What's Left? How to Leverage Benchmarking to Find Diamonds in the Rough

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ABSTRACT

Utility companies have made tremendous strides in enticing building owners to improve the performance of their buildings and reduce energy consumption. The problem that many are facing today is that so much has been done it is difficult to figure out where to invest next. The same building owners keep coming back to the well, and the savings opportunities at their sites are shrinking. Conversely, some owners are convinced that the opportunities for improvement aren't worth the investment of time and resources.

Access to data isn't the challenge; utility companies and building owners are overwhelmed with data. What is needed is a way to analyze the data to find buildings with potential for improvement that justifies the investment. Software capabilities and computing power continue to explode, and we now have the tools available to quickly and accurately benchmark commercial buildings. This paper discusses the B3 Benchmarking platform, which makes it easy for utilities and their customers to quickly understand where the greatest potentials for energy improvement—and maximum return on investment—are. Using monthly utility billing data and some basic information about commercial buildings, B3 Benchmarking creates simple reports in order for stakeholders to systematically: monitor building energy performance against relevant benchmarks; determine the best candidates for improvement and investment; prioritize projects; and verify project effectiveness.

Learn how utility companies in the Northeast are using the B3 Benchmarking platform to identify high savings potential opportunities out of building portfolios, and how they can use the information to make meaningful and impactful changes to their buildings and provide increased savings to both the utility and their customers.

Introduction

When looking at the entire building stock, the largest portion of energy savings potential is in upgrades to existing buildings. Over 80% of the commercial building stock in the U.S. is more than 15 years old (CBECS 2012). Utility companies have implemented numerous programs during the last decade to motivate building owners to improve the energy performance of their buildings. These programs range from design assistance and new construction programs to direct installing measures, auditing, and recommissioning.

Owners and portfolio account managers of existing buildings face a number of pressures to reduce energy consumption from government mandates and commitments to their monthly energy expenses. Strategic capital planning for energy improvements is vital due to the limited resources often available; however, the vast and diverse existing building stock coupled with an overwhelming amount of data and ideas makes it difficult to prioritize and predict expected returns on investment.

B3 Benchmarking

The B3 Benchmarking platform was created in 2004 as a tool for effectively evaluating an entire building portfolio for energy efficiency and savings potential. The program was funded by the Minnesota Departments of Commerce and Administration in response to state legislation passed in 2001 requiring all public buildings to track energy usage for the purpose of establishing energy efficiency benchmarks and conservation goals (MN Session Laws 2002). Over the past decade, B3 Benchmarking has amassed a database of more than 12,000 buildings in 5 states, 22 state agencies, 410 cities, 60 college campuses and over 200 school districts.

B3 Benchmarking couples monthly utility data and basic building information with real-time energy simulations, allowing users to:

- compare building energy performance against relevant peers;
- compare building energy performance against current local energy codes;
- identify buildings with the greatest savings potential for improvement and investment;
- prioritize and align energy improvement projects with capital planning initiatives;
- verify improvement project effectiveness through ongoing performance monitoring with weather normalization to compare a building with itself over time.

B3 Benchmarking calculates expected energy consumption and provides peer comparison for each building based on location, size, space usage and specific operational schedules.

There are several commercial and public software tools that allow users to track their energy consumption, analyze their utility bills, and benchmark compared to peer buildings. The most widely used is ENERGY STAR® Portfolio Manager® (ESPM), created by the US Environmental Protection Agency. Some of these tools use energy consumption data at an hour or less granularity to analyze energy consumption. This can be a challenge for buildings without interval meters, or smart meters. B3, like Portfolio Manager, only requires monthly energy consumption. The main difference between the two tools is that Portfolio Manager compares to a statistical model of buildings based on the Commercial Building Energy Consumption Survey, and B3 benchmarks to each building to the state energy code. Because a statistically significant sample size of actual buildings across the country needs to be surveyed for each building type that can be scored, there are only select building types available in Portfolio Manager. The B3 approach, by using the prevailing state energy code is more easily extended into additional building types. In the 12,000 buildings in B3, 98% of them had a B3 Benchmark for that building, and only 20% of them were eligible to receive an Energy Star Portfolio Manager Score.

