METERING AND MONITORING—M13B

Eco-efficiency opportunities for Queensland manufacturers

Electricity metering

Electricity meters are used to obtain more accurate energy consumption data when undertaking the survey stage of the monitoring plan (see Step 3 in the Metering and monitoring—M13A: Setting up an electricity monitoring plan *fact sheet).*

Meters are used to highlight exactly where electricity is used within an operation. The accuracy required depends on the overall monitoring plan objectives.

Note: Metering is required when undertaking level 2 or 3 energy audits, in line with *Australian/ New Zealand Standard: Energy audits* (AS/NZS 3598:2000).

To optimise the effectiveness of electricity meters, they must

- be installed in the most appropriate location
- record the required parameter
- record information with sufficient detail
- be installed for the right length of time.

This fact sheet provides information to help make these decisions. It should be read in conjunction with fact sheets *Metering and monitoring—M13A: Setting up an electricity monitoring plan* and *Metering and monitoring—M13C: Interpretation of electricity monitoring results*.

Determining electricity usage

Developing an inventory of all equipment can help to determine which equipment may need to be investigated. The inventory should include large electricity intensive pieces of equipment such as ovens, freezers, compressors or air-conditioning systems, and smaller equipment including motors, pumps and fans. Including the hours of use will help to determine which equipment should be prioritised for investigation.

For example, an inventory may show that although motors only use a quarter of the energy of an oven, they are operating constantly and therefore use more energy in total and should be prioritised for investigation.

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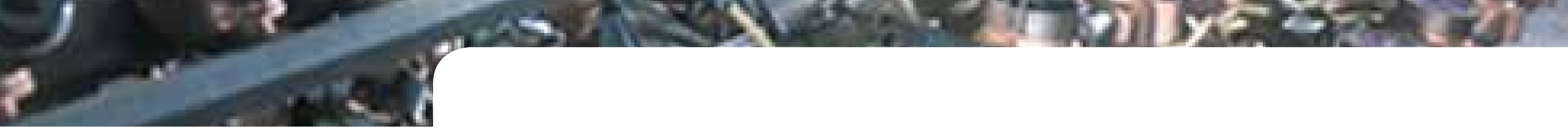


Production variations

The monitoring plan should take into consideration operating and non-operating periods. Collecting data during shutdown periods (overnight or weekends) can identify whether electricity is wasted.

Other variations in electricity use over time should be considered. For example:

- those operations that have several shift changes per day (e.g. night shifts may use fewer production lines compared with day shifts, which may correspond to reduced energy use)
- seasonal variation in production (e.g. food industry peaking around Christmas or other holiday periods)
- high production periods (e.g. filling unexpected or new customer orders).

If it is not feasible to capture all seasonal variations, they should be considered during the data analysis phase. Examining at least the past 12 months of electricity bills can provide an indication of seasonal variation, but will not provide as much detail as metering equipment (see *Metering and monitoring—M13A: Setting up an electricity monitoring plan*).

Monitoring parameters

Most meters used these days are digital rather than the old analogue type. They work by measuring at least three pieces of data—time, current and voltage. From this they calculate power (voltage times current) and energy (power multiplied by time interval).

Meters can be permanently installed on equipment or distribution boards. There are various meters available for specific applications (e.g. for detecting brownouts, measuring power quality or for basic power measurement), so it is important to use the appropriately rated meter for the application. Your supplier can provide further details of what is available.

There are generally two types of meters:

1. **Accumulative meters** add the electricity use progressively. This is the type of metering provided by the energy retailer and data can be obtained from the electricity bill.
2. **Interval meters** keep a record of electricity used over a specific time interval set by the user (e.g. if the time interval is 60 minutes the amount of energy used during the past 60 minutes will be recorded).

This fact sheet describes considerations for general interval metering, which is most often suited to measuring specific equipment items or factory lines.

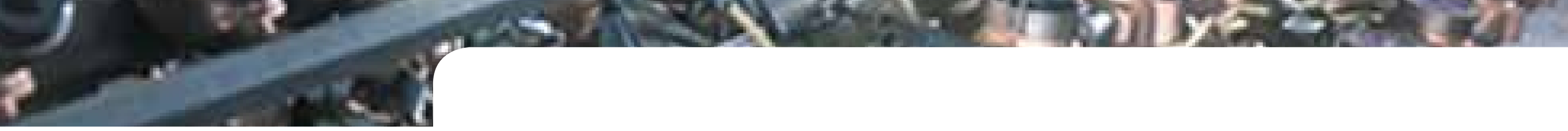
Table 1 below outlines some common electrical terms used in metering and monitoring.

