Understanding monitoring and targeting

By Chris Burgess, director Alpha Management Solutions Ltd

Energy Monitoring and Targeting (M&T) is one of the fundamental techniques that an energy manager can use for the long-term management of energy consumption and to highlight potential improvements in the efficiency of energy use.

The output from an effective M&T scheme will enable the energy manager to:

- detect avoidable energy waste that might otherwise remain hidden;
- identify areas for investigation and action prompted by unexpected patterns of consumption;
- quantify the savings achieved by energy saving projects in a manner that accounts for factors such as variations in weather or levels of production output;
- provide visible feedback to staff on the results of energy efficiency campaigns; and
- improve budget setting.

Significant savings can be achieved through the application of M&T but M&T itself does not save energy; it is the actions taken as a result of interpreting M&T output results that provide the savings. Checking fiscal energy meters and utility bills as a cost control measure might once have been considered a basic form of monitoring but now M&T is evolving into an industry in its own right with several different products and services available from many suppliers.

The relative cost of metering has fallen over recent years while at the same time the technology has advanced. For example, devices incorporating real time displays (smart meters) or with communication capability and analysis software is now available to configure a complete M&T system.

Increased visibility

Smart meters will benefit domestic consumers by increasing the visibility of energy costs and consumption profiles. In the non-domestic sector development has enabled M&T systems to automatically measure consumption which will improve utility management and facilitate more accurate and timely billing. This technology, known as aM&T, is evolving into complete data management systems with, for example, analysis for mandatory carbon reporting, databases for recording carbon reduction projects and facilities such as real-time data displays and consumption dashboards.

There are four main components of an aM&T system starting with the meter. Typically, these would be electricity, natural gas, water and heat or steam meters with a digital interface, commonly a simple pulsed output.

The second component is the automatic meter reading (AMR) system which reads the metered consumption, typically over a 30-minute period, and stores the data ready to be analysed. Meters can be hard wired to the meter reading system but wireless technology is often more practical and cost effective.

The third component is a network of sensors to measure the parameter that "drives" energy consumption, such as heating degree days for space heating or production throughput in a manufacturing facility.

The final component is the analysis software. There is variety of software available with different levels of sophistication in terms of the depth of analysis. All should have the basic M&T analysis capability described in the Carbon Trust publication1 and briefly described here. Some of the aM&T software provides additional features such as CRC reporting or bespoke analysis required by specific customers. Typically, the software sits in the cloud and is accessible via the web, which means the user only requires an internet enabled PC.

For small sites those responsible for energy could start by using their own spreadsheet analysis using electricity supplier half hourly data or manual meter readings, but if proprietary M&T software or an integrated system is preferred it is important to select software that suits the level of analysis and features needed; unnecessary sophistication means additional complexity and cost for the user.

There are four stages to monitoring and targeting:

Data collection: in past years energy consumption data may have been obtained from manual meter readings, electricity supplier half-hour data files or fuel bills, but increasingly the process is

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automated with AMR;

Data analysis: the aim is to provide a comparison of estimated and current actual consumption, as a means of controlling energy use and detecting avoidable waste. Checks should be made to confirm the accuracy, completeness and quality of the data and some form of reconciliation should be carried out to 'sense check' the fit between the data and the output reports;

Reporting: to be effective, the M&T process should include management reports specifically for each energy accountable area, which might be, for example, a site, process or fleet of vehicles. The management reports generated should provide the stimulus to improve performance and quantify improved energy performance. Where possible, if periodic targets are exceeded exception reports should be produced automatically, so as to highlight areas of concern and to motivate actions to be taken; and

Action: it is essential that those responsible for energy management make effective use of the M&T reports to achieve the potential savings.

Highlight action

One of the key objectives of any M&T scheme is to highlight where corrective action is required because of instances of unexpected high consumption of energy. An overspend league table is an effective way to ensure excessive consumption is quickly spotted and can be applied for buildings, production processes or vehicle fleet consumption.

The table is based upon actual financial overspend above the estimated expected cost for the period. The table is configured to show the highest overspend at the top of the list to draw attention to the most important.

