean temperatures into a clean source of heat and air conditioning. While systems vary, especially with utility scale geothermal, the general functionality for residential and commercial geothermal heat pumps is the same. A network of pipes carrying either air or liquid is buried below the frost line where temperatures are approximately 50 degrees year-round.[35] Using a simple pump the liquid is circulated into the building where heat exchange can occur. In the summer heat is brought up from underground and in the winter the process is reversed and heat is drawn out of the building and into the ground[36]

Energy Savings Estimates: Geothermal systems are simpler in design that conventional heating and cooling systems because they have fewer moving pieces. As a result, they require less energy. The Department of Energy estimates that geothermal heat pumps can save as much as 50% of the electricity required by standard HVAC systems.[37] The EPA estimates that geothermal heat pumps are able to reduce

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[32] Energy Star. *Learn about LEDs*. https://www.energystar.gov/products/lighting_fans/light_bulbs/learn_about_led_bulbs
[33] Department of Energy. *LED Lighting*. https://energy.gov/energysaver/led-lighting
[34] Energy Information Administration, "Commercial Buildings Energy Consumption Survey (CBECS): Table EIA. Major Fuel Consumption (BTU) by End Use for All Buildings," September 2008. Accessible at http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/detailed_tables_2003.html)
[35] Union of Concerned Scientists. *How Geothermal Works*. http://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/how-geothermal-energy-works.html#.WOxFFxLyuRt
[36] Geothermal Energy Association. http://geo-energy.org/Basics.aspx#heatpumps
[37] Department of Energy. *Choosing and Installing Geothermal Heat Pumps*. https://energy.gov/energysaver/choosing-and-installing-geothermal-heat-pumps

energy demand by 44% for air-forced heat pumps and as much as 72% for standard air conditioning equipment.[38]

Key Considerations for Attractiveness: Beyond just energy savings, geothermal heat pumps are very durable since much of their components are buried underground. The piping system often has warranties for 25-50 years and the heat pumps often have warranties of 25 years.[39] Therefore, even though the upfront cost can be high their longevity benefits their ROI. Furthermore, because they have few moving parts they often require less ongoing maintenance which can be a time-saver for management staff.

Ground sourced geothermal heat pumps are likely to achieve 25-50% in total building energy savings over conventional HVAC distribution systems but CWD should be remain mindful that the largest additional expense for CWD would be the installation requirement of drilling the holes for the underground pipes. While upfront costs are reduced through installation horizontal pipes, CWD's downtown property profile does not provide adequate space requirements in the five properties selected for analysis. As a result, geothermal heat pumps could be twice the cost of a conventional heating and cooling system, providing a payback within 5 – 10 years in most cases. [40]

Building Envelope

Overview of how it works: Many energy efficiency technologies are focused on how energy is created or distributed. Investing in the building envelope is all about managing and maintaining the energy once you have it. Generally, this means making improvements to "tighten up" a building so its warm and cool air are not lost through gaps in the walls and roof and increasing the amount of insulation so that heat is not lost via heat exchange with the exterior of the building. Common projects include: better caulking and sealing, wrapping of exterior walls, increased insulation, and better windows

Energy Savings Estimates: Adding insulation to CWD's interior wall caveats is particularly attractive for CWD because older structures typically lack wall insulation or it is degraded.[41] Major improvements to the building envelope such as recladding can increase efficiency by as much 70%.[42] However, projects of this scale tend to be very expensive up front and have very long payback periods. On the contrary, smaller improvements like caulking and insulation are generally much cheaper. While not a perfect comparison to commercial buildings, a study of the DOE's residential weatherization program found a 6-7% energy savings for electric heat and 16-18% energy savings for gas heating.[43]

Key Considerations for Attractiveness: Weatherization and building envelope improvements can have a very low upfront cost. For example, reports conducted by the DoE found that caulking leaky areas typically cost $0.5/sqft.[44] The additional cost of insulation is $0.25 /sqft per additional inch of thickness. Building envelope investments are possible for both new construction and retrofits. However, it should be

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[38] Department of Energy. *Choosing and Installing Geothermal Heat Pumps*. https://energy.gov/energysaver/choosing-and-installing-geothermal-heat-pumps
[39] Department of Energy. *Choosing and Installing Geothermal Heat Pumps*. https://energy.gov/energysaver/choosing-and-installing-geothermal-heat-pumps
[40] Urban Green Council (2009) *Cost of Green in NYC* (New York: Urban Green Council)
[41] Charles J. Kibert. *Sustainable Construction: Green Building Design and Delivery*. Wiley. Fourth Edition, 2016.
[42] McGraw Hill Construction. *Business Case for Energy Efficient Building Retrofit and Renovation*. https://energy.gov/sites/prod/files/2013/12/f5/business_case_for_energy_efficiency_retrofit_renovation_smr_2011.pdf
[43]Department of Energy. https://energy.gov/sites/prod/files/2015/08/f25/WAP_NationalEvaluation_WxWorks_v14_blue_8%205%2015.pdf
[44]Department of Energy. http://www.nrel.gov/docs/fy14osti/61005.pdf

noted that many of these improvements, like insulation, will be much cheaper during new construction and major renovation when walls and roofs are exposed.

