Evaluating Climate Change Mitigation:
Using Monitoring and Targeting Techniques to inform decision-makers

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Abstract

The old refrain goes: "If you can't measure it, you can't manage it". This paper provides practical advice on impact assessment or measurement techniques for senior personnel who have to deliver real operating reductions in Greenhouse Gas Emissions.

The techniques explored here are based on a process called Monitoring and Targeting (M&T), and are equality applicable in large industrial, institutional and commercial organisations.

The paper demonstrates that, when properly implemented, M&T can provide an unambiguous measure of performance for complex organisations. Drawbacks of M&T are also considered, such as the need for historical data to set performance targets and challenges around metering.

Practical considerations covered in this paper include:

- Why it is better to manage emissions in "original units", such as kWh of electricity
- How variable data can be used to remove "external" effects such as weather
- Issues of granularity, or at what level performance should be measured
- The frequency of measurement
- Why normalising data over different time-periods should be avoided

For many large organisations there is acceptance that reducing greenhouse gas emissions is a desirable objective. By adopting the techniques described in this paper, professionals will be better equipped to achieve true reductions.

Keywords: monitoring and targeting, performance assessment, emissions reporting, management

The challenge

The challenge of emissions reporting is illustrated by a recent report from a large UK water company which stated: "*Our GHG emissions for 2006/07 were 1,482,000 tonnes CO_2 equivalent, a small reduction (0.6%) from our 2005 performance but a reduction of 11.27% when compared to our 1990 baseline (normalised per megalitre of water supplied and wastewater treated)*."

Initially this seems like positive news - an 11.27% improvement since 1990. However the majority of these emissions are due to electrical energy and the official UK emissions conversion factors from grid electricity to CO_2 changed from 0.77 Kg CO_2/kWh in 1990 to 0.52 Kg CO_2/kWh in 2006/07[1] - a reduction of 32% in the period. The *fact* of the emissions reduction by the water company is entirely correct, but not any implication that this was something that resulted from improved efficiency within the company.

The second interesting point about the statement is the use of a production ratio, as indicated the term "*normalised per megalitre*". The problem with ratios is that they fail to take into account base-load emissions or energy use (for example lighting or air-conditioning in a waste water plant would be unaffected by volumes). Figure 1, bellow illustrates this effect. Since we know that clean water volumes were constant and sewerage rose by 20% during this period, it is reasonable to assume that the water company's results are being flattered by the use of ratios in the context of rising production.