Therefore, a fundamental requirement of any M&T scheme is to estimate the expected consumption so that it can be compared with the actual consumption over the chosen reporting interval.

In the past it has been quite common to assume that the expected consumption is the same as that for the same period in the previous year. The obvious weakness is it assumes that the conditions that affect consumption, such as weather or production output, remain at the same level. This approach, although simple, has limitations which makes activity-based M&T better.

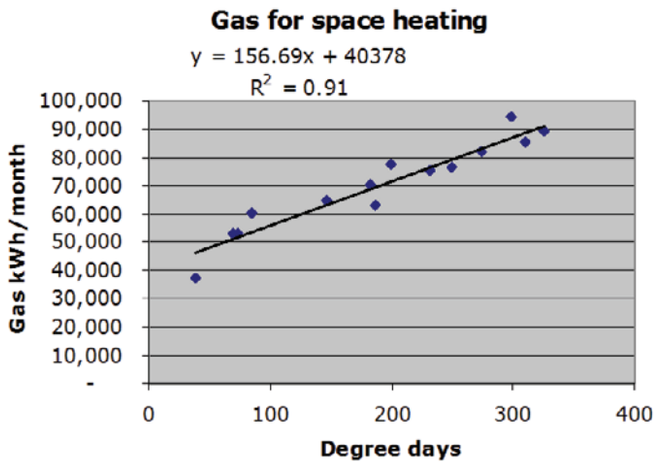
Figure 1: Example of an overspend energy league table

	A	B	C	D	E	F
1	Overspend analysis for week commencing 17 Feb 2014					
2						
3	Site	Energy	Expected consumption	Actual (meter reading)	Difference	%	Excess cost
4			kWh	kWh	kWh		£
5	Site 98	Elec	217,339	238,557	21218	10	2334
6	Site 04	Gas	49,056	108,283	59227	121	1777
7	Site 32	Elec	206,129	219,195	13066	6	1437
8	Site 86	Elec	87,785	97,474	9689	11	1066
9	Site 16	Gas	104,729	136,907	32178	31	965
10	etc						

The starting point for activity-based M&T is to identify a driving factor for each consumption stream to be monitored. Typical driving factors are production throughput (energy-intensive manufacturing), degree days for space heating or cooling and mileage for vehicles. Any measurable variable can be used provided it indicates the level of activity during the monitoring period in such a way that when the consumption is plotted against the driving factor a straight-line relationship exists.

This line, called the characteristic line or the trend line, can be represented by an equation of the form: $y = m x + c$ where m is the gradient of the line and c is the intercept with the y-axis. The values of 'm' and 'c' are significant as can be seen by using space heating as an example. Fuel consumption for space heating will normally exhibit a straight-line relationship to heating degree days. The gas consumption and degree day data can be plotted as a scatter graph. Each point on the graph is gas consumption during the monitoring period (day, week or month) shown on the vertical (y) axis and the number of degree days for the identical period shown on the horizontal (x) axis. Figure 2 shows the scatter graph for an example set of energy consumption and degree day data.

Figure 2: Characteristic line for the data shown



The value where the line intercepts the vertical axis, is the value 'c' in the equation, and represents the fixed demand or base load consumption i.e. gas used at zero degree days when the space heating load should be zero. The base load consumption could just be due to boiler standing losses or other loads which are included in the metered data but are not dependent upon external temperature - this could include gas used for domestic hot water or catering.

The slope of the characteristic line (the value of 'm' in the equation) indicates the increase in gas used for each degree day.

Expected consumption

The formula representing the characteristic line can be used to calculate an estimate of the expected consumption for any period using the appropriate degree day value. This value can then be compared with the current metered consumption for the same period, to determine whether an over or under consumption has occurred and to establish whether or not the heating system is performing consistently and as expected.

The same calculation can be performed to set an annual budget for space heating energy by using the number of degree days for the average year or for the analysis of production or process energy using a measure of the annual production output.

The mathematical functions

within a spread sheet will include a statistical analysis tool called "least squares linear regression" and this can be used to calculate the formula for the "best fit" characteristic line.