Cool Roof

Overview of how it works: As one quickly realizes when wearing a black shirt on a hot day, dark colors absorb heat much more than light colors. This is the underlying principle behind "cool" or reflective roofs. When a building has a dark colored roof it absorbs a considerable amount of the solar heat radiating upon it. This increased thermal load means that the buildings air conditioning systems must work harder to cool the building. Cool roofs function no different than a conventional roof other than the fact that they are light colored. This can be achieved by using light colored shingles, reflective paints, or even living "green" roofs. By reflecting away a higher amount of solar energy a cool roof could be as much as 50 degrees cooler.[45]

Energy Savings Estimates: The energy savings from a cool roof will vary depending on the local climate. Not surprisingly, sunnier climates have a higher potential benefit. A study of cool roofs conducted in Spain found an energy savings of nearly 50%[46]. However, this will not be the case in Grand Rapids. Dow Chemical in a joint research project with Oak Ridge National Laboratory is estimating that their flexible reflective coating could improve efficiency by up to 20%[47]

Key Considerations for Attractiveness: While costs for high emissivity roof installations are slightly ($1 - $2/SF) more than conventional black roofs, substituting a weathered cool white roof (solar reflectance 0.55) for a weathered conventional gray roof (solar reflectance 0.20) in ideal climate conditions typically yield annual significant cooling energy savings per unit conditioned roof area.[48] However, given Michigan's local climate as well as the energy savings potential from the technology occurring in the summer months, these constraints were considered. The resulting annual energy cost savings potential has been reported to be around $0.126/m2 for CWD. [49]

Variable Frequency Drives

Overview of how it works: VFDs are devices that can modulate the speed of electric motors. HVAC systems are typically designed to meet a building's loads at peak conditions. However, most buildings operate at full load conditions for only short periods and older buildings are susceptible to operating at full load by not making this distinction. [50]By installing VFDs on fans and pumps that drive the building's HVAC systems, the technology allowing management to reduce the speed of fan motors at night and on weekends and holidays, thereby cutting energy consumption.

Energy Savings Estimates: Substantial energy savings can be achieved when the fan speed of CWD's electric motors is reduced in response to changing load conditions; the larger the motor, the greater the

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[45] Department of Energy. *Cool Roofs*. https://energy.gov/energysaver/cool-roofs
[46] Boixo, S., Diaz-Vicente, M., Colmenar, A., & Castro, M. A. (2012). Potential energy savings from cool roofs in Spain and Andalusia. *Energy,38*(1), 425-438. doi:10.1016/j.energy.2011.11.009
[47] Dow Chemical Company. http://msdssearch.dow.com/PublishedLiteratureDOWCOM/dh_08a3/0901b803808a3895.pdf?filepath=news/pdfs/noreg/162-02615.pdf&fromPage=GetDoc
[48] EDF Climate Corps Handbook: Energy Efficiency Investment Opportunities in Commercial Buildings. Appendix G. Sixth Edition.
[49] Ronnen Levinson & Hashem Akbari. "Potential benefits of cool roofs on commercial buildings: conserving energy, saving money, and reducing emission of greenhouse gases and air pollutants." *Energy Efficiency* (2010) DOI 10.1007/s12053-008-9038-2
[50] Charles J. Kibert. *Sustainable Construction: Green Building Design and Delivery*. Wiley. Fourth Edition, 2016.

energy savings potential. For example, a 20% reduction in fan speeds reduces the energy used by the motor by 50 %. [51] A recent EPA study confirmed that installing VFDs its energy potential impact, achieving a mean savings of 52% in fan speed energy requirements.[52]

Key Considerations for Attractiveness: VFDs are now extremely economical options for all for all fan sizes of motors, from the triple-phase induction motors down to fractional horsepower applications. Typical upfront costs fall in the range of $65,000 per VFD installed holdings a payback of one year or less. [53] However, along with economizers, the immediate energy savings from VFDs can diminish over time and cause issues to CWD operators because continual oversight is needed to ensure they are operating correctly. When left unchecked they can operate the building at full load, and thus, commissioning and recommissioning is recommended.[54]

Building Management System

Overview of how it works: For a real estate company like CWD, Building Management Systems (BMS) allow for centralized monitoring and control of energy use across their portfolio's building systems. For example, centralized monitoring and control of lighting, HVAC, refrigeration as well as individual electric meters. Building managers can troubleshoot issues and schedule energy usage across building systems and a portfolio of properties.

Energy Savings Estimates: There is certainly a value proposition to aligning data collection goals with energy management initiatives across CWD's enterprise. Lawrence Berkeley National Lab estimates 10%-20% median portfolio savings by implementing an energy information system (EIS) company wide.[55]

Key Considerations for Attractiveness: BMS systems are used to continuously fine-tune the operation of HVAC and lighting systems, with the current occupancy and climate conditions. The systems hold the ability to maximizes energy efficiency, manage the building's utility demand rate usage, and occupant comfort. Key to CWD's Michigan-based location, they also track and measure the atmospheric conditions inside and outside the building, saving time needed for CWD operations employees through automation. In addition, BMS systems are programmed to provide automatic alerts when any systems are operating outside of their designed parameter in order to prompt maintenance activities.[56] The time savings potential for CWD is significant, as personal controls for HVAC systems have been reported to reduces complaints to as low as 10 calls per 1,000 employees per year.[57] Less time dealing with complaints leads to more time to complete preventative maintenance, better equipment longevity, and lower operating costs overall.

