Digital is better?

Dr Martin Gill

Certification of smart meters is so woefully inadequate it allows measurement errors to exceed 500%. The AEMC's mandated rollout of these meters, combined with an unwillingness to address the problem, means Australian consumer electricity bills will continue to be calculated using unreliable measurements until at least 2040!

Introduction

The Australian Energy Market Commission (AEMC) has mandated the rollout of smart meters. Over the next 10 years most Australian households will have their meter replaced by an AEMC smart meter.

The AEMC hope the mandated rollout of smart meters will improve the efficiency of Australia's electricity market. In common with many other AEMC decisions they are mistaken.

The problem is the AEMC chose to ignore the growing body of evidence that digital meters are inaccurate [Ref 1]. Specifically laboratory testing shows measurement differences across a range of "approved" digital meters can exceed 500%.

Put another way the AEMC mandate ensures consumer electricity bills are calculated using highly questionable measurements. Worse they will continue to be calculated using these unreliable measurements until the meters are replaced sometime after 2040. This is unacceptable.

Approved Meters

Australia's National Measurement Law requires all equipment used to bill consumers be "approved". Approval is managed by Australia's National Measurement Institute (NMI).

Approval involves the meter manufacturer submitting documentation showing they have tested their meter. Various requirements are detailed in a NMI prepared document, NMI M6 [Ref 2].

For almost a decade NMI have been considering adopting international approval processes. Specifically the International Organisation of Legal Metrology (OIML) R46 which includes additional testing intended to address meter accuracy issues.

While this suggests NMI has both the means and ability to fix meter measurement issues, they continue to move at (a pre-climate change) glacial pace.

Australian and International meter standards

NMI M6 refers to various meter standards. These meter standards were prepared by the International Electro-technical Commission (IEC). The IEC meter standards are used by virtually all countries (excluding the USA and Canada).

NMI could refer directly to the IEC meter standards, however they instead choose to refer to Australian versions of the standards. This creates another barrier to the timely resolution of meter accuracy issues.

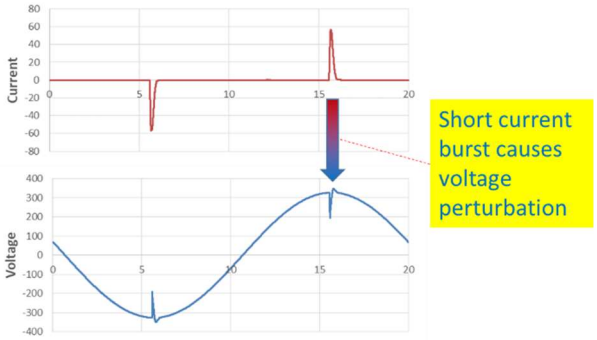
The IEC is working to address the unacceptably large meter measurement errors. A major investigation will release its findings in mid-2021. These finds will *hopefully* result in updates to the IEC meter standards. Unfortunately any improved standards will not be released until at least 2025.

Australian meter standards then lag the IEC versions by a number of years. In Australia meters addressing the issues will not be available until around 2030. By 2030 virtually all Australian household will already have been forced to install an AEMC smart meter. Their electricity bills will continue to be calculated using the unreliable measurements made by these meters until the meter is replaced, sometime after 2040!

Appliance electricity use has changed

The way modern appliances use electricity has changed. Many appliances, including pool pumps and lights now draw current in short bursts.

Electricity use of modern appliances



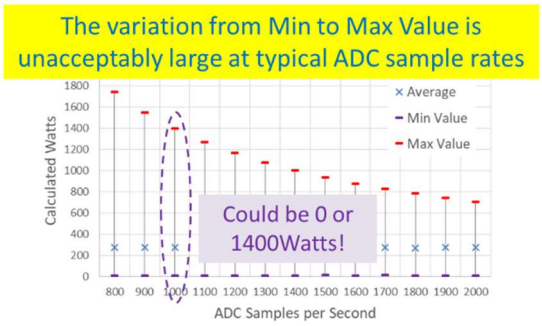
Laboratory testing shows when the above voltage and current are applied to a range of "approved" meters differences can exceed 500%! These measurement differences are well outside the meter accuracy determined using existing test methods.