A wide scatter of points can be due to poor quality or inconsistent data but could be due to inadequacy or malfunction of the heating system controls. The correlation may also be poor if heating accounts for only a small proportion of the fuel requirement. A reasonable characteristic line can, however, usually be produced but this does not mean that the heating system is operating efficiently, merely that its performance is consistent.

Once established, the performance line can be used as a 'performance target' for the future operation of the heating system. Any significant deviation in fuel consumption should be investigated and prompt corrective action taken.

A simple bar chart can help to identify trends and make comparisons against the previous year's consumption, however this does not account for different weather between the two years if looking at space heating or different production outputs if looking at a production process.

A better method to show consumption trends more clearly and to determine an effective target is to use CUSUM analysis (Cumulative SUM deviation analysis). The calculations required for this are described in Reference 1.

The most basic metering strategy would be to obtain data available from the fiscal meters or if available, using half hourly electricity data from suppliers. For smaller premises or sites this might be as far as M&T needs to go but there are advantages to be gained in automating the process and collecting data from additional sub-meters to give a clearer picture of how the energy is consumed.

The sub-metering strategy, therefore, needs to be developed to account for areas of significant consumption particularly where a "driving factor" can be established. This might be building by building for a large property portfolio or floor by floor in a large building. Within a manufacturing site, individual processes or production areas might be sub metered. Since most M&T systems are modular remember it is possible to start small and build the system over time.

Figure 3: Degree days and actual energy use

Month	Degree day	Gas kWh
Apr	199	77,558
May	147	64,663
Jun	69	53,222
Jul	73	53,034
Aug	38	37,701
Sep	85	60,443
Oct	183	70,551
Nov	250	76,352
Dec	325	89,394
Jan	298	94,679
Feb	310	85,368
Mar	274	81,874
Apr	232	75,502
May	186	63,155

Historically, gas and electricity suppliers provided fiscal data using OFGEM-approved metering but since 2006 new fiscal meters have had to comply with the Measurement Instrument Directive (MID). Existing products already certified in the UK can be sold and used until the end of their certification period but no later than 30 October 2016. Sub meters for internal use are not covered.

Half-hour electricity meters have been a requirement for certain segments of the electricity market for many years. Since 2009 energy suppliers have been required to install advanced meters for new large gas supplies to provide data at a maximum of 60 minute time periods. Energy Services and Technology Association has developed a code of practice for automatic meter reading service providers to set standards for the collection, processing and storage of gas meter data.

For simple situations it is feasible to develop M&T software in-house, using basic spreadsheet analysis. The overspend league table is easy to produce but the more advanced steps (such as regression analysis) might be more of a challenge, though not beyond a capable spreadsheet user.

However, since proprietary software is readily available it may not be considered cost effective to develop bespoke in-house systems. The number of metering points and the way information is collected does, however, need to be carefully considered to avoid the system being underutilised, especially if it requires excessive amounts of information when a few important indicators would suffice. Over-detailed reporting can also cause staff to ignore vital information. Linear regression and CUSUM calculations become more appropriate as energy consumption data becomes available at shorter time periods with automatic meter reading technology.

Quick response needed

The ability to respond quickly is an important factor in the success of any M&T system. Data collection and input should be as near real-time as feasible and practical. Exception reports indicating excessive consumption should be generated speedily to allow early action and it is necessary for the energy manager to establish how the organisation will respond to whatever the M&T highlights.

Although there are many proprietary M&T software packages available, not all of them are designed to provide full M&T analysis. Some software supplied with automatic meter reading hardware may do little more than display demand-profile charts and other energy accounting software may lack the analytical and target-setting functions found in products with more of a bias towards physical performance.

To provide the full benefits of waste-avoidance analysis the software needs, at a minimum, to incorporate the principles and procedures explained in Reference 1. Appropriate products may have the following hallmarks:

- an emphasis on the assessment of physical performance (as distinct from energy accounting);
- facilities for calculating expected consumption, at least using straight-line relationships with single driving factors;
- provide scatter and CUSUM charts and employ them actively in the target-setting process; and
- provide an overspend league table.

Some M&T companies offer turnkey solutions to supply and install all aM&T components while others provide single components and the end-user assembles the complete system. This can require a degree of metering and IT expertise to piece it all together and there are obvious installation risks and cost implications to consider.