The B3 Benchmarking platform allows users to continuously monitor their Benchmark ratings and peer ratings, and it also provides interoperability with ENERGY STAR® Portfolio Manager® saving the user time and money by eliminating utility data entry on both platforms. Figure 1 provides a glimpse of the B3 Benchmarking platform displaying the Benchmark rating, Peer rating, and ENERGY STAR score that is displayed when a score is available.

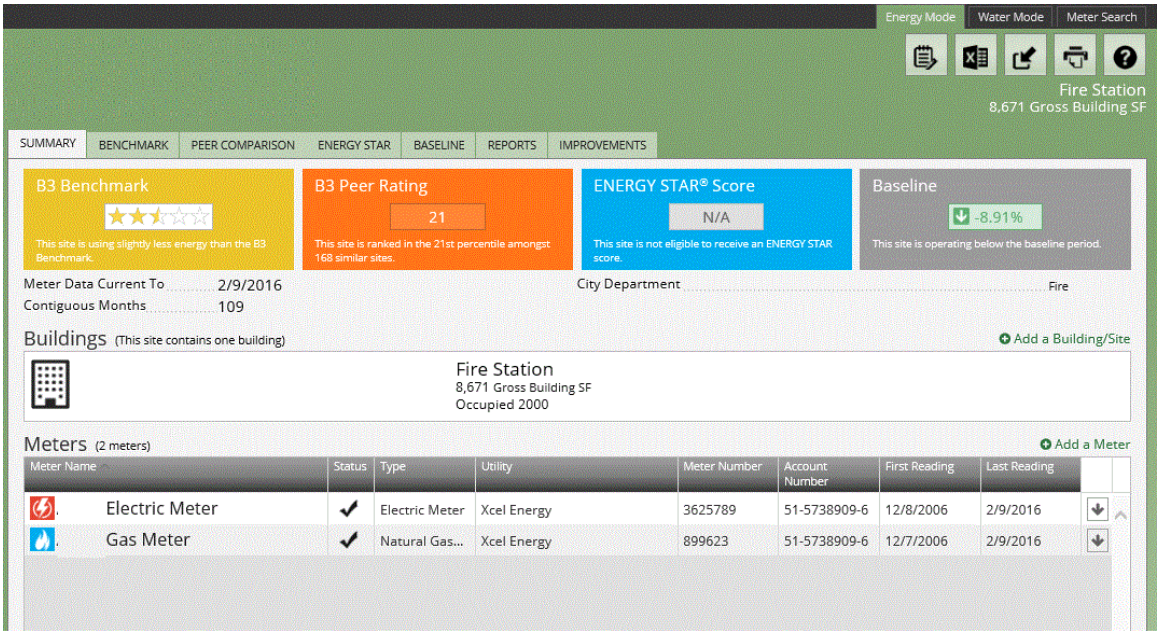

Figure 1. B3 benchmarking platform: summary. *Source*: B3 Benchmarking 2016.

Figure 1 also provides an ongoing performance tracking summary telling the user how well their building is currently performing compared to local energy code. As shown, this particular building is currently performing close to 9% better than a minimally code-compliant building (this screenshot does not show the benchmark, Figure 2 does). This information is continuously updated as new monthly utility data is available. The comparison also uses weather normalization to account for actual monthly weather data. Users can view more detailed information about their building such as monthly energy consumption by source and compare against the baseline, as shown in Figure 2. The customizable reporting features allow building owners the flexibility to view data and generate reports to serve whatever their current needs.