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[51] Urban Land Institute: *Retrofitting Office Buildings to Be Green and Energy-Efficient*. (2009). Independent Publishers Group.
[52] Morris, P. *The Cost of Green Revisited: Reexamining the feasibility and cost impact of sustainable design in the light of increased market adoption*. Journal Langdon. July 2007. http://global.ctbuh.org/resources/papers/download/1242-cost-of-green-revisited-reexamining-the-feasability-and-cost-impact-of-sustainable-design-in-the-light-of-increased-market-adoption.pdf
[53] EDF Climate Corps Handbook: Energy Efficiency Investment Opportunities in Commercial Buildings. Appendix G. Sixth Edition.
[54] Morris, P. *The Cost of Green Revisited: Reexamining the feasibility and cost impact of sustainable design in the light of increased market adoption*. Journal Langdon. July 2007. http://global.ctbuh.org/resources/papers/download/1242-cost-of-green-revisited-reexamining-the-feasability-and-cost-impact-of-sustainable-design-in-the-light-of-increased-market-adoption.pdf
[55] Source: Davies, J. "*Three Big Myths About Big Data: How Analytics Can Optimize Enterprise-Level Energy Management*." GreenBiz Big Data Report. 2015.
[56] Granderson, J. & Lin, G. *Energy Efficiency* (2016) 9: 1369. doi:10.1007/s12053-016-9428-9
[57] Rocky Mountain Institute. Greening the Building and the Bottom Line: Increasing Productivity Through Energy-Efficient Design. Snowmass, CO. 1994.

Occupancy Sensors

Overview of how it works: Occupancy sensors can identify whether there is someone in a given space and turn the light off if there is not. More sophisticated systems can also dim the interior lights when there is sufficient light from outside.

Energy Savings Estimates: The effect on energy will vary depending on the space and the existing behavior. However, it can be significant. Below are some examples of potential saving found in common commercial building spaces[58]:

Private Office: 13-50%
Conference Room: 22-65%
Restroom: 30-90%
Corridors: 30-80%
Storage Area/Closet: 45-80%

Key Considerations for Attractiveness: The major advantage of occupancy sensors is that they do not require behavior change which humans are notoriously bad at. This is amplified depending on the lease structure of a given building. For example, if tenants are not responsible directly for the energy costs of their space they have fewer incentives to turn the lights off in areas they are not using. This is also true in common areas, even if the expenses are shared, because individual actions may not necessarily change the overall outcome which acts as a disincentive.

HVAC Economizer

Overview of how it works: Air side economizers use a damper to control intake of outside air. When air is cooler than return air, the damper adjusts to maximize air intake; when outside air is warmer, the damper reduces outside air intake to the minimum required by building codes. [59] Air side economizers can also be used to pre-cool buildings at night.

Energy Savings Estimates: Because 33% of the energy used by small and medium commercial buildings is dedicated to HVAC units, and most rely on uncoordinated controls, economizers have shown immediate energy cost savings in the range of $1.35 per square foot. [60]

Key Considerations for Attractiveness: While economizers provide immediate overall energy savings at little upfront cost to the building owner, its effect on demand rates is minimized due to the fact that peak power charges are most severe in the summer months when economizers would see as much use. In addition, when the outside air temperature drops below 62 degrees F, a frequent occurrence given the local climate conditions of CWD's portfolio, the building still requires cooling because of lighting, computers and to meet the comfort needs of occupants. [61] However, economizers have been known to break down quickly where it will lose its controllability and thus risk tenant complaints of comfort.

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[58] Environmental Defense Fund. (2010). *Climate Core Handbook*. https://www.edf.org/sites/default/files/11048_climate-corps-handbook.pdf
[59] US EPA, "Energy Star Buiulding Upgrade Manual: Air Distribution Systems," October 2008. www.energystar.gov/index.cfm?c=business.epa_bUm_CH8_airdistsystems#ss_8_4_5
[60] EIA, 2003
[61] Urban Green Council (2009) *Cost of Green in NYC* (New York: Urban Green Council)

Similar to VFDs, the energy savings potential can diminish over time due to lack of oversight, commissioning and recommissioning.[62]

Old Boiler Replacement

Overview of how it works: Many properties within CWD's portfolio utilize a hydronic heating system that holding boiler inefficiencies caused by uncontrolled operation cycles. The greatest cause of energy waste in hydronic heating system is the mismatch between the amount of heat hat the building loses and the amount of heat that the boiler delivers. These deficiencies cause historic buildings prone to deteriorated pumps and motors. Old boiler replacement with thermal process control can maximize efficiencies through determining real time heating requirements of the building.

Energy Savings Estimates: Individual case studies of historic sites who have chose old boiler replacement over their current hydronic heating system have shown energy savings potential in the range of 40% - 60%. [63] This is maximized through the new boiler's ability to modulate boiler output to make up only the amount of heat that is being lost.

*Key Considerations for Attractiveness:*There are no applicable rebates within CWD's portfolio to replace its hydronic heating system to high efficiency boiler with thermal process control. In addition, the price premium of such an investment was the highest among technologies compared and in the range of $25-40 per square foot of the building. [64]

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[62] Morris, P. *The Cost of Green Revisited: Reexamining the feasibility and cost impact of sustainable design in the light of increased market adoption*. Journal Langdon. July 2007. http://global.ctbuh.org/resources/papers/download/1242-cost-of-green-revisited-reexamining-the-feasability-and-cost-impact-of-sustainable-design-in-the-light-of-increased-market-adoption.pdf

[63] Urban Land Institute: *Retrofitting Office Buildings to Be Green and Energy-Efficient*. (2009). Independent Publishers Group.