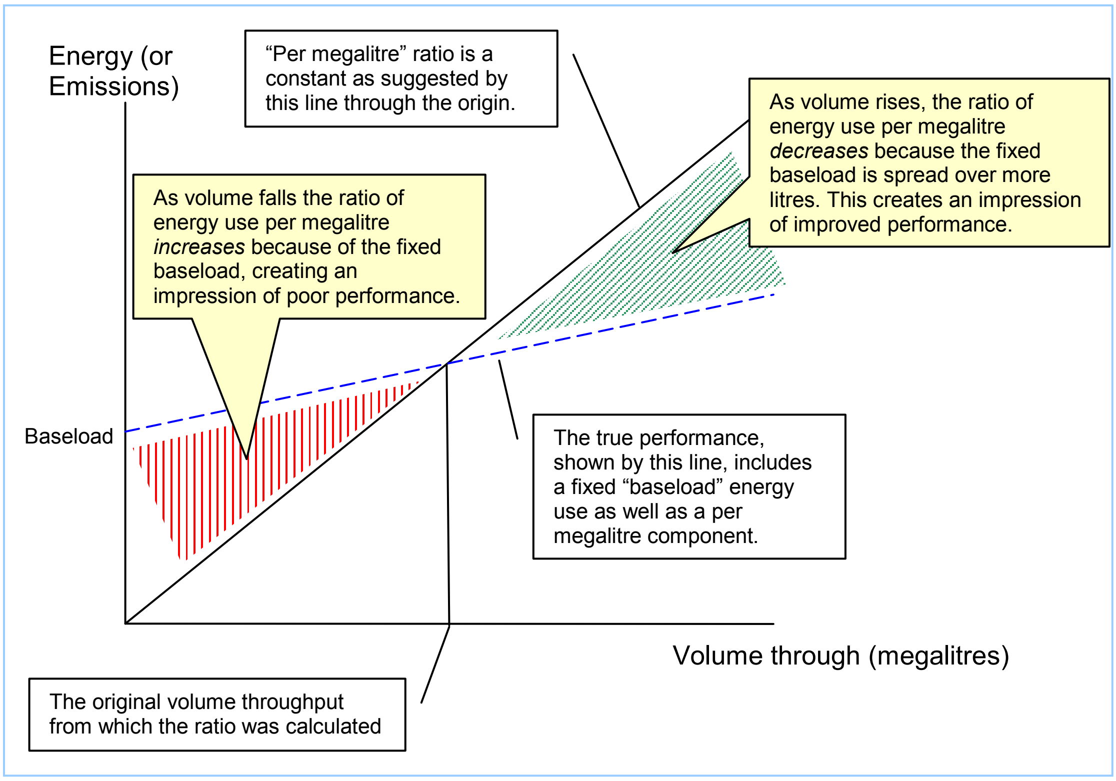

Figure 1: Illustrating the misleading effect that simple ratios can have on emissions performance data, due to baseload effects.

So we can see that headline emissions reports, like the one above, are often unsuitable for performance management.

Many emerging standards for GHG reporting are attempting to deal with the complexities of corporate reporting. The World Business Council for Sustainable Development has created its Greenhouse Gas Protocol, the closest there is to a global standard[2 3]. Accounting organisations have also approached the subject of carbon accounting with mixed success as illustrated by the withdrawal of the IFRIC 3 standard. In reporting regulated emissions, such as those under the EU-Emissions Trading Scheme (EU-ETS), the formulae and methodology are rigorously defined because substantial financial values are at stake. In Australia, there is the National Greenhouse and Energy Reporting Act 2007[4] which provides the methodology for larger emitters to measure their performance.

The bottom line is that these methodologies are not helpful in terms of emissions management, because of the numerous assumptions that underlie them, the lack of detail they offer or their infrequent annual calculation. While they may serve the function of *reporting or quantifying* emissions, they don't serve the function of *managing* emissions.

The solution

There is a technique, known as Monitoring and Targeting or M&T[5], developed in the UK but now used worldwide, which offers a solution. With over 20 year's success in industrial and commercial utility efficiency, it is highly applicable to emissions management, as in many cases reducing emissions equates to reducing energy use. The attractiveness of M&T is that is can typically deliver 5-15% utility cost savings with little capital investment, other than in metering.

M&T provides objective measures of performance on a regular basis, typically using regression analysis techniques, the *monitoring* component, and then, through the *targeting* element makes individuals responsible for improving that performance. It is essentially a *management* process.

The first consideration in adopting M&T is what to measure. Because M&T succeeds by developing clear-cut relationships between energy or emissions and underlying drivers (called variables), such as production or weather, we need to ensure we are measuring each fuel independently and place our metering at a level where these drivers can be isolated. For example, electricity used to spray paint automobiles in a car factory will largely be governed by the number of cars painted while the electricity used to supply air-conditioning will be governed by how hot it is outside. Because these two sources of emission have different drivers, then they should ideally be measured independently.

We might want to further sub-divide our consumptions in order to align these with the management structure of the business; for example to have one figure for air-conditioning electricity use on the production line and another for the offices so that we can make individuals in each part of the business responsible for the usage (through budget allocations or incentives, for example).

Cost can also guide metering decisions. A rule of thumb is to assume a very conservative 3% annual saving. Using this assumption we can get a 2-year payback on a $1,000 electricity meter if we are measuring at least $16,667 of electricity through the meter per annum.

It must be pointed out at this point that few complex commercial or industrial facilities will ever have perfect sub-metering. Advanced techniques, such as "virtual metering", can overcome this.

A second key decision in M&T is to select the time-period over which to carry out the measurements. Clearly annual reporting leads to infrequent assessment of the performance and makes the interpretation of the cause of variation difficult because of the length of time that has passed.

Given this, typical M&T cycles are daily or weekly for larger facilities (say over US$500,000 p.a. of utility costs) or monthly for smaller facilities. Higher frequencies, such as hourly or by shift are only really possible where the data analysis is automated and are only useful in diagnosing variances, rather than for periodic reporting. It is not uncommon for the variable data, such as production, to determine the frequency of the M&T cycle, as this data is more difficult to obtain. It is also important to align the metered data with the variable data, for example if weekly production data in a factory goes from a Monday morning to a Sunday night, then the meter readings should be taken over the same period in order to reduce error cause by normalising the data to identical time-frames.