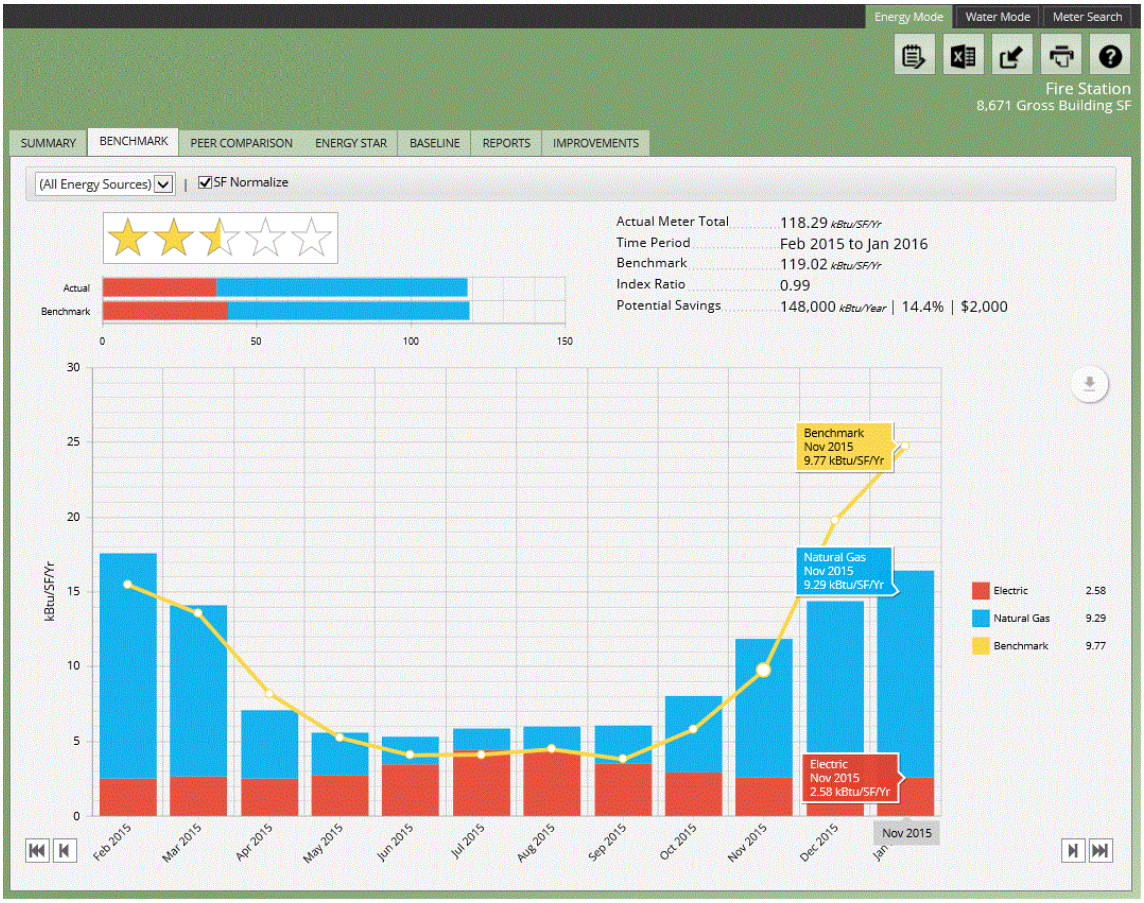

Figure 2. B3 benchmarking platform: benchmark. *Source*: B3 Benchmarking 2016.

Owners now have the technology to quickly sort through the overwhelming amount of data available to their account managers and benchmark all of their buildings. The B3 Benchmarking platform enables them to make effective decisions to maximize the return on investment (ROI) for capital improvement projects.

The value behind B3 Benchmarking is centered on its ability to avoid costly and time-consuming energy audits. Traditionally, a utility or owner would have to spend time and money auditing their entire portfolio in order to determine buildings with the highest savings potential. The consistent and objective methodology of B3 Benchmarking's data-driven approach identifies those buildings with the highest savings potential out of an entire portfolio of buildings by simply gathering basic building information, such as building type, space usage, hours, and months of use, space conditioning (heating, cooling, ventilation), building energy sources, along with monthly energy consumption data. More detailed information including occupant density, plug load density, and minimum ventilation requirements can be provided in an Advanced Benchmarking mode. This avoids costly energy audits for buildings with low savings potential and allows investment in those with the highest returns.

The benchmarking platform consistently shows that roughly 75% of the savings potential for an entire portfolio can be achieved by focusing improvement projects and capital investment on just 30% of the buildings. B3 Benchmarking has demonstrated these outcomes on several

portfolios, including a recent study at a college campus in upstate New York where 13 buildings were identified, out of the 49, that represented over 75% of the campus savings potential.

B3 Benchmarking enabled the quick identification of these 13 buildings and provided actual energy cost savings estimates through its data-driven methodology. B3 Benchmarking avoided auditing of over 960,000 square feet of the 26 buildings with low energy cost savings potential. Based on a Level I energy audit cost of $0.10 per square foot, B3 Benchmarking saved the College roughly $97,000 in auditing fees, which does not include additional administrative time associated with that process.