[64] Urban Land Institute: *Retrofitting Office Buildings to Be Green and Energy-Efficient*. (2009). Independent Publishers Group.

Exhibit 5: U.S. Commercial Real Estate Participants of ENERGY STAR Portfolio Manager Benchmarking Tool

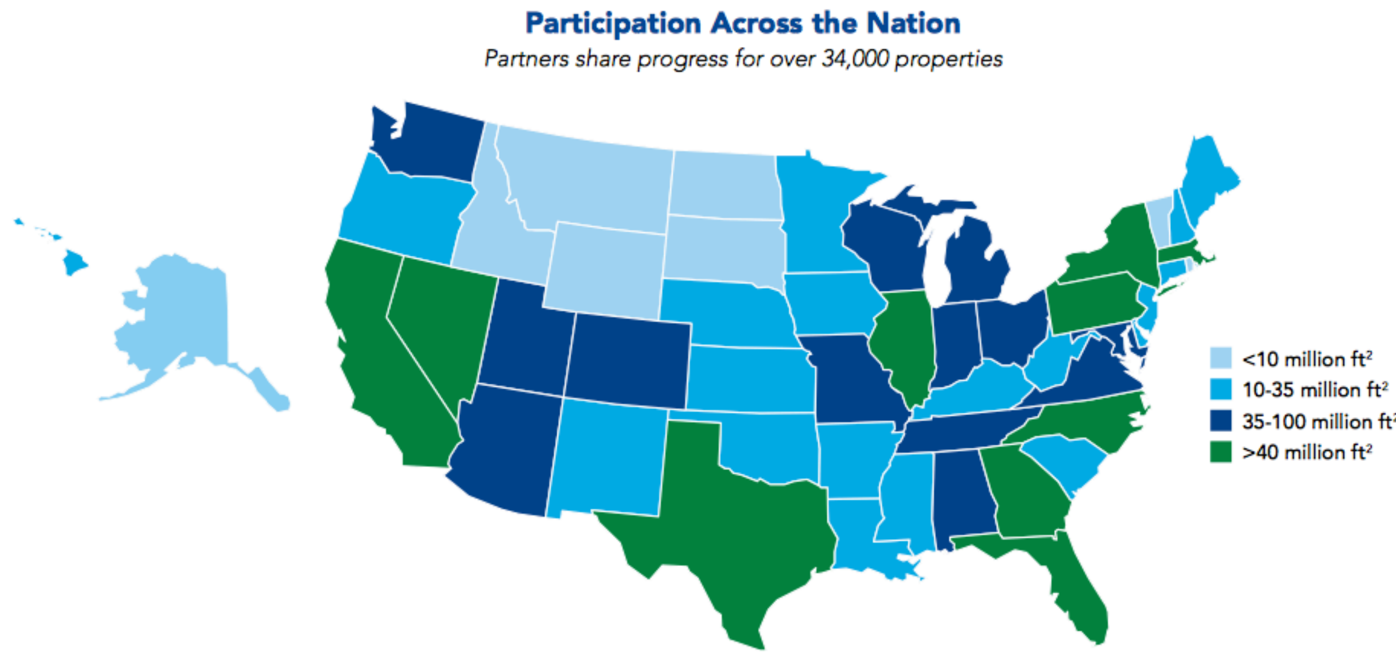

Exhibit 6: AHP Calculations

Upfront Cost

Upfront Cost	LED Lighting	Geothermal	Building Envelope	Cool Roof	Variable Frequency Drives	Variable Air Volume	Building Management System	Occupancy Sensors	HVAC Economizer	Old Boiler Replacement	
LED Lighting	1.00	3.00	0.20	3.00	0.14	3.00	0.33	0.14	0.33	5.00	16.152
Geothermal	0.33	1.00	0.14	1.00	0.20	0.33	0.20	0.11	0.20	3.00	6.521
Building Envelope	5.00	7.00	1.00	7.00	3.00	5.00	3.00	0.33	3.00	9.00	43.333
Cool Roof	0.33	1.00	0.14	1.00	0.20	0.33	0.20	0.11	0.20	3.00	6.521
Variable Frequency Drives	7.00	5.00	0.33	5.00	1.00	5.00	5.00	0.14	3.00	7.00	38.476
Variable Air Volume	0.33	3.00	0.20	3.00	0.20	1.00	0.20	0.14	0.20	5.00	13.276
Building Management System	3.00	5.00	0.33	5.00	0.20	5.00	1.00	0.33	3.00	7.00	29.867
Occupancy Sensors	7.00	9.00	3.00	9.00	7.00	7.00	3.00	1.00	5.00	9.00	60.000
HVAC Economizer	3.00	5.00	0.33	5.00	0.33	5.00	0.33	0.20	1.00	9.00	29.200
Old Boiler Replacement	0.20	0.33	0.11	0.33	0.14	0.20	0.14	0.11	0.11	1.00	2.686
											0.000
Total	27.20	39.33	5.80	39.33	12.42	31.87	13.41	2.63	16.04	58.00	246.031