The problem arises because testing detailed in meter standards is unrelated to the electricity use of modern appliances. As a result claimed meter accuracy is unrelated to actual measurement errors.

One possible reason

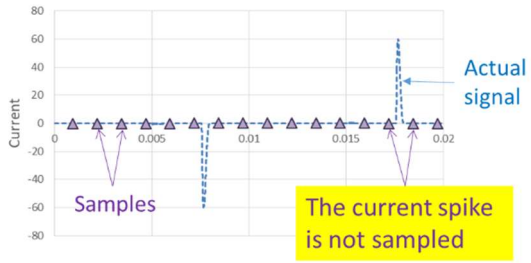
Smart meters use micro-processors (small computers) to perform the calculations. The first step is to convert the voltage and current waveform to a digital format. This involves sampling the waveform.

The failure to apply meaningful test waveforms allows meter manufacturers to sample the waveforms slowly (lowering the cost of the meter). The following figure shows calculated Watts when the above waveform is sampled at rates typically used by most meters.



The figure shows individual measurements can vary significantly, for example a meter sampling the voltage and current waveforms 1000 times a second will report the Watts somewhere between 0 and 1400! The variation depends on where the samples fall.

Sampling the current waveform 800 times a second



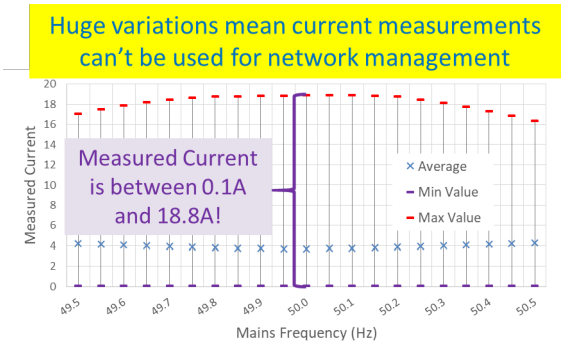
The above figure shows the sample points corresponding to the Min Value, revealing the meter failed to sample the current spike. The conclusion is slow sample rates cannot accurately represent actual appliance waveforms, resulting in large measurement variations.

Smart Meters and Power Quality Analysers

In common with most smart meter rollouts the AEMC requires their smart meters be capable of making power quality measurements. In particular all meters must measure both voltage and current.

Accurate voltage and current measurements can be used to improve the efficiency of the electricity network. For example identifying areas in which the installation of domestic solar systems is causing over-voltage.

For the measurements to be useful the meters must capture short term peaks, for example to identify where a voltage peak might have caused damage to appliances.



The above figure shows how small changes to the mains frequency affect current measurements. This suggests current measurements lie somewhere between 0.1Amps and 18.8Amps! Such huge measurement variations mean the measurements cannot be used to manage distribution networks.

The AEMC meters are only required to report average voltage and current (average voltage and current does not deliver network benefits). The above figure reveals even this figure varies by 20% for a 0.5% change in mains frequency. Hence even the average values reported by AEMC meters are probably too unreliable to be used to significantly increase the efficiency of electricity networks.

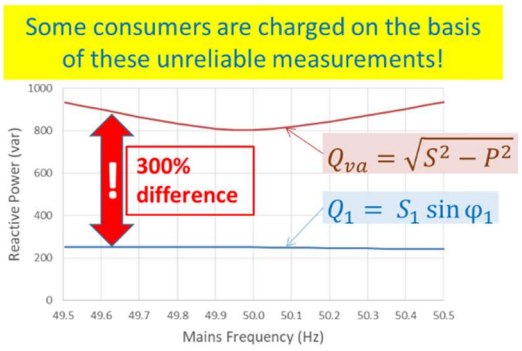
To be clear meter standards do not test voltage and current measurements. If the AEMC wanted their meters to support network benefits they should have referred to other standards. That they failed to do so supports the assertion they do not understand the issues.