Once B3 Benchmarking identifies buildings with high savings potential for energy-efficient improvement projects, a building end-use analysis can then be conducted to identify what type of energy conservation measure (ECM) analysis is most beneficial to pursue; such as simple lighting retrofits, metered interval data regression, calibrated energy modeling, auditing or full recommissioning services. The end-use analysis compares expected and actual consumption for heating, cooling, lighting, plug, and fan/pump end-uses to identify ECMs with the highest return. B3 Benchmarking allows rapid distillation of the campus-wide energy profile and building portfolio into those particular buildings with the highest savings potential so that resources are not wasted in the search but are focused on the fix.

B3 Benchmarking has been successfully benchmarking building portfolios for states, cities, campuses and school districts over the past decade. Utility companies represent a new frontier for utilizing benchmarking in order to meet requirements of demand side management (DSM) programs. Utility companies are actively utilizing benchmarking to identify high energy savings opportunities out of the vast building stock within their territories, and to motivate buildings owners to increase savings to both the utility and customers. The next section discusses recent pilot programs for utility companies in the Northeast using B3 Benchmarking to motivate customers and increase energy savings.

Benchmarking Compared to Heuristics

We expect that the majority of the energy savings potential will be realized by assessing and improving the few worst performing buildings, also known as the Pareto Principle (Pareto, Page and Schwier 1971). The Pareto Principle is a common rule of thumb in business, economics, science, and software, which states that 80% of the outputs will come from only 20% of the inputs. This has important implications for addressing energy consumption of existing buildings because resources can be focused on the minority, but how do we identify the best candidates for energy savings when we know that the building with the highest energy use does not correlate to the best opportunity for improvement?

In the past, we used heuristics. Common approaches included looking at the largest buildings first, or the oldest with the expectation they must be performing poorly simply due to size or age. Sometimes we used stereotypes based on space types such as laboratory facilities or healthcare facilities. We've used total energy use and energy use intensity (EUI). We've even monitored building utility data looking for spikes in usage or other distinguishing characteristics. All of these methods may have worked well on the unique occasion, but have not provided a reliable methodology for identifying buildings with the greatest savings potential in lieu of time-consuming and expensive energy auditing.

Benchmarking with ENERGY STAR® Portfolio Manager® allows us to compare a building's energy consumption to peer buildings, normalized for hours of use, occupancy, and local climatic information. This benchmarking allows us to clearly see which buildings are

performing well compared to their peers, and which ones are consuming more energy. ESPM allows any building to track its energy consumption over time and provides a peer percentile ranking for 20-25% of the built environment. With the forthcoming release of the 2012 CBECS data and ENERGY STAR® updates expected in 2018, there will be a few additional building types added (ESPM 2016).

To supplement ESPM and provide potential savings for additional building types, the B3 Benchmarking system developed by the State of Minnesota compares the energy consumption of a building to that of a minimally code-compliant energy model of that building. This provides a savings potential and energy use ratio compared to a code-compliant building for 98% of Minnesota's public building portfolio, including state agencies, public higher education, school district, and local government buildings.

To test the commonly used heuristics, we compared each heuristic to a calculated savings potential if the building was retrofitted and commissioned to meet the Minnesota Energy Code, ASHRAE 90.1-2010, on over 12,000 existing buildings.

