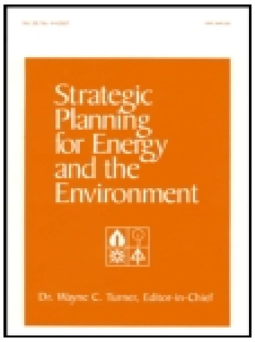

Strategic Planning for Energy and the Environment

ISSN: 1048-5236 (Print) 1546-0126 (Online) Journal homepage: http://www.tandfonline.com/loi/ustp20

Using Data Analytics to Drive Operational Savings Assessing Your Available Data—The First Step in Applying Analytics

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Strategic Planning for Energy and the Environment 2015.35:73-80.

ABSTRACT

The ability to effectively utilize the data from building systems presents the next opportunity to drive efficiency and value for facility owners. Commonly referred to as "analytics," results have been demonstrated across thousands of buildings consisting of hundreds of millions of square feet. Owners that have adopted analytics have seen strong financial returns, improved occupant satisfaction and reduced operating expenses.

Operational analytics has demonstrated great results, but many owners and operators have still not embarked on the "journey" to take advantage of these tools. That word—journey—may be one of the reasons.

ITS NOT AN LED LIGHT BULB

Applying analytics to building systems is not like simply buying new equipment with lower energy consumption. It's not possible to calculate the exact savings that will result from analytics, and perhaps even more important, it's not an "install it and forget it" solution. Analytics is a tool that enables us to see how our building systems are really performing—not how we hope or think they operate, but what they are actually doing. Analytics looks at operational data to identify faults, deviations from expected performance, and other anomalies, all of which represent opportunities for energy and operational savings, as well as greater occupant satisfaction.

ACHIEVING RESULTS REQUIRES ACTION

Analytics turns operational data into actionable information, but operators still need to act on that information. If analytics detects equipment operating outside of occupancy, or heating and cooling simultaneously, someone still needs to react to correct the issue. There's no "magic" to eliminate the need for human interaction. Actions may involve replacement of defective equipment such as sensors, valves, dampers, or very low-cost, no-cost steps like correcting operating schedules and eliminating overrides to equipment systems and setpoint reset strategies.

THE ROLE OF DATA

Analytics acts as an ever-present expert watching the operation of equipment systems; detecting failed sensors, improper control sequences, equipment overrides, declining performance… a nearly endless list of "bad things" that happen in buildings. Humans cannot effectively monitor all these systems without the aid of analytics technology.

To take advantage of the compelling benefits of analytics, we need access to data. The availability of data has a direct affect on the types of analytics that can be accomplished and the resulting benefits. In our experience we see customers fall along a wide spectrum in their ability to access data. Some have virtually no available data, others have easy access to live data from building automation and other equipment systems.

The good news is that you can get significant value from even a very limited amount of data. You don't need live, real time access to every sensor and system in your building to take advantage of analytics. In fact, many successful projects start by simply importing interval meter energy data in a CSV (comma separated variable) format. With just these minimal data, building owners can identify:

- Buildings starting early
- Buildings running late
- Buildings that operate continuously (schedules overridden)
- Demand peaks that occur outside of occupied times
- Peak load, annual and monthly and short load durations

It's reasonable to ask if this could be done manually. While possible, the reality is that companies just don't have the resources to manually analyze all of these data. With analytics there's no need to manually hunt through the data, the software automatically finds issues and directly provides operators with all of the details.

ASSESS YOUR DATA

All data are not created equal. Some data are harder to get than others. Some have greater value than others. When looking to get started with analytics, it makes sense to drive the greatest value with the lowest investment. So how can you get the most value? Start with easily available data.

Most buildings have a range of equipment systems which can be sources of data (building automation systems and meters for electricity, gas, and water, can be good sources of data), but the work required to access the data can vary considerably. So, the first step is to find out what data you have, where it is, how to connect to it, what format it is in, and how well it is documented. If you have thorough data on HVAC equipment operation (fan status, temperatures, setpoints, etc.), analytics can identify issues such as simultaneous heating and cooling, economizers open when they shouldn't be, short cycling, lack of adequate temperature drop across coils, broken sensors, etc.