Reactive Energy Measurements

Another claimed benefit of the AEMC smart meters is the measurement of reactive energy (varh).

To date no testing has been released detailing reactive energy measurement errors. It is anticipated such testing will also reveal huge measurement differences. The reason is because reactive energy meter standards apply the same overly simplistic voltage and current waveforms shown to be unrelated to actual appliance electricity use.

Here it is suggested the measurement differences are likely to be even larger. The reason is because the reactive energy meter standards fail to define how reactive energy should be calculated. When applying the overly simplistic waveforms differences between various algorithms are relatively minor. As more realistic waveforms are applied the differences become far larger.



The above figure compares two common reactive energy algorithms. The analysis reveals a 300% difference when using actual appliance waveforms. Note: this difference would be *in addition* to the measurement differences reported for active energy.

The AEMC primarily included reactive energy measurements to improve the efficiency of the electricity network. Given the huge measurement differences it is considered unlikely reactive energy measurements will benefit network operators.

While small consumers are not billed for reactive energy, many business customers are. It is hoped in the near future laboratory testing will be released providing insights into the accuracy, or more likely inaccuracy, of the reactive energy measurements made by digital meters.

"Inadequacies"

In their analysis of meter errors Rietveld [Ref 1] notes:

> Our study also [revealed] a few meters with shunt and current transformers showed error readings, up to 40%. For the latter types, the error reading might not be related to the current sensing technique but due to other inadequacies

The measurement differences presented in this article arise purely from digital sampling, in all other regards the meter is perfect. The analysis is intended to confirm Rietveld's comment "other inadequacies" can cause significant measurement differences.

It is not suggested meter standards specify a minimum sampling rate! For example as the sample rate is increased the difference between the two reactive energy algorithms shown above would actually increase.

Updating meter standards to include more realistic testing is actually only the start. As noted once realistic waveforms are applied it leads directly to questions about the accurate value when these realistic waveforms are applied.

Conclusion

All meters used to bill consumers must be approved by Australia's National Measurement Institute (NMI). This approval requires meter manufacturers submit documentation they have tested their meter.

NMI documentation makes extensive use of meter standards, however testing detailed in these standards has been shown to be inadequate. This leads directly to concerns consumer electricity bills are inaccurate.

The NMI continues to monitor international developments. Disappointingly waiting for an international solution means Australian electricity bills will continue to be calculated on the basis of unreliable measurements until at least 2040.

Perhaps a faster solution is available. The Australian Energy Market Commission (AEMC) has mandated the rollout of smart meters. Measurement inaccuracies mean the cost savings used to justify the mandate will not be delivered. The AEMC could protect consumer interests with minor changes to their meter specification. For example defining the Reactive Energy algorithm and test waveforms to verify the algorithm.

Unlike Standards organisations, the AEMC can make rapid changes to Australia's metering rules. It is just a thought.

References

1. Conducted EMI causing Error Readings of Static Electricity Meters, Rietveld, Hoogenboom and Acanski

2. National Measurements Pattern Approval NMI M6

Citation

Please accurately attribute all quotes and references to this article including the title "Digital is better?". It would be appreciated if references included the author's website drmartingill.com.au.

Comments or Questions?

The author is happy to receive comments or questions about this article. He can be contacted at martin@drmartingill.com.au

About Dr Martin Gill

Dr Martin Gill is an independent consultant specialising in the provision of consumer advice. This advice is based on a deep understanding of Australia's energy industry and strong analytical skills. As a consultant he has prepared advice for consumer advocates, government regulators, electricity distributors, electricity retailers, asset operators and equipment vendors.

Dr Gill is a metering expert. During the National Smart Metering Program he facilitated the development of a specification for Australian smart meters. Innovative metering products developed by his teams have been externally recognised with the Green Globe Award, NSW Government's Premier's Award and Best New Product by the Australian Electrical and Electronics Manufacturers Association.

He currently represents the interests of consumers on a range of Standards Australia working groups including metering, renewable power systems, battery storage and demand management.