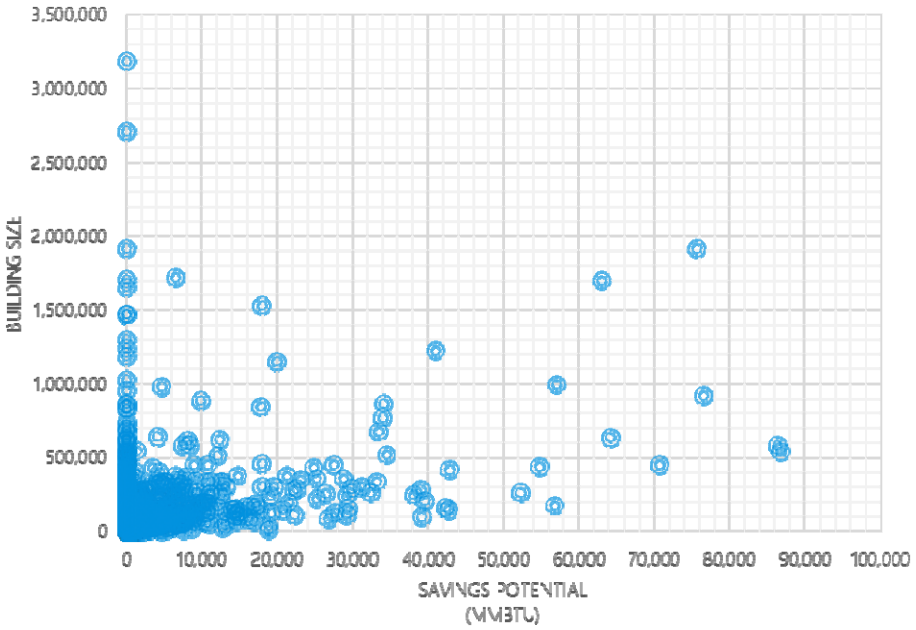

Figure 3. Building size versus savings potential.

Figure 3 reveals that there is not a high correlation between building size and savings potential. There are a number of very large buildings that are performing at or better than current energy code and have no savings potential, and yet there are small buildings that show relatively high savings potential. Also, there is a dense cluster of buildings with relatively low savings potential and then a select few with high savings potential. This is to be expected by assuming the Pareto Principle holds true, and solidifies the importance of identifying those buildings for further investigation. We speculate that the low savings potential in the largest buildings is due to their owner and operators having maintenance staff or contracts to keep them operating well.

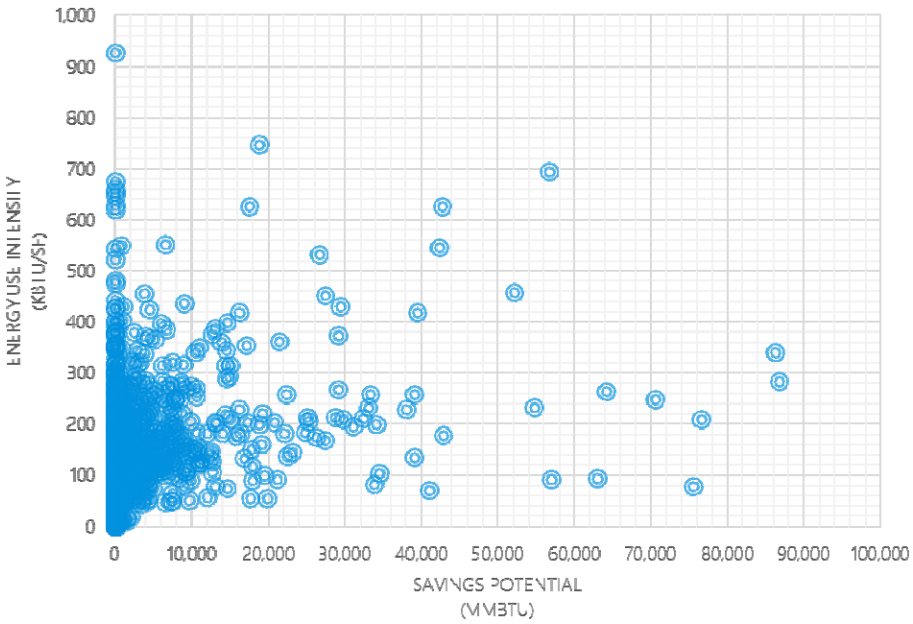

Figure 4. Energy use intensity versus savings potential.

The comparison with EUI, shown in Figure 4, does indicate that buildings operating at or below 50 kBtu/sf EUI have little to no energy savings potential. This is approximately half the energy use intensity of an average building per CBECs 2003. Interesting, even buildings slightly above 50 kBtu/sf EUI at times have significant savings potential. The analysis reveals almost no correlation between EUI and savings potential for any building above 50 EUI and also provides an important takeaway—that an 80 kBtu/sf office building can have more savings potential than a 120 kBtu/sf laboratory.

Total annual energy use was also compared against the calculated savings potential. Figure 5 graphs the same data set with total annual energy use compared to savings potential.