Normalized Matrix

Upfront Cost	LED Lighting	Geothermal	Building Envelope	Cool Roof	Variable Frequency Drives	Variable Air Volume	Building Management System	Occupancy Sensors	HVAC Economizer	Old Boiler Replacement	Average Criteria Weights (W)
LED Lighting	0.037	0.076	0.035	0.076	0.012	0.094	0.025	0.054	0.021	0.086	0.052
Geothermal	0.012	0.025	0.025	0.025	0.016	0.010	0.015	0.042	0.012	0.052	0.024
Building Envelope	0.184	0.178	0.173	0.178	0.242	0.157	0.224	0.127	0.187	0.155	0.180
Cool Roof	0.012	0.025	0.025	0.025	0.016	0.010	0.015	0.042	0.012	0.052	0.024
Variable Frequency Drives	0.257	0.127	0.058	0.127	0.081	0.157	0.373	0.054	0.187	0.121	0.154
Variable Air Volume	0.012	0.076	0.035	0.076	0.016	0.031	0.015	0.054	0.012	0.086	0.041
Building Management System	0.110	0.127	0.058	0.127	0.016	0.157	0.075	0.127	0.187	0.121	0.110
Occupancy Sensors	0.257	0.229	0.518	0.229	0.564	0.220	0.224	0.380	0.312	0.155	0.309
HVAC Economizer	0.110	0.127	0.058	0.127	0.027	0.157	0.025	0.076	0.062	0.155	0.092
Old Boiler Replacement	0.007	0.008	0.019	0.008	0.012	0.006	0.011	0.042	0.007	0.017	0.014
Total	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	

Consistancy Score

Upfront Cost	LED Lighting	Geothermal	Building Envelope	Cool Roof	Variable Frequency Drives	Variable Air Volume	Building Management System	Occupancy Sensors	HVAC Economizer	Old Boiler Replacement	Sum	Sum/Weight
LED Lighting	0.052	0.071	0.036	0.071	0.022	0.124	0.037	0.044	0.031	0.069	0.56	10.79
Geothermal	0.017	0.024	0.026	0.024	0.031	0.014	0.022	0.034	0.018	0.042	0.25	10.65
Building Envelope	0.258	0.165	0.180	0.165	0.462	0.207	0.331	0.103	0.277	0.125	2.27	12.61
Cool Roof	0.017	0.024	0.026	0.024	0.031	0.014	0.022	0.034	0.018	0.042	0.25	10.65
Variable Frequency Drives	0.361	0.118	0.060	0.118	0.154	0.207	0.552	0.044	0.277	0.097	1.99	12.90
Variable Air Volume	0.017	0.071	0.036	0.071	0.031	0.041	0.022	0.044	0.018	0.069	0.42	10.15
Building Management System	0.155	0.118	0.060	0.118	0.031	0.207	0.110	0.103	0.277	0.097	1.28	11.56
Occupancy Sensors	0.361	0.212	0.541	0.212	1.079	0.290	0.331	0.309	0.462	0.125	3.92	12.71
HVAC Economizer	0.155	0.118	0.060	0.118	0.051	0.207	0.037	0.062	0.092	0.125	1.02	11.09
Old Boiler Replacement	0.010	0.008	0.020	0.008	0.022	0.008	0.016	0.034	0.010	0.014	0.15	10.88

Technology Count	10
Lamda Max	11.40
Consistancy Index	0.155
Random Index (n=10)	1.49
Consistancy Ratio	0.104

Payback Period

Payback Period	LED Lighting	Geothermal	Building Envelope	Cool Roof	Variable Frequency Drives	Variable Air Volume	Building Management System	Occupancy Sensors	HVAC Economizer	Old Boiler Replacement	
LED Lighting	1	7	5	7	0.14286	0.33333	0.33333	0.33333	0.14286	5	26.28571
Geothermal	0.142857143	1	0.2	1	0.11111	0.14286	0.14286	0.14286	0.11111	1	3.993657143
Building Envelope	0.2	5	1	7	0.14286	0.2	0.33333	0.2	0.14286	3	17.21905
Cool Roof	0.142857143	1	0.142857143	1	0.11111	0.14286	0.14286	0.11111	0.11111	1	3.904764286
Variable Frequency Drives	6.999860003	9.000090001	6.999860003	9.000090001	1	3	5	3	1	9	53.99990001
Variable Air Volume	3.00003	6.999860003	5	6.999860003	0.333333333	1	3	3	0.33333	7	36.66641334
Building Management System	3.00003	6.999860003	3.00003	6.999860003	0.2	0.333333333	1	0.33333	0.33333	7	29.19977334
Occupancy Sensors	3.00003	6.999860003	5	9.000090001	0.333333333	0.333333333	3.00003	1	0.33333	9	38.00000667
HVAC Economizer	6.999860003	9.000090001	6.999860003	9.000090001	1	3.00003	3.00003	3.00003	1	9	51.99999001
Old Boiler Replacement	0.2	1	0.333333333	1	0.111111111	0.142857143	0.142857143	0.111111111	0.111111111	1	4.152380952
Total	24.68552429	53.99976001	33.67594048	57.99999001	3.485717778	8.62860381	16.09529714	11.23177111	3.619041111	52	265.4216457