Ideally the metering and variable information is automatically collected and interpreted. However, for many organisations this is both excessively expensive and impractical. In weekly or monthly M&T, manual meter readings are usually viable for all or some meters. Variable data may also be obtained from corporate finance systems and rarely require additional metering.

M&T establishes relationships between the energy or emissions and the underlying influencing factor or *variable* for a discrete part of the site, known as an Energy (or Emissions) Account Centre (EAC), usually (but not exclusively) using regression analysis techniques. For example the amount of oil used (hence the CO_2 emitted) by a boiler depends on how much heating load a building requires. This in turn is influenced by the external temperature (heating degree days).

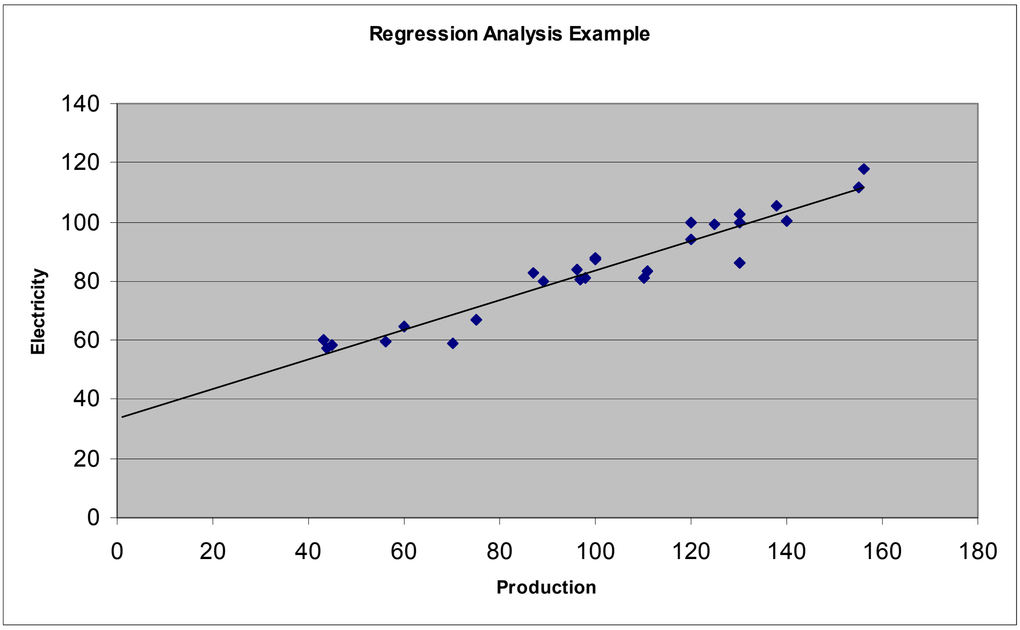

Figure 2: Example of a single linear regression analysis to compare electricity use and production showing the best fit line interpolated back to the y axis to demonstrate the baseload.

Regression analysis provides a formula that describes the relationship between the energy use and the production value. For single linear regressions this takes the classic $y=mx+c$ form where y is the energy use, x is the production variable and m and c are constants, with c being the baseload. It should be stressed that not all relationships between variables and energy or emissions will be linear and there may be multi-factorial relationships where more than one variable needs to be considered or, more rarely, exponential relationships.

The baseload provides useful insight into the system or process. A high baseload indicates that energy is being used in a non-production context (for example equipment is regularly left running) and this will point engineering staff to immediate areas of opportunity. Another valuable aspect of these baseloads is that they can be aggregated across multiple EACs to provide a site total.

Another benefit of the regression approach is that future EAC emissions can be forecast by plugging forecast variable data into the regression formulae. Since the capacity to accurately forecast emissions lies at the heart of managing an emissions trading position, the importance of this cannot be underestimated.

