iJET EXPLORE International Journal of Engineering & Technology
CENTRE OF PROFESSIONAL RESEARCH PUBLICATIONS
ISSN 2049-3444

International Journal of Engineering and Technology Volume 3 No. 7, July, 2013

Optimizing Energy Consumption in Industrial Plants through Effective Energy Monitoring & Targeting

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ABSTRACT

Energy prices have risen to new heights, and supply interruptions are an issue for many industrial plants in Nigeria. Efficient use of energy and active management of energy demand are more important than ever. Electric and gas utilities are under constant pressure to reduce peak demands, and this affects their large industrial customers. Many large customers now have alternate sources of energy to choose from, and this further complicates the energy use equation. Hardware and software vendors are responding to these challenges by offering products that help end users manage and control energy use. This paper explores energy monitoring and targeting techniques, and shows how organizations can adopt an appropriate level of monitoring and targeting in a way which will help them to save energy and cut costs.

Keywords: *Energy Efficiency, Energy Targeting, Energy Management, Energy Monitoring*

1. INTRODUCTION – THE ENERGY DILEMA

Energy is essential to economic development and to meeting the Millennium Development Goals. Yet, according to the United Nations Foundation, 1.4-billion people lack access to electricity and 3-billion people do not have access to clean cooking fuel or stoves. 2-million women and children die prematurely every year due to illnesses caused by indoor air pollution. Energy is the biggest opportunity to address climate change.

According to the International Energy Agency (IEA), the fact is that we have to cut the world's CO2 emissions in half by 2050. However, energy demand – a major source of CO2 emissions – will double by that date. Renewable energy sources are mandatory but not enough to change the energy mix today.

It is expected that Energy demand will double by 2050 while Electricity demand will also double by 2030. In order to save our environment, we will need to half CO2 emissions to avoid dramatic climate change by 2050
The following are expected facts about the world situation by 2030

- 8 billion inhabitants. 60% will live in cities
- 2 billion will join the middle class
- Demand for electricity will be 76% higher than in 2007
- China and India will represent 50% of the incremental energy demand
- 1.3 billion people will not have access to electricity – mostly in Africa and India
- Electric vehicle will represent 60% of world share in passenger vehicle sales
- Renewable energies will have a 22% share in the global energy mix.

2. THE NEED FOR ENERGY MONITORING & TARGETING

The purpose of monitoring and targeting (M&T) is to relate energy consumption data to the weather, production figures or other measures in such a way that one can get a better understanding of how energy is being used. In particular, it will identify if there are signs of avoidable waste or other opportunities to reduce consumption.
An M&T scheme will provide essential underpinning for energy management activities, allowing one to:

- Detect avoidable energy waste that might otherwise remain hidden.
- Quantify the savings achieved by any and all of your energy projects and campaigns in a manner that accounts fully for variations in weather, levels of production activity, and other external factors.
- Identify fruitful lines of investigation for energy surveys.
- Provide feedback for staff awareness, improve budget setting, and undertake benchmarking.

To find out how much one might be able to save, one will need to review his/her current use of energy – this is the heart of the energy survey.

3. ENERGY TARGETING MODELS

Calculating expected energy consumption fall can be done using any of these two models

- Precedence (comparison with previous periods) based targeting
- Activity-based targeting - that relate expected consumption to its driving factors (weather, production throughput, mileage, etc.).

3.1 Precedent-Based Targeting Model

Precedent-based targeting models are most commonly used in monthly monitoring schemes, when expected consumption can be deduced from what was used in the corresponding month a year before. One weakness of this procedure is that it assumes that conditions (especially the weather) were comparable in the two months. This is not always the case, although in some circumstances the differences may not be too significant.

3.2 Activity-Based Targeting Model

Activity-based targeting models calculate expected consumption by reference to its driving factors – the measurable things that cause consumption to vary. Examples of these are given in *Table 1*.