To ensure continued meter data integrity the system must be maintained and this is typically done through a service contract, often with additional costs for important software updates.

An alternative is to outsource the entire or part of the M&T activity to a bureau or energy management specialist company. These providers often offer a range of additional services beyond energy and carbon reporting such as invoice validation, tenant billing and energy procurement.

Monitoring and targeting provides mechanisms for the long-term management of energy and if correctly applied can help save energy and cut costs. However, it is important to adopt the appropriate level of M&T whether the choice is bespoke in-house M&T, a turn-key system or a bureau service.

References

1: Monitoring and Targeting Carbon Trust publication CTG008 available at http://www.carbontrust.com/media/31683/ctg008_monitoring_and_targeting.pdf

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How to obtain CPD accreditation

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This is the tenth and final module in the eleventh series and focuses on understanding monitoring and targeting. It is accompanied by a set of multiple-choice questions. To qualify for a CPD certificate readers must submit at least eight of the ten sets of questions from this series of modules to ***Energy in Buildings and Industry*** for the Energy Institute to mark. Anyone achieving at least eight out of ten correct answers on eight separate articles qualifies for an Energy Institute CPD certificate. This can be obtained, on successful completion of the course and notification by the Energy Institute, for a fee of £15 (for members) or £25 (for non-members).

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MARK THROWER, MANAGING EDITOR

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Completed answers should be mailed to:

The Education Department, Energy in Buildings & Industry, P. O. Box 825, GUILDFORD, GU4 8WQ

SERIES 11 MODULE 10: QUESTIONS

MONITORING & TARGETING

Please mark your answers on the sheet below by placing a cross in the box next to the correct answer. Only mark one box for each question. You may find it helpful to mark the answers in pencil first before filling in the final answers in ink. Once you have completed the answer sheet in ink, return it to the address below. Photocopies are acceptable.

1. What step in the M&T process actually achieves energy saving?
- ☐ Collection energy consumption data
- ☐ Reporting the consumption data
- ☐ Taking action based on the results of M&T
- ☐ Analysing the data to determine results.

2. Output from the M&T process will help the energy manager in a number of ways. Which of the following is not one of them?
- ☐ Detecting avoidable energy waste that might otherwise remain hidden.
- ☐ Prompting action by identifying unexpected patterns of consumption.
- ☐ Improving energy budget setting
- ☐ Developing the energy policy

3. Which of the following is not one of the four basic stages in M&T process?
- ☐ Data collection
- ☐ Data analysis
- ☐ Calculating an energy benchmark
- ☐ Communicating results

4. What is aM&T?
- ☐ Automatic collection of data
- ☐ Automatic setting of targets
- ☐ Automatic analysis of data
- ☐ Automatic collection and analysis of data.

5. The characteristic line is shown on?
- ☐ Cusum chart
- ☐ Scatter chart
- ☐ Monthly consumption bar chart
- ☐ Annual consumption bar chart.

6. What is the significance of factors such as production volume or number of degree days for activity-based M&T?
- ☐ They introduce noise into the data which impedes analysis
- ☐ Raw consumption data must be adjusted to eliminate their distorting effect
- ☐ They cause the consumption
- ☐ They can usually be ignored.

7. What does AMR stand for?
- ☐ Automatic monthly reading
- ☐ Automatic metering ratio
- ☐ Accredited meter register
- ☐ Automatic metering reading

8. Which of the following is a fundamental requirement of any M&T scheme?
- ☐ To interface with fiscal meters only
- ☐ To monitor every energy stream
- ☐ To produce complicated reports that no-one reads
- ☐ To estimate expected consumption vs actual consumption to identify over or under consumption.

9. An energy manager has been relying solely on data from energy invoices but realises that physical M&T could be better. What should his first action be, assuming that so far done none have been carried out?
- ☐ Evaluate suitable aM&T software
- ☐ Retain a consultant
- ☐ Plot a set of CUSUM charts
- ☐ Start reading meters regularly

10. Which of the following is not a key component of aM&T?
- ☐ Energy meters
- ☐ Automatic meter reading systems
- ☐ Meter data analysis software
- ☐ Hardwired connection between meters and PC running the software