At the root of M&T is the concept of creating accountability for the performance of each EAC by giving a target to the individuals who manage the operations in the EAC. There are a variety of approaches to target setting, some involving new regressions and others selecting improvement in specific elements such as the baseload. Probably the easiest target to use is the initial the best-fit line. By using this as a target it is possible to state to the employees that "on average" they have met the target half the time in the past, so it is a *fair*, *honest* and *achievable* target.

At this point it is evident that M&T requires historical data and experience suggest that the absolute minimum number of data points needed is 12. For a weekly system 3 months would be the minimum historical data requirement, but ideally one would have a full year's worth in order to be able to tease out seasonal influences. This is one of the few drawbacks of M&T.

It should be noted here that the original regression relationship between the energy/emissions and the variables are always preserved in an M&T system and are called the *baseline.* Targets, on the other hand, are reset frequently so that a process of continuous improvement is put into place.

Having established the target, and baseline, the M&T process then operates by informing the EAC manager of any variance from target as and when the most recent meter and production data is analysed. Since the target is calculated to a high precision and meters have inaccuracy, the actual consumption will never precisely match the target, so a process of exception reporting is adopted to avoid "false positives".

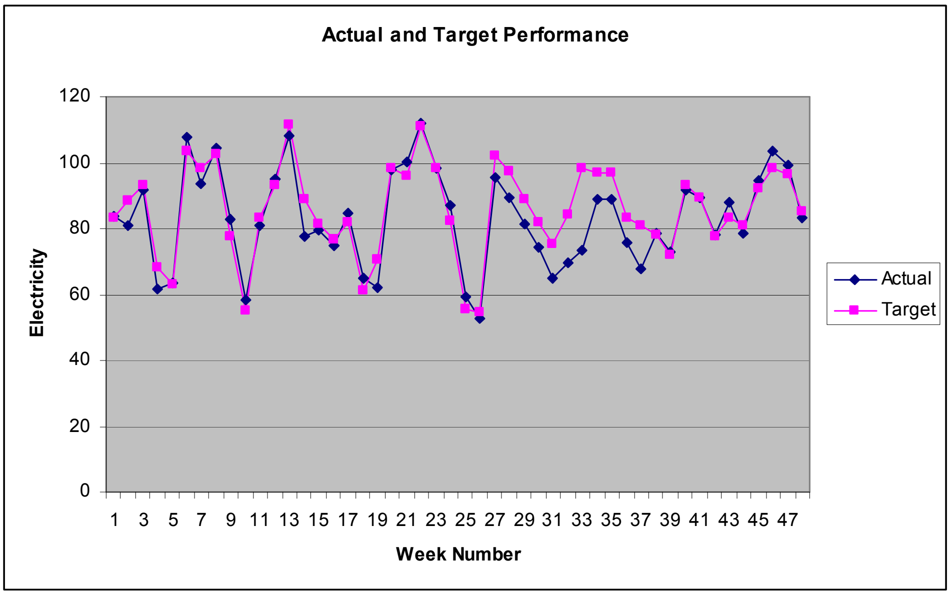

Figure 3: A typical time-series showing actual and target performance for an EAC.

In the time-series examples provided in Figures 3 and 4, there is dramatic improvement in performance in week 27 and the return back to the original performance in week 37. This is much easier to discern in Figure 4, the Cumulative Sum (CUSUM)[6] graph. Wherever a CUSUM graph changes direction, there is an event that merits further investigation and this will be a key analysis tool for the EAC manager.