Table 1 – Activity-based targeting – driving factors

Energy Use	Possible Driving factors
Space Heating	Outside temperature
Air Conditioning	Outside temperature, possibly also humidity level
Steam raising	Quantity of steam produced
Production process	Production quantity
Exterior ;lighting	Hours of darkness
Drying	Quantity of water removed from product

To further clarify activity-based targeting model, see below examples of "consumption driven by weather" and "production throughput"

Consumption driven by Weather

With very few exceptions, energy users of all kinds are dealing with weather-related energy consumption, usually for heating but increasingly also for cooling. Here, external air temperature is the dominant influence. For convenience, regional or local air temperature data can be converted into 'degree-day' values, which provide an index of how cold (or hot) the weather was in a given place in any particular week or month

Fuel consumption for space heating will normally exhibit a straight-line relationship to heating degree days (*Figure 1*), while electricity consumption should relate to cooling degree days (*Figure 2*) if any chilling plant exists on the metered circuit.

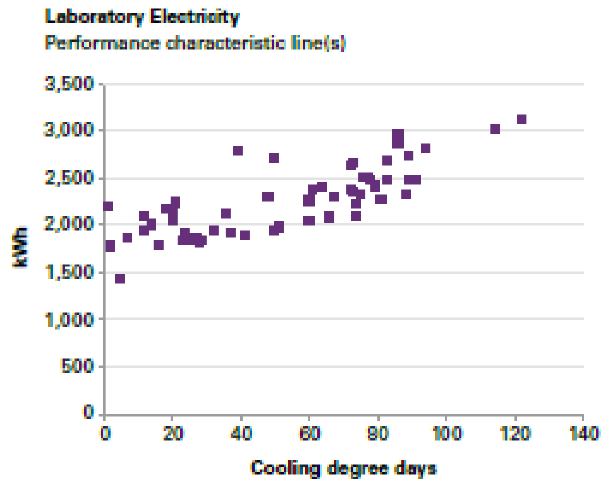

Fig 1 - Example of relationship between fuel consumption and heating degree days

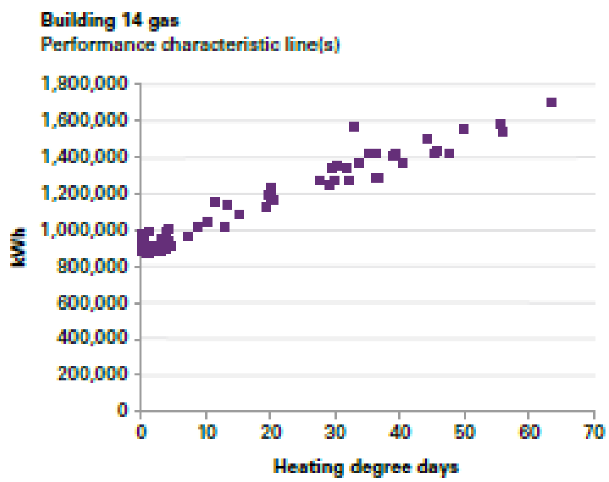

Fig 2 - Example of electricity consumption related to cooling degree days

In either case, it is possible to identify a performance characteristic line which typifies the relationship. For a given degree-day value, the characteristic line enables energy users (or, more usually, the M&T software or spreadsheet) to 'read off' the expected consumption (see *Figure 3*).

In *Figure 3*, the expected consumption where degree days = 28 is 1,250,000kW/h. The intercept (energy = 900,000kW/h where degree days = 0) shows the consumption where no heating is required. The values on the graph at this point could represent gas being used for production or hot water etc. The scatter points can indicate various things, including how well controlled the heating system is, but they can be influenced by other variables such as varying production levels in a factory.

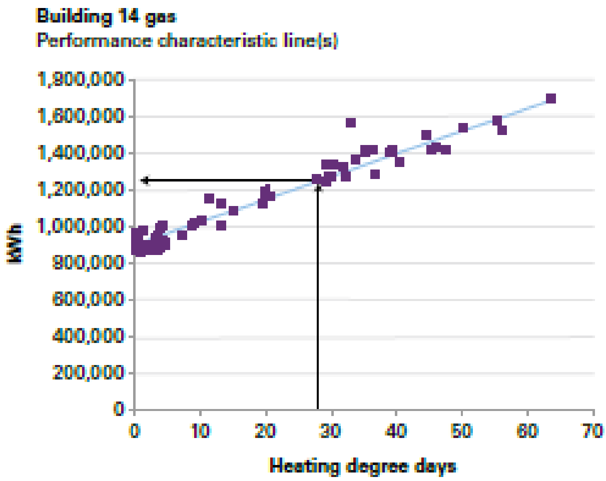

Fig 3 - The performance characteristic line superimposed on the scattered data points

Consumption Driven by Production Throughput

In some (but by no means all) production processes, energy consumption can be related to production throughput using the same straight-line basis that was explained above. *Figure 4* illustrates just such a case for gas used in a commercial bread oven.

