Turning Data into Action with Monitoring Based Commissioning

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Large commercial buildings today have become increasingly complex as codes, certification programs, building owners, and design teams push operation to increasingly higher levels of efficiency. The ever increasing complexity in HVAC and building automation systems can often cause gaps between a building's potential level of energy efficiency and its actual operation. A vast amount of data is now available to analyze equipment operation and identify these gaps. Fortunately, analytical software tools are able to turn the flood of building data into actionable information. Monitoring-Based Commissioning (MBCx) is the process of using monitored data to assess equipment operation, typically for an ongoing length of time, with the resulting benefits of increased energy efficiency and improved indoor environment.

To process the increasing amount of data available, new analytics software tools for buildings have been entering the marketplace in recent years at an increased rate. With so many options available it can be difficult to navigate the capabilities and benefits of each tool. The image to the right displays a range of different analytics tool categories ranging from basic use of the building automation system to tools that automatically change equipment settings based on real time feedback. Here we are focusing on the category referred to as 'Fault Detection and Diagnostics' (FDD), also called 'System monitoring and analytics' or 'Monitoring-based commissioning (MBCx) systems', which is the term that will be used here. MBCx systems can process large amounts of operating data from varied sources, a key source being the building automation system (BAS), and can be programmed with rules to automatically detect issues.

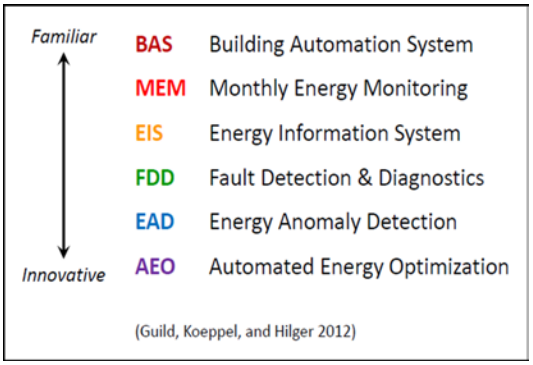
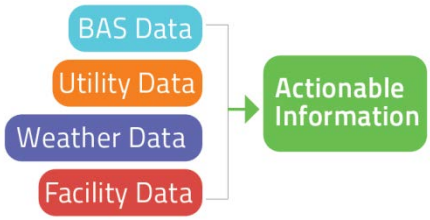


Figure 1: Range of building analytics software tools

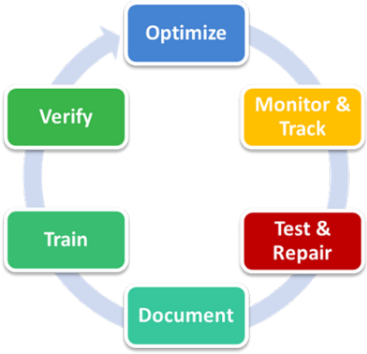
The 'Energy Information System' (EIS) tools typically only take in meter data and have limited ability to identify operating issues. EIS tools may be able to identify a scheduling or demand peak reduction opportunity, but they typically do not have the capability to analyze complex operation at the equipment level. MBCx systems allow the user to dig deeper into actual equipment operating parameters for detailed analysis and commissioning. Examples of MBCx systems include SkySpark, Ezenics, Analytika, SCIEnergy, KGS Buildings Clockworks, and more. More information on the different types of tools can be found in the Energy Management and Information System (EMIS) Technology Classification Framework paper prepared by the Lawrence Berkeley National Laboratory.

MBCx systems take in data from a variety of sources including the building meter, weather data, and the building automation system. All of the data is stored in a database where analytics are applied using programmed rules. These data points are constantly monitored and the rules automatically detect if specific operating conditions are not met. MBCx systems are typically one-way, read only information and do not make automatic changes to the system – *human action is still required*.



Most MBCx systems available on the marketplace today are provided as a cloud based Software as a Service (SaaS) with a subscription model. There is often an upfront fee to integrate the system then an ongoing fee to access the software through a web browser. The cloud hosted model requires a method to get data from the BAS to the MBCx system server. Understanding the software IT requirements and connection options available is an important first step when considering these analytics tools.