Table 1: Common monitoring parameters

Term	Abbreviation	Description/use
Joule	J	Measure of total energy used.
		Usually represents total electrical and thermal energy use.
Watt	W	Equal to joules per second.
		Measures power or rate of electricity use over time.
Kilowatt hour#	kWh	1 kWh equals 1000 W of energy used over one hour.
		This is the most common unit of electricity use.
Ampere (or amps)	A	Measures current in a circuit.
		It could be used to determine whether a piece of equipment needs maintenance by comparing the current it is drawing over time.
		Current can increase due to general wear and tear of equipment. It could also indicate unbalanced phases or under-voltage conditions.[1]
Voltage (or volts)	V	Measure of the electric potential difference between two points.
		Used to check that the voltage going through the item is within an acceptable range to that specified in the manufacturer's specification. Higher voltage than specified can reduce the life of the equipment and result in energy loss through heat generation.[2]
Active power (kilowatt)	kW	Active power is the energy required to produce work or heat.
		Used to calculate power factor.
Reactive power (kilovolt ampere reactive)	KVAr	Reactive power is the energy required to create a magnetic field.
		Used to calculate power factor.
Actual or total power# (kilovolt ampere)	kVA	The vector sum of active and reactive power.
		Used to calculate power factor.
Power factor		The ratio of total power to active power.
		It is expressed as a number between 0 and 1 (perfect score).
		Generally determined using a power factor meter.
		It is a measure of how efficiently a site is using energy.[3]
		A low power factor is an indication of inefficient energy use.
		Ideal values are between 0.9 and 1.
		Often energy companies apply additional charges if power factors are lower than 0.85 or even 0.90.
		A site that uses a lot of reactive power may have a low power factor.[4]
		For more information see *Metering and monitoring—M13C: Interpretation of electricity monitoring results*.
Harmonics		Harmonics occur when the current and voltage are not in balance. They can cause overheating and degradation of equipment.[5]
		The wave curves of current, voltage and the three phases needs to be measured to determine if there is harmonic distortion.
		For more information see *Metering and monitoring—M13C: Interpretation of electricity monitoring results*.

 # Note that Queensland power suppliers generally charge consumption in c/kWh and demand in $/kW with an additional service fee, compared with some interstate suppliers that charge in kVA.

1 Longo, *What do all those things on an AC motor nameplate mean?*, Longo, New Jersey, viewed 16 December 2011, ‹www.elongo.com/pdfs/MotorNameplate990519.pdf›.
2 Energywise, *Voltage optimisation*, Energywise, Sydney, 2010, viewed 16 December 2011, ‹www.energywise.net.au/index.php?option=com_moofaq&view=category&id=52&Itemid=170›.
3 Schneider Electric, 'Energy University', *Energy University course transcript*, Energy efficiency—Units and concepts, 2010.
4 Schneider Electric, *Energy University course transcript*, 2010.
5 Energywise, *Energy savings—advanced*, EnergyWise, Sydney, 2010, viewed 16 December 2011, ‹www.energywise.net.au/index.php?option=com_moofaq&view=category&id=54&Itemid=172›.



Time intervals

The time interval is the frequency at which the monitoring equipment records the data. The data recorded is the amount of electricity used over that period.

The time interval should be set close enough together to pick up variations in accordance with the objectives. However, if the intervals are too close together a large amount of memory is used up quickly. If the meters have internal memory storage, short time intervals may use up the memory within days and not capture changes over time. Table 2 below provides guidance on choosing a time interval.

Table 2: Typical time intervals

Time interval	Use
Less than 15 minutes	While frequent time intervals can provide very detailed information on energy use, generally the shortest time interval required is around 15 minutes.
	Using very frequent time intervals uses up data storage memory quickly and produces large amounts of data that can be difficult to manage.
	Frequent intervals could be used to determine whether there are instantaneous spikes in energy use; however, generally a longer time interval (such as a 15 minute recording) can provide sufficient information to show this.
15 minutes	Typically the minimum interval used in industry.[6]
	Provides feedback on energy use to determine when and why peak demand is occurring, such as during startup and shutdown periods.
60 minutes	Generally the maximum interval used in industry.[7]
	Could be used initially when developing a monitoring plan, providing general information about energy use that can be shortened if it is determined that the area needs more investigation.
	Can be used to provide information on more general energy use, such as baseline or after-hours energy use or general factory capacity.
Greater than 60 minutes	Generally time intervals greater than 60 minutes may not allow real variation in energy use to be identified.
	Could be used to determine seasonal variation, such as peaks during end-of-month or holiday periods.