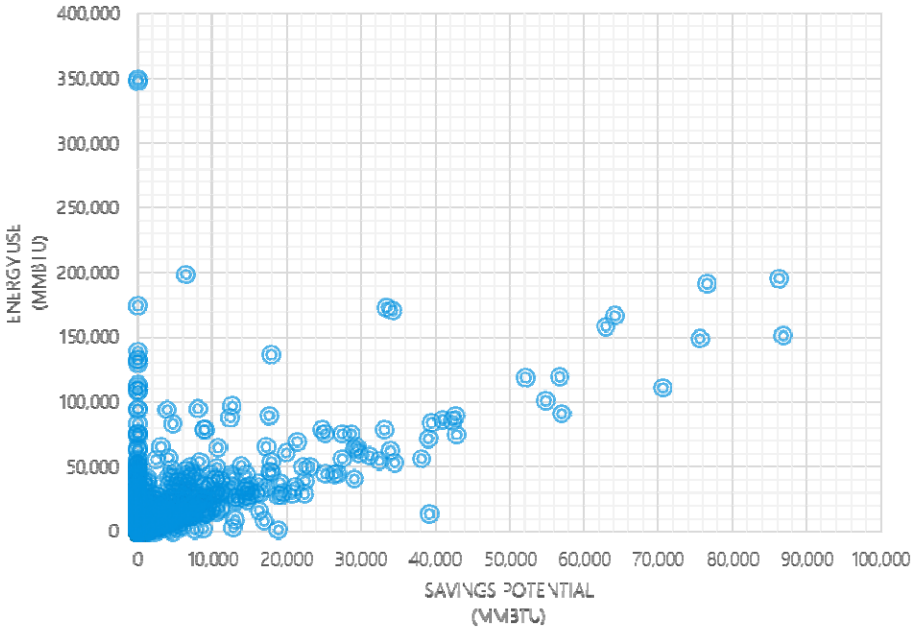

Figure 5. Total energy use score versus savings potential.

The results show an increased correlation between annual energy use and savings potential relative to the comparison with building size shown in Figure 3. This is to be expected since the goal is reducing energy and a relationship is expected between energy use and associated savings. However, calculating a correlation coefficient of determination (or R^2) reveals that only 36% of the variance in the savings potential is attributable to the total energy consumption. There is some correlation between total annual energy and identifying buildings with high savings potential, but using this as a metric will only provide 36% certainty.

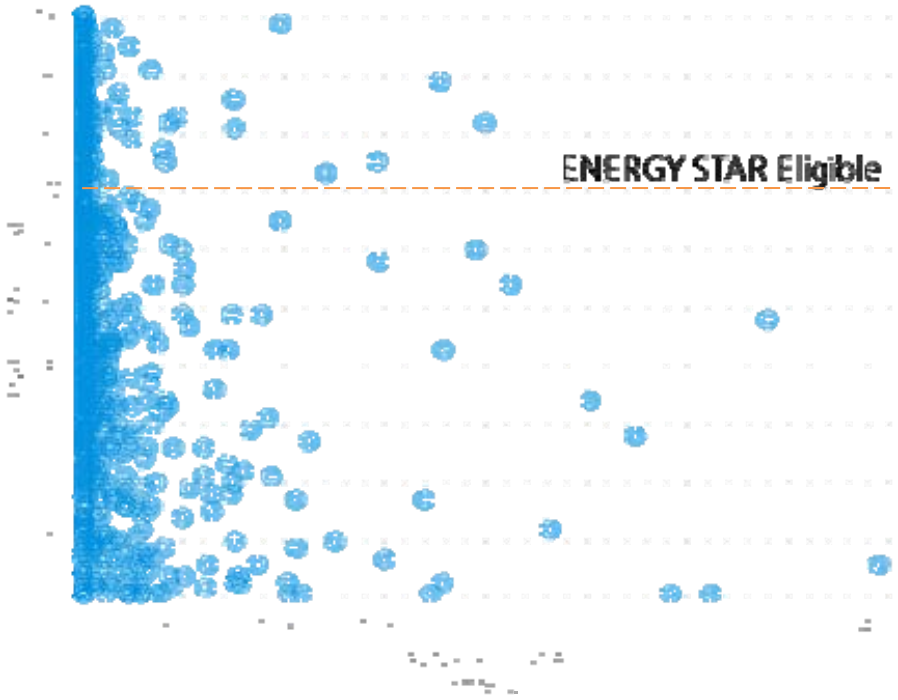

Figure 6. ENERGY STAR® score versus savings potential.