Once data is flowing to the MBCx system, it can be used for a variety of purposes. This includes commissioning the operation of newly installed equipment or controls, identifying energy efficiency opportunities (which can be done through a retro-commissioning process), performing ongoing monitoring for troubleshooting issues, and measurement and verification (M&V) to confirm changes and energy savings. An MBCx system would ideally be used from initial commissioning through ongoing monitoring to continuously optimize equipment operation.



With rules programmed into the MBCx system, issues and opportunities can be automatically detected at all times. This can include energy focused issues such as turning equipment off at night, or more comfort related issues, such as VAV boxes that are not meeting airflow or temperature setpoints. The following outlines some of the issues/opportunities that can be detected:

- General Air-Side Opportunities – Equipment scheduling, ventilation/economizer control issues, and temperature setpoints not met.
- Optimized VAV System Operation – Duct static pressure optimization, ideal discharge air temperature control, ideal morning warm-up sequence, and minimum VAV box flow reduction.
- Water Side Opportunities – Chilled water, condenser water and heating water supply temperature optimization, ideal water-side economizer control, improved pump and pressure control, and equipment staging optimization.

The following chart provides an example from an MBCx tool indicating an air handling unit (AHU) that was unintentionally operating 24/7 when it should have been on an office schedule. This issue was identified by a programmed rule ("AHU On During Scheduled Unocc"). Additional data is also displayed to evaluate the fan operating data further.

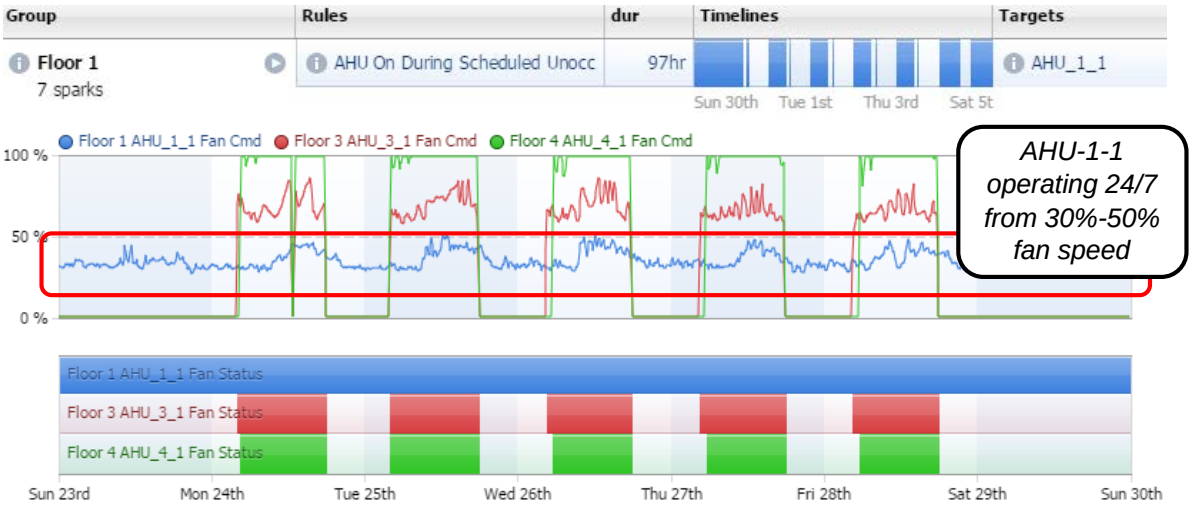


Figure 2: AHU Scheduling Fault with Trend Data

A typical commissioning process can identify opportunities that reduce energy costs by 5-20% on average. However, the use of an MBCx system can greatly increase the amount of opportunities identified during commissioning since so much more data can be quickly analyzed. An MBCx system can make it possible to assess 100% of zone level equipment using programmed rules in lieu of the sampling approach often used for large quantities of equipment. MBCx systems also make it possible to look at long time ranges and multiple seasons which is typically too much data to be handled in a spreadsheet. After initial commissioning, buildings can experience a negative drift in energy efficiency as operation degrades over time. MBCx systems make follow up rounds of verification and ongoing commissioning more feasible to maintain the energy savings achieved with the initial investment.