Duration

The duration of the monitoring plan depends on the overall objectives (see Step 1 in *Metering and monitoring—M13A: Setting up an electricity monitoring plan*).

At the very least, the meters need to be in place long enough to capture variation in usage. For example, if the objective is to highlight seasonal changes in energy use or month-end production/energy increases, the meters should be in place long enough to capture this data. For monthly changes it would be better to operate the meters to cover at least a three to four month period to minimise the possibility of reading anomalies.

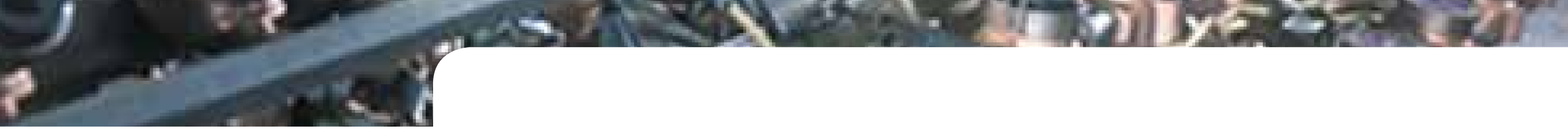
If the metering equipment is only available for a short period of time, the monitoring plan may need to be designed to focus on one aspect, such as a production line, piece of equipment or total electricity use of the business.

For example, metering may be used to:

- determine the comparative efficiencies of different brands of compressors
- determine the amount of electricity consumed by a certain production line
- investigate variations in electrical use to determine if there is any unused capacity.

Temporary or short-term meters and data loggers can be useful to get snapshots of consumption and help develop a more permanent monitoring plan.

Temporary meters can also be useful to determine the best locations for permanent meters. Permanent meters are useful for continuous improvement. They may be installed either on a certain production line or on individual equipment, depending on the needs of the business.



Data management

For long-term energy monitoring, the method for data management needs to be considered.

For simple monitoring systems, data can be manually downloaded from a meter and analysed using basic software.

Alternately a web-based tool could be used to monitor, measure and reduce energy consumption across multiple sites. This could be integrated with an existing or new energy meter and designed to identify where corrective actions could be taken to reduce energy and carbon emissions and decrease costs.

There are numerous companies that offer web-based monitoring software. Contact your existing electricity supplier or a data management software provider for more details.

Logistics and workplace health and safety

There are several different types of meters that can be used. The meter chosen should suit the objectives of the monitoring plan.

The logistics of installing meters and workplace health and safety issues need to be considered when choosing the right meter for the job:

- Power point or plug-in meters plug into the power point and the appliance plugs into the meter. These can be easily installed by anyone on the factory floor. Ensure the meter is designed to handle the current and voltage passing through the equipment (e.g. many meters can handle currents up to 15 A but most industrial equipment use currents well over 15 A). Note that they may not have data storage capacity. Often equipment is hardwired and cannot be plugged into power point meters.
- **All meters connected to machinery or distribution boards must be installed by a licensed electrician.** It is best to engage an electrician who is familiar with meter installation.
- Ensure the licensed electrician understands the requirements of the installation and reads and understands the meter instructions before they install the meters.
- Current transformers (e.g. clamps or tongs) are often required to install the meters. The electrician must ensure the correct size is used for the location. This generally depends on the amount of electricity passing through the wire.
- Other logistics, such as whether there is sufficient space inside the junction box, need to be taken into consideration.
- After a meter is installed, it is important to crosscheck or compare readings (e.g. compare readings with other meters to ensure correct measurements are being obtained).
- Creating simple line diagrams or schematics of the electrical system showing location of meters and major loads/equipment is very useful. This will highlight the best location for meters to be placed and whether there are too many or any redundant meters.

More information

For more information, including the other fact sheets referred to in this document, visit www.ecoefficiency.com.au

For more information on setting up a long-term monitoring and verification plan, refer to *A best practice guide to measurement and verification of energy savings*[6] and the *Australian/New Zealand Standard: Energy audits* (AS/NZS 3598:2000).

This series of fact sheets provides examples and suggestions to the modern manufacturer on how to achieve both economic and environmental benefits from eco-efficiency. Visit the project website at www.ecoefficiency.com.au for more ideas and case studies. This fact sheet has been compiled by the Working Group for Cleaner Production through UniQuest at The University of Queensland.

6 The Australasian Energy Performance Contracting Association for the Innovation Access Program of AusIndustry in the Australian Department of Industry, Tourism and Resources, *A best practice guide to measurement and verification of energy savings*, Energy Efficiency Council, 2004, viewed 16 December 2012, ‹www.eec.org.au/Best%20Practice%20Guides›.

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