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The Value of Prediction in Realizing DSM New Construction Portfolio Savings

For more than two decades, energy modeling, often as part of new construction energy design assistance programs offered by utilities around the country, has been used to assist architects and engineers during design. Recently, a team at The Weidt Group analyzed the design models of past projects in comparison to actual building performance to verify that savings predicted through utility programs are being realized. In the analysis, 12 months of metered energy use of 160 buildings—including colleges and universities, K-12 schools, office buildings, retail stores, warehouses, healthcare buildings and police and fire stations—were compared with their respective energy model at the time of construction completion. The findings: electric consumption for the overall portfolio of these 160 projects showed the meter was using four percent more electricity than the design models. For the 57 projects utilizing natural gas, meter usage was one percent less than the models over the portfolio. This analysis confirms quality energy models can be used with confidence to inform design decisions, and utilities and building owners are realizing their expected savings.

Introduction

Although use of energy modeling to inform design has become significantly more prevalent, some skepticism remains about its accuracy and, therefore, long-term value. To address this accuracy question, The Weidt Group assembled a team to analyze 160 completed buildings that have all been in operation for a minimum of two years. This group of buildings range from educational centers to warehouses.

It is well known that, during operation, individual buildings may be used differently than expected in design—from changes in space use, to occupancy and weather. This acknowledges that some buildings may use more or less than expected due to changes in occupant needs. Thus, over a portfolio of work, how close are design models to their operating buildings? To answer this question, the analysis compared metered energy consumption data to design energy model expectations, looking at the overall performance of the portfolio of buildings. The compiled statistics show variations of the portfolio within four percent, without any correction for weather or occupancy.

Analysis Values and Realized Savings

Energy modeling is best suited for comparative analysis, or assuming the value of implementing one strategy over another relative to energy code guidelines or energy savings capacity. This is what makes modeling during design so valuable, as building owners and design teams can understand the relative value of one design option versus another. Despite this, a desire often exists to compare design models to actual building performance to indicate if the comparative analyses are sound. The challenge is that factors, such as hours of operation, weather and the final as-built conditions of the building, may vary between the model and the operated building. These challenges result in differences between the model and the metered energy consumption, while still providing reasonably accurate comparative analysis between different design alternatives.

In collectively analyzing this group of projects, the value lies in the average savings over the portfolio. This means that some projects will likely be higher energy users than expected, while some are lower. This is illustrated as an example with the scatter plot below. The line indicates the average savings. Some projects are shown above the line. These projects may or may not be inefficient for many reasons, for instance a building may be utilizing more hours in the space or may have more people, which can lead to increased energy use. However, even if this is the case, they may be utilizing energy in an efficient manner. The same scenario applies to projects below the average. For example, these buildings may operate more efficiently than expected, or they may only be partially occupied, showing that many factors can affect increased or decreased energy use in a building. This is the main reason to focus on the average, as this reflects the impact on the overall utility grid.

In all the data, the key variable is building occupants' capacity to do whatever they please. There is no accurate way to factor actual occupant loads, equipment use or even the weather during design—models can only make educated assumptions. For these reasons, energy model accuracy can be questioned. However, this recent analysis shows that accuracy is achieved at a level that benefits both utility companies and their customers. In fact, over the entire portfolio of 160 buildings analyzed, the actual buildings used only four percent more electricity and one percent less natural gas than the design models predicted. Thus, when looking at a new construction utility program, for example, the design models accurately estimate the savings to the utilities grid, demonstrating that the programs are having the desired impact. Let's look at this from a more comprehensive standpoint. This study included numerous building categories, from office buildings and universities, to warehouses and healthcare buildings. The 62 K-12 schools, providing electric data, used one percent less electricity than the energy models. The 10 retail buildings used eight percent more electricity than the models. Lastly, the 26 offices used 11 percent more electricity than the models. The variations by building type are likely attributed to different users and building operators. Trusting well-built energy models allows utilities and their customers to accurately predict potential energy savings of a wide portfolio of building types.

To further bolster this point, let's look at natural gas data. Of the 57 buildings tested using natural gas, their building meters recorded one percent less than the model predicted over the portfolio. The 19 K-12 schools used seven percent more gas than the models. The six offices used two percent more gas than corresponding models.

The overall accuracy of the portfolio demonstrates that design teams and owners can provide information that accurately represents how they expect to use and operate new buildings. However, the data also shows that some building types have more variation in actual occupancy that is difficult to predict. Retail buildings, for instance, host an irregular number of customers per day. Office building tenants may work irregular hours, unlike the typical 8:00 AM to 3:00 PM schedule of the average school. Irregular schedules equal unpredictable energy usage. Most healthcare buildings run 24-hours a day, however, there is no standard to predict how many patients will visit emergency departments on any given day.

Energy modeling should first be used to inform energy efficiency strategies during the design process. Taking the time during design to understand how the building is going to be used leads to more accurate models and better savings predictions. While certain observations can be made from building type data, the aggregate effects on the grid show the true value of design models in the end. Using modeling empowers architects, engineers and building owners to invest in strategies that will have the greatest economic and environmental impacts for their particular buildings. This benefits those paying the investors, those paying the utility bills and society at large.

Data Summary

Though no investment is without risk, The American Council for an Energy Efficient Economy (ACEEE) describes energy efficiency as having the risk profile of a bond with the financial returns of the stock market.[1] This means the volatility of energy modeling is less than most investments required to construct a building.

Conclusion

This data combines a comprehensive analysis of 160 buildings of various types. Despite slight variations—often due to weather, occupant behavior and operational decisions—when considered as a portfolio, total electricity consumption fell within four percent of the models, and total natural gas consumption fell within one percent of the models. Although the primary purpose of energy modeling during design is not to predict energy bills, the data reveals that the value proposition of energy modeling extends to utilities, building owners, building tenants, energy policy makers and manufacturers. Energy modeling can, in fact, guide us in creating more energy-efficient commercial buildings.

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[1] Source: http://cleanenergyaction.org/2013/11/30/exploring-a-carbon-price-for-colorado/

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