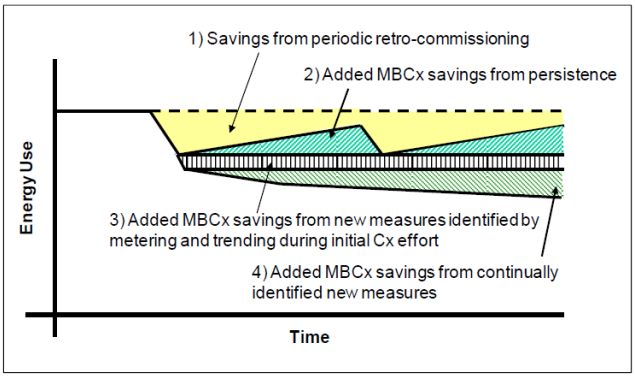


Figure 1. MBCx provides three streams of additional energy savings relative to RCx.

Lawrence Berkeley National Laboratory, June 2009 report - Monitoring-Based Commissioning: Benchmarking Analysis of 24 UC/CSU/IOU Projects

Figure 3: Negative Drift in Energy Use

Benefits from the use of an MBCx system include:

- Lower energy use
- Lower operating costs
- Higher Energy Star score
- Improved occupant comfort
- Increased proactive maintenance

Ideally, the MBCx tool would be used in an ongoing manner to continue identifying issues as they arise. The weather varies from season to season, occupants and tenants change, and systems are dynamic – an MBCx system can help visualize and assess the impact of these changes over time.

The following provides example economics for MBCx with an initial retro-commissioning project:

Economics example

- 200,000 SF office building, $400,000/yr in utility costs ($2/SF)
- Initial project cost of $50,000 (RCx project with MBCx system integration, before any utility rebates)
- Energy cost savings of 10%, $40,000/yr
- Annual cost of $10,000/yr for Ongoing Monitoring ($0.05/SF for third party software hosted on the web plus consulting support)

Item	Year 1	Year 2	Year 3	Total
Costs	$ (50,000)	$ (10,000)	$ (10,000)	**$ (70,000)**
Savings	$ 40,000	$ 40,000	$ 40,000	**$ 120,000**
Net Profit	$ (10,000)	$ 30,000	$ 30,000	**$ 50,000**

Simple Payback: 1.3 years ROI over 3 year period: 71%

For a facility operator, an MBCx system can be a “go to” tool for trouble shooting and ongoing optimization. It can be the first stop when a complaint call is received and it can be used in a proactive manner to assess the issues found by the system before they turn into problems for the occupants. This can be particularly helpful for a large portfolio of buildings or a building with a large quantity of equipment. An MBCx system can also be used to integrate systems and provide a common ground for a variety of building automation systems.

To effectively use an MBCx system internally it helps to have a designated staff person on the facilities team in charge of learning the tool and reviewing the faults at specific intervals ranging from daily to monthly. This person should have a good understanding of the equipment operation and control system sequences to turn the issues identified by the tool into meaningful recommendations and work orders.

Initial training and follow up communication are expected in order to fine tune the rules and faults detected by the system. A process will need to be established to track the issues identified, note responsible parties, and document actions taken for resolution.

While MBCx systems can provide great benefit, they are not a fit for all facilities. The following are some key questions to key consider when determining if this solution is right for you:

1. Does my building have large central systems with complex control sequences and/or high quantities of equipment?
2. Does my building have high energy costs in dollar value and/or compared to similar facilities?
3. What upcoming major projects are planned? Are major equipment or controls planned for replacement? *If so, MBCx may be a better approach after these upgrades are performed.*
4. Is the BAS up to date? Does the BAS have the ability to store trend data or does the platform have the ability to output point readings? *A BAS upgrade may be a first step prior to monitoring.*
5. How would an MBCx system connect to the BAS data? Are there major IT limitations?
6. How will the MBCx system information be used to take action? Who will be responsible for leading change? *There is no value from monitoring alone. There must be a plan for change.*

“Big data” and analytics are all around us. They are used for everything from making online shopping recommendations to driving significant business decisions. Today’s large modern buildings are no exception. The amount of data available is vast and we need the right tools to understand what the data is telling us. MBCx systems are a great way to turn data into meaningful information and drive lasting change.