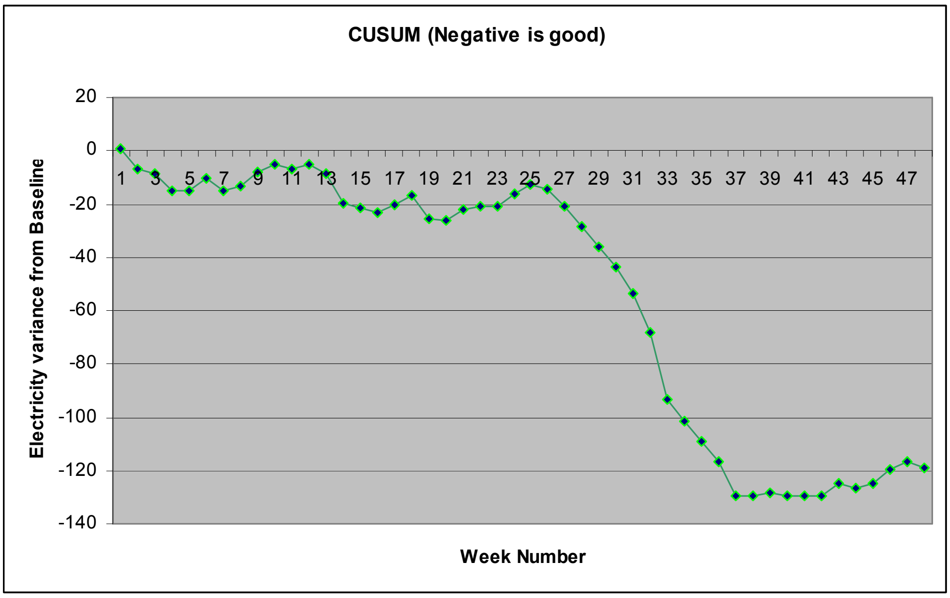

Figure 4: A typical CUSUM graph showing savings compared to the baseline, determined by the sum of variances.

These techniques are immensely powerful in terms of measuring performance and investment at a plant or equipment level and driving improvements. However the aggregate of many lower-level EAC's performance can also provide a highly accurate picture of site-level, or even organisation-level performance, especially where balancing calculations are undertaken at main meter level to account for unmetered consumptions.

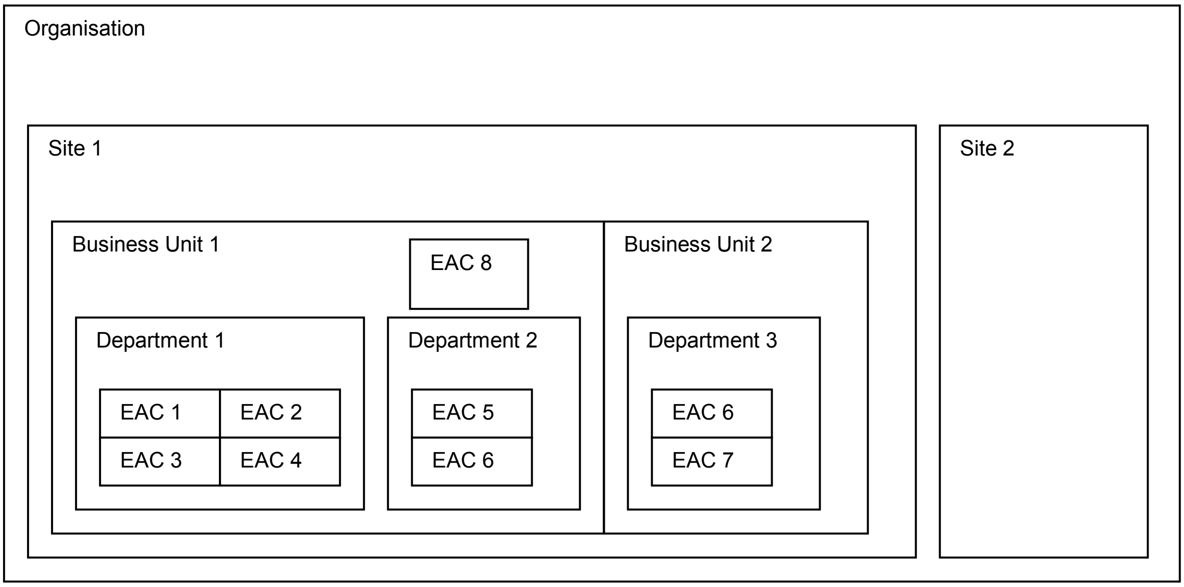

Figure 5: An illustration of the bottom-up approach to corporate emissions management using M&T techniques.

Conclusions

M&T is a proven process, having been applied in the UK since the mid 1980's. In order to achieve savings it involves engaging with employees, so it is no "green plug", "fire and forget" solution. Nevertheless it is the best available technique to drive real, systematic performance improvement.

Because it involves employees, M&T can engender commitment and result in significant operational savings at low capital cost. This author has participated in over 300 projects and in the vast majority of cases the return on investment from the adoption of M&T was less than a year.

While this paper has touched on the measurement aspects of M&T, it should be recognised that there are also important aspects of awareness, motivation and engagement which ensure that all levels of the organisation get behind the program.

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