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OPTIMIZING ENERGY USE IN EXISTING BUILDINGS

Optimizing energy use is essential in reducing energy consumption in existing buildings. Building systems, such as HVAC, lighting, and building controls, in existing buildings are typically older, this in turn presents opportunities for optimizing how energy is used.

Research by Lawrence Berkeley National Laboratory (LBNL) has found that the cost of reducing demand for energy by optimizing how energy is used is often less than half of constructing a new plant to generate the same amount of electricity. That is one reason interest in energy efficiency is increasing in the building sector. In 2014, 85-95% of building construction spending was in total major renovation/retrofits, up from 66-75% in 2009[1]. This trend is likely to continue.

Energy efficiency and sustainability has a significant impact on the long-term operating costs, social costs, and environmental cost of a building. So, how can we reduce these costs for our buildings?

1. REQUIREMENTS FOR HIGH-PERFORMANCE BUILDING RETROFIT

When building owners start to think about retrofitting existing buildings, the first step should be to define their requirements for the retrofit project. Some of these requirements may include:

- Retrofit must meet the owner's project requirements
- The building retrofit should be based on the building as a system approach, where the whole building is considered as one system
- The entire design and construction team, commissioning team, operation and maintenance staff, and owner must be part of retrofit process from the start
- Some form of acceptable energy modeling is used to estimate the energy savings associated with the energy efficiency measures
- Financial analysis of the project is based on life cycle cost analysis
- The building retrofit should include real time measurement and monitoring of key parameters of building systems and energy use
- Energy, resources, and materials are used as efficiently as possible
- Durable material that requires less maintenance and are recyclable are used
- The building systems and building are commissioned to ensure all systems are working as intended and meet the owner's requirements

[1] McGraw Hill Outlook 2011

2. Lifecycle Cost

Often, the design and construction cost of an asset represents only 20% of the asset life cycle cost, while the operations and maintenance costs, which includes energy costs, represent 80% of the life cycle cost.

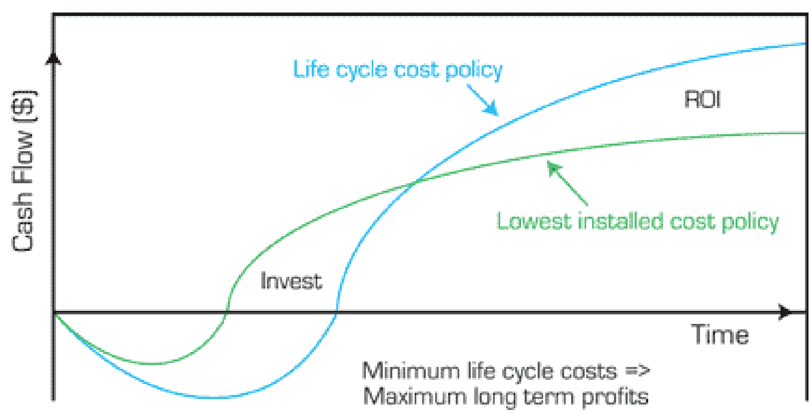
Life Cycle Cost Analysis (LCCA) allows building owners to assess the financial performance of any energy efficiency projects. LCCA takes into account the capital cost of energy efficiency improvements, as well as reduction in energy costs and maintenance costs to evaluate the cost of the project over the life of the measures. In effect, it takes into account the net expenses and the net savings over the life of the measures. For example, while LED lights may cost more, they use less electricity and have a much longer life expectancy so lights do not have to be replaced as often.

LCCA allows building owners to compare different retrofit projects or measures against each other to determine which has the lowest life cycle cost.

Capital and maintenance costs can be obtained from the equipment vendors and contractors, while energy costs can be determined using energy modeling with inputs that include equipment efficiency and input rating, operating hours, and energy prices.

Figure 1 illustrates that while a lowest installed cost policy, which is common with many projects, may have a shorter payback, over the life of the measure, a life cycle cost polity will have a higher return on investment and result in greater cash flows.

Figure 1. Life Cycle Cost vs. Lowest Capital Cost



3. Building as a System

A whole-building integrated approach is also important to improving building performance. For example, using lighter interior colours may reduce the indoor lighting needs, or using more efficient lights, which produce more light and less heat, may result less cooling load and smaller chillers. Not only does this reduce energy use, but it may also result in lower capital costs.

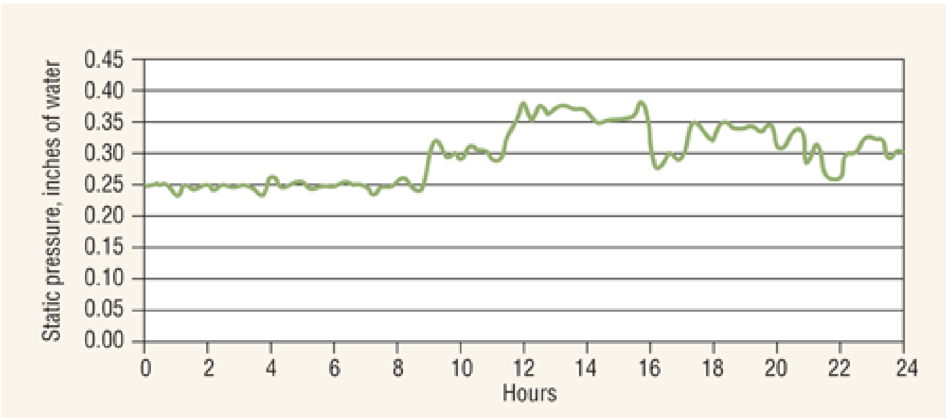
4. Measurement and Monitoring

Real-time measurement and monitoring of key parameters of building systems and energy use is essential in optimizing the building's energy use. Building automation systems, metering, and submetering will allow the building operators to use trend logs and immediately identify operational issues which may impact equipment and system performance and energy use. It goes back to the industry cliché, "you cannot manage what you cannot measure."