Normalized Matrix

Payback Period	LED Lighting	Geothermal	Building Envelope	Cool Roof	Variable Frequency Drives	Variable Air Volume	Building Management System	Occupancy Sensors	HVAC Economizer	Old Boiler Replacement	Average Criteria Weights (W)
LED Lighting	0.041	0.130	0.148	0.121	0.041	0.039	0.021	0.030	0.039	0.096	0.070
Geothermal	0.006	0.019	0.006	0.017	0.032	0.017	0.009	0.013	0.031	0.019	0.017
Building Envelope	0.008	0.093	0.030	0.121	0.041	0.023	0.021	0.018	0.039	0.058	0.045
Cool Roof	0.006	0.019	0.004	0.017	0.032	0.017	0.009	0.010	0.031	0.019	0.016
Variable Frequency Drives	0.284	0.167	0.208	0.155	0.287	0.348	0.311	0.267	0.276	0.173	0.247
Variable Air Volume	0.122	0.130	0.148	0.121	0.096	0.116	0.186	0.267	0.092	0.135	0.141
Building Management System	0.122	0.130	0.089	0.121	0.057	0.039	0.062	0.030	0.092	0.135	0.088
Occupancy Sensors	0.122	0.130	0.148	0.155	0.096	0.039	0.186	0.089	0.092	0.173	0.123
HVAC Economizer	0.284	0.167	0.208	0.155	0.287	0.348	0.186	0.267	0.276	0.173	0.235
Old Boiler Replacement	0.008	0.019	0.010	0.017	0.032	0.017	0.009	0.010	0.031	0.019	0.017
Total	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	

Consistancy Score

Upfront Cost	LED Lighting	Geothermal	Building Envelope	Cool Roof	Variable Frequency Drives	Variable Air Volume	Building Management System	Occupancy Sensors	HVAC Economizer	Old Boiler Replacement	Sum	Sum/Weight
LED Lighting	0.070	0.117	0.225	0.114	0.035	0.047	0.029	0.041	0.034	0.085	0.80	11.33
Geothermal	0.010	0.017	0.009	0.016	0.027	0.020	0.013	0.018	0.026	0.017	0.17	10.34
Building Envelope	0.014	0.084	0.045	0.114	0.035	0.028	0.029	0.025	0.034	0.051	0.46	10.18
Cool Roof	0.010	0.017	0.006	0.016	0.027	0.020	0.013	0.014	0.026	0.017	0.17	10.23
Variable Frequency Drives	0.493	0.151	0.316	0.147	0.247	0.424	0.438	0.369	0.235	0.154	2.97	12.01
Variable Air Volume	0.211	0.117	0.225	0.114	0.082	0.141	0.263	0.369	0.078	0.120	1.72	12.19
Building Management System	0.211	0.117	0.135	0.114	0.049	0.047	0.088	0.041	0.078	0.120	1.00	11.44
Occupancy Sensors	0.211	0.117	0.225	0.147	0.082	0.047	0.263	0.123	0.078	0.154	1.45	11.78
HVAC Economizer	0.493	0.151	0.316	0.147	0.247	0.424	0.263	0.369	0.235	0.154	2.80	11.90
Old Boiler Replacement	0.014	0.017	0.015	0.016	0.027	0.020	0.013	0.014	0.026	0.017	0.18	10.49

Technology Count	10
Lamda Max	11.19
Consistancy Index	0.132
Random Index (n=10)	1.49
Consistancy Ratio	0.089

Time Savings

Time Saving	LED Lighting	Geothermal	Building Envelope	Cool Roof	Variable Frequency Drives	Variable Air Volume	Building Management System	Occupancy Sensors	HVAC Economizer	Old Boiler Replacement	
LED Lighting	1	0.333333	9	7	5	9	0.333333	5	7	0.333333	43.999999
Geothermal	3.000003	1	9	7	5	9	0.333333	5	5	3	47.333336
Building Envelope	0.111111111	0.111111111	1	0.333333	0.2	1	0.111111	0.333333	0.333333	0.111111	3.644443222
Cool Roof	0.142857143	0.142857143	3.000003	1	0.333333	3	0.111111	0.333333	0.333333	0.111111	8.507938286
Variable Frequency Drives	0.2	0.2	5	3.000003	1	5	0.142857	3	5	0.142857	22.685717
Variable Air Volume	0.111111111	0.111111111	1	0.333333333	0.2	1	0.111111	0.333333	0.333333	0.111111	3.644443556
Building Management System	3.000003	3.000003	9.000009	9.000009	7.000007	9.000009	1	7	9	3	60.00004
Occupancy Sensors	0.2	0.2	3.000003	3.000003	0.333333333	3.000003	0.142857143	1	5	0.142857	16.01905648
HVAC Economizer	0.142857143	0.2	3.000003	3.000003	0.2	3.000003	0.111111111	0.2	1	0.111111	10.96508825
Old Boiler Replacement	3.000003	0.333333333	9.000009	9.000009	7.000007	9.000009	0.333333333	7.000007	9.000009	1	54.66671967
Total	10.90794551	5.631748698	52.000027	42.66669333	26.26668033	52.000024	2.730157587	29.200006	42.000008	8.063491	271.4667815