Lastly, energy savings potential was compared to ENERGY STAR® scores and is shown in Figure 6. We found that the largest savings potential had lower ESPM scores, but even buildings eligible for an ENERGY STAR® rating, those in the top 25% of their peers, often had significant energy savings potential. This is not wholly unexpected with energy codes having become significantly more stringent since 2003, when Minnesota still had ASHRAE 90.1-1989 as the State Energy Code.

Building size, annual energy use, EUI, building type, and ENERGY STAR® scores were all shown not to be reliable indicators for savings potential, revealing that a consistent methodology is still needed to rate existing buildings on performance and provide metrics for quickly identifying candidates for improvement.

The following section describes how the B3 Benchmarking platform is addressing the lack of reliable indicators for savings potential by highlighting programs in the Northeast where utility companies are using B3 Benchmarking to identify high savings potential across vast portfolios of data.

Utility Companies and B3 Benchmarking

Utility companies in the Northeast are addressing mandates such as Executive Order No. 88, which requires state buildings to reduce EUI by 20% by the year 2020 (State of New York 2012), through a number of objectives including data driven energy management and strategic planning. Part of the solution to the data driven approach was a pilot program of the B3 Benchmarking platform.

The pilot project conducted B3 Benchmarking for 36 office and higher education facilities in New York. Using utility-provided monthly energy consumption along with basic

building information, the B3 Benchmarking platform automatically developed energy simulations for each building based on the ASHRAE 90.1-2010 energy code to predict expected energy consumption and allow for comparison between actual and expected energy use by fuel type. The B3 Benchmarking platform used these results along with the Peer comparison to calculate the energy cost savings potential for all 36 buildings and identify those reporting the highest. Figure 7 ranks the 36 buildings by savings potential by energy fuel type.