Without measurement and monitoring, the operators won't know how systems and equipment are performing, especially when the building is unoccupied. They can see when if equipment was operating when it should have been off. Having real time data building operators can track the performance of energy efficiency measures and building systems in real time and will not have to wait until building performance is adversely affected. Building operators can also use the data to optimize building operations, and continuously recommission the building systems, which can help reduce energy consumption by 5 to 8% through low-cost/no-cost operational improvements.

The trend log in **Error! Reference source not found.** shows that the static pressure in the duct starts to increase at 10 pm, which indicates that the fan was started at that time, when it should normally be off.

Figure 2. Fan Trend Log



Some low-cost/no-cost measures that can reduce energy use include:

- Scheduling of HVAC equipment
- Scheduling lighting systems
- Tuning of HVAC equipment
- Resetting temperatures for HVAC equipment
- Optimizing zone temperatures
- Resetting supply temperature and static pressure seasonally on HVAC equipment
- BAS troubleshooting and commissioning

- Resetting chilled water and condenser water temperatures
- Resetting hot water supply temperatures on boilers
- Optimizing airside and waterside economizers

5. Building Occupants and O&M staff Training

More than one-third of new commercial building space includes energy-saving features. However, according to a paper published in the journal *Building and Environment*, without training or an operator's manual, most occupants won't know about these features and how to use them[2].

Many building owners and building designers focus all efforts on identifying and implementing energy efficiency measures, and forget about training the building occupants and operators on how to take full advantage these energy efficiency features. Their behaviour significantly impacts a building's energy use and its performance. Training and engagement of building occupants and building operators is essential in reducing building use.

Building occupants and operators should be involved in the process as early as possible during the design phases of a retrofit project. This helps them understand the technical features of some energy efficiency measures and how effective operation can take full advantage of their potential. Engaging occupants and building operators early will also help identify areas where training will be required.

6. Operation and Maintenance

A study by the US Department of Energy (DOE) in stated that preventative maintenance can save an average of 15% on O&M costs and predictive maintenance can save an additional average of 10% on O&M costs. So including an O&M plan early in the design phases of the retrofit project is important to reduce lifecycle costs, reduce risk, ensure data quality, sustain investment in commissioning, and maintain building certification.

It is important to involve O&M staff and the commissioning agent during the design and design review phase. Their involvement allows for developing a continuous commissioning plan, which ensures the building system operate effectively and efficiently. It is also important in these stages to conduct thorough serviceability reviews to ensure safe and easy access of equipment.

7. Measurement & Verification

Measurement and verification (M&V) is essential in both verifying the energy savings and optimizing building performance. It helps identify any variation from expected energy use, such as peaks and valleys

[2] https://news.wsu.edu/2014/12/02/missing-ingredient-in-energy-efficient-buildings-people/#.VIia0PnF98E

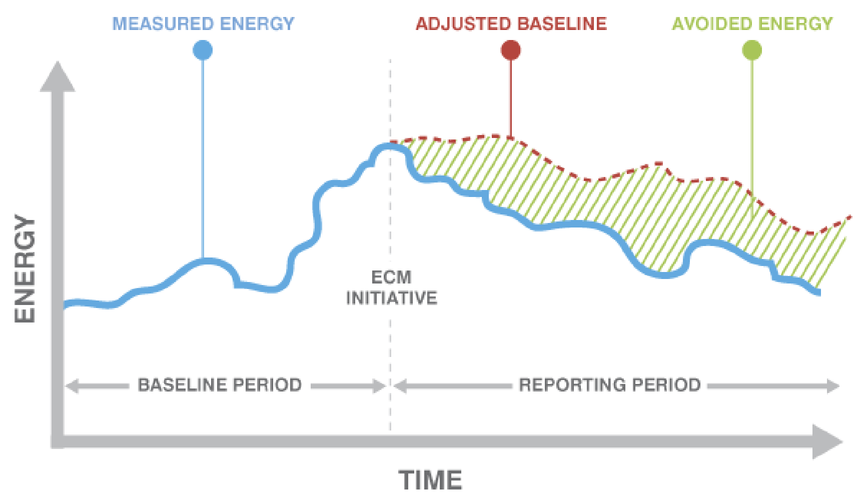
in energy demand and when they occur. Using submeters can help assess performance of individual systems and equipment and provide more detailed information.

Furthermore, real time M&V helps operators and engineers drive building performance and identify low-cost or no-cost conservation opportunities.

The data collected from buildings can be normalized for both weather and occupancy using regression analysis, which can then be used to create baseline energy use and establish energy use targets.

Figure 3 illustrates how M&V techniques can be used to determine energy savings from the baseline.

Figure 3. Measurement & Verification



8. Conclusion

There is no single path to a high performance building retrofit. Many factor can impact the energy performance buildings even after energy efficiency measures have been implemented. It is important to understand how these factors can impact energy performance and maximize return on investment in energy efficiency projects.

Contact us for a free no obligation assessment of how we can help you save money and improve your bottom line by effectively managing your energy costs.

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