Use an Incremental Approach

Unlike the installation of major capital equipment, you can start with a very limited amount of data to get results that quickly drive operational savings and then go deeper, driving financial results at every step.

Real Time or Historical Data

Another common misconception is that you can't derive value from data unless they're live—continuously updating in real time. This simply isn't true. Live data are great, but by no means essential to getting started with analytics. You can get tremendous value using analytics on a snapshot of historical data. Also, one of the benefits of starting with historical data is that you can avoid the costs and delays associated with IT approval for network access to live systems.

A great example of what you can do with snapshot data is an initial portfolio assessment to identify best- and worst-performing buildings and the characteristics of your energy use—finding those buildings

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where schedules have been overridden for example. You can also do deep equipment analytics with only historical equipment data.

Assessing Your Data with a Capability Maturity Model

Using a capability maturity model approach can be an effective way to assess where you stand with data. The process of assessing your data capability starts with a few essential questions:

- What data do you have available?
- Where are those data located?
- How will you connect to the data to bring them into an analytics application?
- Is there documentation that describes the data and naming conventions?
- Do you have modern building automation and equipment systems that support an industry standard, open protocol?
- Do you have security policies that will affect the ability to access data from these systems?

Based on the answers to the above questions we can classify our standing relative to data accessibility.

Level 0: No data available in electronic format

If you find yourself at this level, look at implementing meters to measure energy consumption and demand. Be sure to look for products that will provide the data in an open, standard format.

Level 1: Access to only interval meter data in CSV (or similar) file format

As we've discussed, a lot of value can be derived from this limited type of data even without a live connection.

Level 2: Live interval meter data

This might be provided via utility-installed meters, a utility website, or by meters connected to a BAS.

Note: Both Levels 1 and 2 will give you what you need to assess where you stand with energy performance and your energy use profile throughout the day. These are essential steps in understanding your facility operation, comparative efficiency, and opportunities for further investigation.

Level 3: Live data from equipment systems

While energy-only data are a great place to start, access to equipment data takes us much farther into the benefits of analytics. With access to equipment data (sensors, control points, schedules, etc.), more sophisticated rules can look for faults and operational issues.

Level 4: Integration with BAS and enterprise CMMS systems

Beyond finding issues, analytics can help drive resolution by automatically generating work orders in a computerized maintenance management system. While not all analytic findings can be directly connected with specific response actions, many can, and this level of integration further helps streamline facilities management to reduce costs.

BRINGING TOGETHER DIVERSE DATA AND MAKING THEM WORK—AN INTRODUCTION TO DATA MAPPING/TAGGING/SEMANTICS

The point made earlier regarding documentation of data is essential to consider and often overlooked. Given we are discussing the critical role of building systems data, a review of one of the key challenges encountered is warranted.

One of the key challenges in utilizing data to drive efficiency improvements is the effort involved in integrating data from a wide range of sources that utilize different formats.

Most operational data available from control systems, meters and other equipment systems have poor descriptive information (also known as semantic modeling) and a manual, labor-intensive process to "map" them is required before they can be used by analytics software. As more and more building owners look to take advantage of data analytics, the data mapping effort is gaining more attention as shown in this quote:

> "Recent technology, market and policy drivers (smart meters, energy performance disclosure laws, etc.) are resulting in a rapid increase in the generation of building and energy data... But this data is still hard to access, aggregate, share and utilize because it is housed in many decentralized databases, and in different formats. Stakeholders consistently reported that they spend more time on data formatting and cleaning than they do on conducting analysis. The lack of standard data formats, terms and definitions is a significant ongoing barrier to realizing the full utility of empirical information about building energy performance."[1]

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Representing Data Meaning—
An Example of Semantic Tagging in Action

To begin the analytics process we have to know the meaning of our data. For example, if we get a datum from a BAS, and it has a value of 77.6, we can't do any effective analysis until we understand whether it is 77.6 degrees F, or PSI, or RPM, or kW, etc. "Units" is one good example of showing that we need to begin the analytics process, but it is by no means the only one.