Normalized Matrix

Time Saving	LED Lighting	Geothermal	Building Envelope	Cool Roof	Variable Frequency Drives	Variable Air Volume	Building Management System	Occupancy Sensors	HVAC Economizer	Old Boiler Replacement	Average Criteria Weights (W)
LED Lighting	0.092	0.059	0.173	0.164	0.190	0.173	0.122	0.171	0.167	0.041	0.135
Geothermal	0.275	0.178	0.173	0.164	0.190	0.173	0.122	0.171	0.119	0.372	0.194
Building Envelope	0.010	0.020	0.019	0.008	0.008	0.019	0.041	0.011	0.008	0.014	0.016
Cool Roof	0.013	0.025	0.058	0.023	0.013	0.058	0.041	0.011	0.008	0.014	0.026
Variable Frequency Drives	0.018	0.036	0.096	0.070	0.038	0.096	0.052	0.103	0.119	0.018	0.065
Variable Air Volume	0.010	0.020	0.019	0.008	0.008	0.019	0.041	0.011	0.008	0.014	0.016
Building Management System	0.275	0.533	0.173	0.211	0.266	0.173	0.366	0.240	0.214	0.372	0.282
Occupancy Sensors	0.018	0.036	0.058	0.070	0.013	0.058	0.052	0.034	0.119	0.018	0.048
HVAC Economizer	0.013	0.036	0.058	0.070	0.008	0.058	0.041	0.007	0.024	0.014	0.033
Old Boiler Replacement	0.275	0.059	0.173	0.211	0.266	0.173	0.122	0.240	0.214	0.124	0.186
Total	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	

Consistancy Score

Time Saving	LED Lighting	Geothermal	Building Envelope	Cool Roof	Variable Frequency Drives	Variable Air Volume	Building Management System	Occupancy Sensors	HVAC Economizer	Old Boiler Replacement	Sum	Sum/Weight
LED Lighting	0.135	0.065	0.142	0.185	0.323	0.142	0.094	0.238	0.229	0.062	1.61	11.93
Geothermal	0.406	0.194	0.142	0.185	0.323	0.142	0.094	0.238	0.164	0.557	2.44	12.61
Building Envelope	0.015	0.022	0.016	0.009	0.013	0.016	0.031	0.016	0.011	0.021	0.17	10.69
Cool Roof	0.019	0.028	0.047	0.026	0.022	0.047	0.031	0.016	0.011	0.021	0.27	10.17
Variable Frequency Drives	0.027	0.039	0.079	0.079	0.065	0.079	0.040	0.143	0.164	0.027	0.74	11.45
Variable Air Volume	0.015	0.022	0.016	0.009	0.013	0.016	0.031	0.016	0.011	0.021	0.17	10.69
Building Management System	0.406	0.581	0.142	0.237	0.452	0.142	0.282	0.333	0.294	0.557	3.43	12.14
Occupancy Sensors	0.027	0.039	0.047	0.079	0.022	0.047	0.040	0.048	0.164	0.027	0.54	11.33
HVAC Economizer	0.019	0.039	0.047	0.079	0.013	0.047	0.031	0.010	0.033	0.021	0.34	10.36
Old Boiler Replacement	0.406	0.065	0.142	0.237	0.452	0.142	0.094	0.333	0.294	0.186	2.35	12.65

Technology Count	10
Lamda Max	11.41
Consistancy Index	0.156
Random Index (n=10)	1.49
Consistancy Ratio	0.105