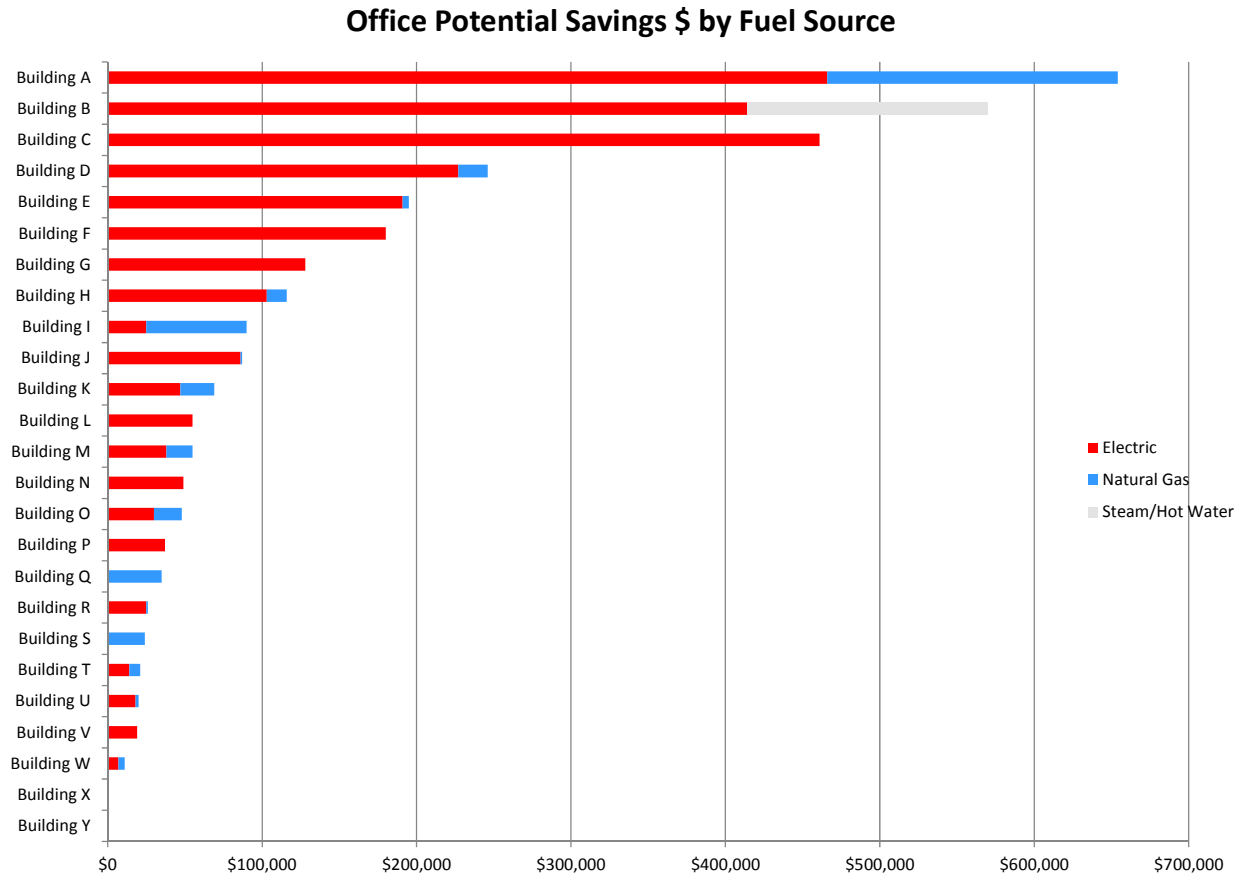

Figure 7. Pilot program savings potential by fuel type. *Source*: B3 Benchmarking 2016.

The pilot program was able to show that 75% of the savings potential for the pilot portfolio was found in only 11 buildings, which represented 33% of the buildings tested closely following the Pareto Principle. B3 Benchmarking's data-driven approach avoided expensive and time-consuming building energy audits of over 3 million square feet.

If the same ratios from the pilot program hold true for the entire state, then roughly 800 buildings of the 3,000 would contain 75% of the energy savings potential. This represents a significant reduction in investment by narrowing the focus to 800 out of the 3,000 buildings. Resources, capital investment planning, and potential incentives can focus energy and effort where the greatest potential return on investments exist.

A detailed calibrated energy model and ECM analysis were done for three of the four highest potential energy savings buildings as part of this pilot program. The B3 Benchmarking platform was able to accurately estimate the potential energy savings to within 10% of the potential savings calculated through the detailed calibrated energy model and ECM analysis.

There is another ongoing B3 Benchmarking pilot project in conjunction with utilities and a university in the Northeast in an effort to demonstrate the capabilities of the platform. The pilot project has benchmarked 16 buildings on campus to date. The buildings represent a variety of typical university building types ranging from housing and dorms, to a student union, to classrooms and more. The pilot has captured just over two million square feet of the 14.4 million campus-wide.

To date, the B3 Benchmarking pilot has identified that nine out of the 16 buildings represent 75% of the total energy cost savings potential. This pilot is still an ongoing project and we are currently investigating some of the data in more detail before finalizing and presenting results.

These results are conclusive. The B3 Benchmarking platform is enabling utility companies to quickly and efficiently identify high savings potential opportunities out of vast building portfolios. B3 Benchmarking is shown to be a consistent and reliable methodology for identifying savings potential compared to other common industry approaches such as building size, energy use, and ENERGY STAR scores. Results from the B3 Benchmarking are allowing building portfolio managers to focus efforts and resources on only the select few buildings where the high ROI is expected, prioritize their capital improvement projects, and verify improvement effectiveness.

Summary

Our ability to efficiently analyze data continues to advance and tools are now available that allow building owners and portfolio account managers to quickly and effectively distill the vast energy consumption data available into discernable and quantifiable resources. The B3 Benchmarking platform is a tool with a tested tenure for providing quick and accurate benchmarking for all buildings types making it easy to understand where greatest energy improvement potentials exist across an entire portfolio. B3 Benchmarking takes basic building information and monthly utility data to systematically monitor building performance and compare against relevant benchmarks, local codes and peers. The data-drive approach allows stakeholders to determine best candidates for energy improvement by prioritizing projects and to verify effectiveness of those investments.

B3 Benchmarking has been successfully implemented for many jurisdictions and campuses over the last decade. Utility companies are now successfully using B3 Benchmarking to motivate building owners to make meaningful decisions for energy improvements to their buildings, ultimately providing increased energy savings to both the owners and the utility. This data-driving solution is enabling focused and reliable efforts, as well as higher returns on investment for energy efficiency of the existing building.

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