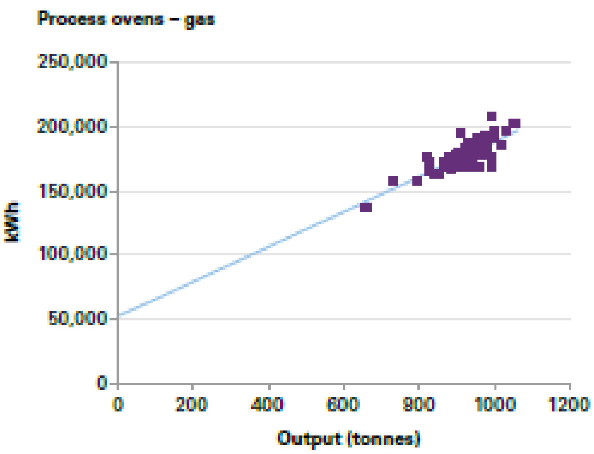

Fig 4 - A performance characteristic line for a simple process

If a simple straight-line relationship is not applicable, other methods can be used. However, as there are operational advantages in being able to represent performance as a straight-line characteristic on a scatter diagram, methods that manipulate the data to make that possible are generally to be preferred.

4. IMPLEMENTING ENERGY MONITORING & TARGETING

In order to implement a Monitoring and Targeting scheme effectively, the following three components must be in place

- Consumption data
- Driving-factor data
- Methods of calculating expected consumption

To manage your organization's energy use you need to implement an effective energy-measurement strategy. This is often referred to as Monitoring and Targeting (M&T).

In brief, the M&T process involves:

- Collecting data on energy and influencing factors such as the weather and production volume.
- Analyzing the data and converting it into useful information.
- Communicating that information to staff.
- Using that knowledge to improve energy efficiency and eliminate waste.

Once an M&T process is established it will help you:

- Detect avoidable energy waste.
- Quantify savings achieved by energy projects and campaigns.
- Identify fruitful lines of investigation for energy surveys.
- Provide feedback for staff awareness campaigns, improve budget setting and undertake benchmarking.
- Calculate achievable energy and carbon targets.

Metering is an important part of M&T. Automatic meter-reading (AMR) systems are a cost-effective and simple way to collect detailed energy data, while portable electric data loggers can be used if converting existing meters to AMR isn't practical.

Consumption data may come from meters (manually or automatically read), from delivery and stock-level figures, or from proxy measures such as run-hours counters or ammeters. The critical task is to ensure that data are synchronized as closely as possible with the required assessment intervals. Repeatability of measurements is more important than accuracy. Systematic bias in readings is of little consequence: it will affect the calculated consumption volume, but the unexpected change that caused it will still be evident.

Meter readings should be read in-house. It is best not to rely on invoice data, as suppliers are under no obligation to provide accurate readings. Nor do suppliers read private sub-meters, which are an important source of data. Furthermore, in-house meter readings can be scheduled at appropriate intervals (such as once a week). On half-hourly metered electricity supplies the data from the supplier will be more reliable, but unless the user makes other arrangements, the data will usually only be available monthly in arrears.

Automatic meter reading is beneficial when meters are inaccessible, too remote, or too numerous for manual reading to be an option. Meters with pulse outputs or serial communications interfaces are needed, along with additional components such as:

- Data loggers (when the meter has no recording capability of its own)
- Data concentrators (when data from multiple logging devices need to be marshaled)
- Gateways (for passing data between networks using different protocols or isolated by a firewall)
- Software to interrogate the devices and record results in a database.

5. CONCLUSIONS

Energy management remains the most effective solution. As energy demands escalate from all aspects of our global society, the most acute pain point is that for every three units of energy created at the power plant, only one makes it to the point of use at the plug. It follow that the war on waste – a focus on the "megawatts" not used – will most likely deliver the best returns for businesses and residences. 57% of the world's CO_2 emission reduction will come from end use efficiency by 2030. The most cost-effective way to deal with high energy prices is to reduce energy use. This is often a byproduct of process optimization, but it can also be the main goal of control system upgrades and refinements.

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