Exhibit 7: Property Specific Score Details

Questions	Measurement	Criteria	LED Lighting	Geothermal	Building Envelop(i.e.Wea ther-ization)	Cool Roof	Variable Frequency Drives	Variable Air Volume	Building Management System	Building Sensors (i.e.Occupancy Sensors)	HVAC Economizer	Old Boiler Replacement
Type of Lease Structure	Gross Mod Gross Triple Net	High: Gross Med: Mod Gross Low: Triple Net	If Gross: High If Mod Gros: Med If Triple Net : Low	If Gross: High If Mod Gros: Med	If Gross: High If Mod Gros: Med	If Gross: High If Mod Gros: Med	If Gross: High If Mod Gros: Med	If Gross: High If Mod Gros: Med	If Gross: High If Mod Gros: Med	If Gross: High If Mod Gros: Med If Triple Net : Low	If Gross: High If Mod Gros: Med	If Gross: High If Mod Gros: Med
	Mod Gross		9	9	9	9	9	9	9	9	9	9
Amount of Common Space (Common SQFT/Total SQFT)	Above Average (40-50%) Average (20-50%) Below Average (Less than 20%)	High: (Above) Technology installed IN common space Med: (Above) Technology shares energy savings building-wide (Average) Technology installed IN common space Low: (Average) Technology shares energy	If Above: High If Average: Med If Below: Low	If Above: Med If Average: Low If Below: NA	If Above: Med If Average: Low If Below: NA	If Above: Med If Average: Low If Below: NA	If Above: Med If Average: Low If Below: NA	If Above: Med If Average: Low If Below: NA	If Above: High If Average: Med If Below: Low	If Above: High If Average: Med If Below: Low	If Above: High If Average: Med If Below: Low	If Above: Med If Average: Low If Below: NA
	Below Average		0	0	0	0	0	0	0	0	0	0
Existing HVAC is inefficient but will be kept	Y/N	High: Improves the functionality of the HVAC system Med: Reduces heating and cooling demand with no effect on HVAC functionality Low: Would require new HVAC system, or	If Yes: Low If No: NA	If Yes: Low If No: NA	If Yes: Med If No: NA	If Yes: Med If No: NA	If Yes: High If No: NA	If Yes: High If No: NA	If Yes: Med If No: NA	If Yes: Med If No: NA	If Yes: High If No: NA	If Yes: Low If No: NA
	No		0	0	0	0	0	0	0	0	0	0
HVAC Nearing End of Life	Yes:System over 20 year old/planning to replace within 5 years No:System has at least 5 years of useabe life	High: (Yes) Viable HVAC replacement Med: (Yes) Reduces Heating and Cooling loads with no effect on HVAC functionality Low: (No) Applicable to HVAC even with replacement pending (No) Requirees HVAC replacement	If Yes: NA If No: NA	If Yes: High If No: Low	If Yes: Med If No: Low	If Yes: Med If No: Low	If Yes: Med If No: Low	If Yes: Med If No: Low	If Yes: Med If No: Low	If Yes: NA If No: NA	If Yes: Med If No: Low	If Yes: High If No: Low
	No		0	1	1	1	1	1	1	0	1	1
Do you have any of the following lighting: Incandescent, halogen, standard metal halide, metal halide, T-	Y/N	High: Lighting replacement Med: Helps optimimize lighting useage NA: Not related to lights	If Yes: High If No: NA	If Yes: NA If No: NA	If Yes: NA If No: NA	If Yes: NA If No: NA	If Yes: NA If No: NA	If Yes: NA If No: NA	If Yes: NA If No: NA	If Yes: Med If No: NA	If Yes: NA If No: NA	If Yes: NA If No: NA
	Yes		9	0	0	0	0	0	0	5	0	0
Major renovation in the last 10 years?	Y/N	High: (No) Technology requires major rennovation Med: (No) Technology requires only modertate rennovation (Yes/No) Technology does not require property renovation Low: (Yes) Technology requires only	If Yes: Low If No: Med	If Yes: NA If No: High	If Yes: Low If No: Med	If Yes: Low If No: Med	If Yes: Med If No: Med	If Yes: Med If No: Med	If Yes: Low If No: Med	If Yes: Low If No: Med	If Yes: Med If No: Med	If Yes: NA If No: High
	Yes		1	0	1	1	5	5	1	1	5	0
Latest commissioning within 5 years?	Y/N	High: (No) Condition of technology can diminish significantly and unpredictably within 5 years Low: (No) Technology condition changes slowly and predictably or technology unlikely to have been recommended over 5	If Yes: NA If No: Low	If Yes: NA If No: Low	If Yes: NA If No: High	If Yes: NA If No: Low	If Yes: NA If No: High	If Yes: NA If No: High	If Yes: NA If No: Low	If Yes: NA If No: Low	If Yes: NA If No: High	If Yes: NA If No: Low
	No		1	1	9	1	9	9	1	1	9	1
Demand Rate accounts for over 20%-55% of monthly utility bill?	Y/N	High: (Yes) Technologly enhances data capturing, energy optimization and/or shows where within building high consumption is occuring (i.e. hotspots) Low: (Yes) Technology reduces energy	If Yes: Low If No: NA	If Yes: Low If No: NA	If Yes: High If No: NA	If Yes: Low If No: NA	If Yes: High If No: NA	If Yes: High If No: NA	If Yes: High If No: NA	If Yes: High If No: NA	If Yes: High If No: NA	If Yes: Low If No: NA
	Yes		1	1	9	1	9	9	9	9	9	1
Roof Nearing Replacement	Y/N	High: (Yes) Techology is a roof Low: (No) Technology applies to an existing roof	If Yes: NA If No: NA	If Yes: NA If No: NA	If Yes: NA If No: NA	If Yes: High If No: Low	If Yes: NA If No: NA	If Yes: NA If No: NA	If Yes: NA If No: NA	If Yes: NA If No: NA	If Yes: NA If No: NA	If Yes: NA If No: NA
	No		0	0	0	1	0	0	0	0	0	0
		Total	21	12	29	14	33	33	21	25	33	12
		Normalized Score	9%	5%	12%	6%	14%	14%	9%	11%	14%	5%

Exhibit 8: Decision-Aiding Tool Tutorial

Step One: Go to the "Analysis Inputs" tab. All the cells in yellow require an input
Step Two: Cells B2-B11 all relate to a specific property. The potential inputs can be found in column C and must be input exactly as shown there

Question	Answer	Possible Answers (*must be exact)*	Notes
Property Name	CWD	Any	
What is the majority lease sturcture?	Mod Gross	Gross, Mod Gross, Triple Net	
How does the percentage of common space to total space compare with other buildings?	Below Average	Above Average, Average, Below Average	Above Average (40-50%) Average (20-50%) Below Average (Less than 20%)
Is the existing HVAC system inefficient but not slotted for replacement	No	Yes or No	
Is the HVAC system nearing its end of life?	No	Yes or No	replace within 5 years No:System has at least 5 years of useabe life
Does the building have any of the following lighting: incandescent, halogen, standard metal halide, metal halide, T-12, mercury vapor?	Yes	Yes or No	
Has there been a major renovation within the last 10	Yes	Yes or No	
Has the building had a commissioning in the last 5	No	Yes or No	
Does demand rate account for over 20%-55% of monthly utility bill?	Yes	Yes or No	
Is the roof nearing replacement?	No	Yes or No	

Step Three: In cells B15-B17 you must enter your desired weights for the potential investment criteria. Be sure that the weights sum to 100%

Criteria Weights (must sum to 100%)	
Upfront Cost	40%
Payback Period	30%
Time Savings	30%
Total	100%

Step Four: You have the option to include a multiplier based on how the technologies affect demand rate. If you decide to include it you can also set the magnitude of the multiplier (High, Medium, Low). Remember to use the exact inputs listed in column C.

Factor in Effect on Demand Rate	Yes	Yes or No
Importance of Demand Rate Impact	Medium	High, Medium, Low

Step Five: Next go to the "Summary Slide". There you will find the scores for each technology and a graph of the outputs. If you would like them in rank order highlight cells E6-16 and sort them from largest to smallest.