Continuing with our example, perhaps the point with the value of 77.6 is named zn3-wwfl4. If I am familiar with the system and the naming conventions used when it was installed, I may be able to determine that the code means Zone 3, West Wing, Floor 4. Now I have a bit of information to work with. If I know the building well, I may also be able to tell that zn3-wwfl4:

Is a zone temperature
Is an exterior zone
Is south facing
Is supplied by a VAV box
Is served by AHU-1
Is operated on occupancy schedule #1 which is 7:30 AM-6:30 PM
Has an occupied cooling setpoint of 74 degrees F

This "data about data" is called meta-data. This meta-data enables me to understand the impact of the current value of 77.6—I can now see that it is about temperature during occupied hours and the occupant is probably getting uncomfortable. Without the necessary understanding of the data, I can't determine the impact of the current value and its relationship to proper system operation. To provide effective analytics, I need to "map" this meta-data to point zn3-wwfl4.

Interestingly, with all of the power they have gained over the last decade, most building automation systems provide poor semantic modeling of the operational data they contain. The systems provide us with a name and a value, but little other information about the specific item. The result is that a labor intensive process is typically required to "map" the data before any analytics can begin.

Mapping Meta-data with Tags

So how can we capture all of this information and associate it with the data items in our automation systems and smart devices? We cannot do it simply by trying to use standardized point names. Clearly, in even our simple example we have more data that can be effectively embodied in a point name. Add to that the fact that we may want to add numerous other meta-data items over time, and it's obvious we need another approach. There are a number of elements to an effective solution.

1. Separate the point name from the representation of meta-data. Use tags to represent the meta-data and associate those "tags" with the point name to provide semantics that describe the point.

2. Utilize a standardized library of tags to provide consistency of meta-data terminology, which will enable automated tools to interpret data meaning.

3. Follow a consistent naming convention for data points so that the mapping of tags can be consistently applied and automated.

Given our earlier example, a record representing the point with its associated meta-data might look like the graphic in Figure 1.

id:	150a3c6e-bef0ee0e	(RecId)
clgsp:	74 °F	(Number)
dis:	zn3-wwfl4	(Str)
equipRef:	Headquarters AHU-1	(RecId)
exterior:	✓	(Marker)
floor:	4	(Number)
point:	✓	(Marker)
schedule:	occupied 1	(Str)
south:	✓	(Marker)
vav:	✓	(Marker)
zone:	3	(Number)
zoneTemp:	✓	(Marker)
mod:	9-Mar-2011 Wed 6:43:21PM UTC	(DateTime)

Figure 1

Pragmatic use of naming conventions and taxonomies can make it more cost effective to analyze, visualize, and derive value from our operational data. A new, open source, industry standards effort called Project Haystack is taking on the challenge. **Project Haystack** is an open source initiative to develop "tag" naming conventions and taxonomies for modeling of building equipment and operational data. The project is developing standardized data models and tag libraries for sites, equipment, and points related to energy, HVAC, lighting, refrigeration and other environmental systems. Substantial libraries of tag names and proposed taxonomy models are already in place.[2]

Project Haystack is open to everyone interested in the continuing journey of building efficiency. You can learn more, including how to participate, at http://project-haystack.org/.

SUMMARY

Analytics is about finding out how your buildings actually perform. It's an exploratory process, and all great explorations begin with a single step. The adoption of operational analytics is no different. Fast results are available from easily available data, and the process can be pursued in stages that are manageable from a cost and resources standpoint, validating the financial value at each stage.

References

1. Building Energy Data Exchange Specification Scoping Report, August 2013, eere.energy.gov
2. What is Project Haystack? http://Project-Haystack.org, 2014

ABOUT THE AUTHOR

John D. Petze, C.E.M., is a partner at SkyFoundry, the developers of SkySpark®, analytics for building, energy and equipment data. John has more than 30 years of experience in building automation, energy management and the Internet of Things, having served in senior positions for manufacturers of hardware and software products including: President & CEO of Tridium, VP Product Development for Andover Controls, and Global Director of Sales for Cisco Systems Smart and Connected Buildings group. At SkyFoundry he helps owners take advantage of advanced operational analytics to create truly intelligent buildings. He can be reached at john@skyfoundry.com.

Strategic Planning for Energy and the Environment 2015.35:73-80.