Proposal for a new 'Small Load' Metering Regulatory Framework for street lighting

26 February 2018

1 | Executive Summary

One of the key barriers in the National Electricity Market (NEM) to the widespread uptake of LED street lighting with smart controls is the current approach to assessing the electrical consumption of street lighting. This was identified in the 2016 IPWEA Street Lighting and Smart Controls Programme Roadmap and in a previous paper by the Lighting Council Australia[1].

This Discussion Paper, commissioned by the Commonwealth Government's Department of the Environment and Energy (DEE) on behalf of the COAG Energy Council's Equipment Energy Efficiency Program, explores the need for a new "Small Load" metering approach tailored to small, dynamic electrical loads in the public domain such as street lighting as well as other emerging smart city devices. This would improve the accuracy of the current metering data calculation approach and help facilitate the widespread introduction of these technologies and the increasingly important societal benefits that they can cost-effectively deliver. This paper has been prepared with input from the Australian Energy Markets Operator (AEMO) and the National Measurement Institute (NMI).

The electricity consumption of most of the 2.4 million utility-owned street lights in Australia is currently assessed through a calculated methodology under an approach referred to as Type 7 metering.

The Type 7 metering approach assumes that street lighting loads:

- are constant;
- remain as first measured in a lab when the lights were new; and
- turn on fully at sunset and turn off at sunrise.

To produce an invoice, the amount of electricity to be charged for is based on this constant load assumption for each light, which is then multiplied by the inventory of street lights held by the utility, for each customer and the applicable network distribution and retail tariffs.

The current Type 7 metering approach was entirely appropriate for the previous generations of lighting and lighting controls but is inadvertently creating a barrier to adoption of street lighting smart control technology.

Smart street lighting control systems are able to:

- accurately measure electricity consumption;
- remotely monitor and report on performance;
- support a wide range of asset management functions;
- maintain constant light output over time;
- trim excess lighting output; and
- adapt lighting levels (both up and down) to meet societal needs.

Smart street lighting control systems are being widely adopted overseas but take-up in Australia has been limited to date at well under 1 per cent. In contrast, more than 35 per cent of the street lights in the UK are now estimated to be controlled by smart controls while large municipal and utility smart street lighting controls deployments are currently underway in the US (e.g. Los Angeles at over 150,000 and Georgia Power at over 400,000 and Florida Power & Light at over 500,000). While not considered as an efficient solution suitable for Australia , the UK's Elexon system for metering dynamic street lighting loads using street lighting Central Management Systems and the example set by Georgia Power USA's use of street lighting Central Management Systems for metering and billing of dynamic street lighting loads provides useful input and learnings. These solutions require hundreds of profiles to be administered to cater for the various customer requirements, which overtime has proved to be

[1] Discussion Paper – Smart street lighting in Australia July 2016

very complex and costly. As such, the preferred approach for fully adaptive street lighting in Australia is introduction of a new small load metering framework.

Main road authorities in Victoria, NSW and Queensland as well as councils are currently considering the benefits of adopting smart lighting controls to dynamically adjust lighting levels to traffic conditions[2], save energy, reduce emissions, reduce environmental impact where lighting levels are unnecessarily high and improve asset management, and support a range of other smart city devices that can be cost-effectively co-located in the street light luminaire or on the street lighting pole.

At present, even if a street lighting customer (generally a main road authority or council) and the utility agreed on the deployment of LEDs with smart controls, there is no practical way for the actual consumption in the field to be reflected on a bill. Having a metering mechanism to properly reflect the energy savings benefits of trimming and dimming is an important aspect of building the business case for smart controls. For example, dimming just half of the 75,000 main road lights in the Ausgrid region by 50 per cent for half the night (e.g. 11pm to 5am) would save councils an estimated $825,000 per year based on current energy pricing. Such savings are an important part of the business case for smart controls.

To achieve high levels of accuracy with large loads, the current metering system in the NEM is necessarily complex but this complexity applies irrespective of the amount of electricity being metered.

This paper recommends that, for very small controlled loads like LED street lighting, a new Small Load metering approach is needed. The introduction of a Small Load metering approach would not only allow for variable loads to be measured but could be both more accurate and more reliable in metering the consumption of each street light than at present. Thus the customer would only be paying for the actual amount of energy used.

While consistent with the metering principles used at present, a new Small Load metering approach should make necessary adaptations for the capabilities of the new technology, the location of the devices it is measuring in the public domain and the small scale of load being measured. In short, while being accurate and robust, compliance with a proposed new Small Load metering approach should be simple, easy, economical and able to cope with the rapidly evolving technical change happening with LED street lighting, smart street lighting control technologies and smart city devices.

Importantly, IPWEA is suggesting that Small Load metering be initially introduced as an option, not a replacement for current Type 7 metering. Type 7 metering arrangements should continue to be used for street lighting without smart controls and for customers who install smart controls but choose not to change their billing arrangements.

Drafts of this Discussion Paper have been distributed to street lighting stakeholders around Australia (electricity distribution utilities, councils, main road authorities, AEMO, NMI, Australian Energy Regulator, Australian Local Government Association, Energy Networks Australia and Lighting Council Australia) for comment.

[Insert summary of feedback received from stakeholders to draft indicating if IPWEA believes that there is broad support for lodgement of a rule change request to initiate a review of street lighting metering arrangements in Australia.]

---

[2] In parallel with the need to review street lighting metering arrangements discussed in this paper, IPWEA acknowledges important parallel research work that the Queensland University of Technology is undertaking, with the support of some main road authorities, to advance knowledge about safe lighting levels on main roads.

[This page left blank to insert summary of comments from key stakeholders.]

2. Introduction

2.1 Street Lighting and Smart Controls (SLSC)

This Discussion Paper is a summary of investigations undertaken by the Institute of Public Works Engineering Australasia's (IPWEA's) Street Lighting and Smart Controls (SLSC) Programme on street lighting metering arrangements. The IPWEA SLSC is a public-private partnership managed by IPWEA and supported by the Government (through the COAG Equipment Energy Efficiency Program), the private sector, key industry associations and other stakeholders involved in street lighting. The SLSC Programme's objective is to accelerate the adoption of highly beneficial LEDs and smart controls in the street lighting sector. The SLSC Programme, its participants and a range of resources can be found on the website http://www.slsc.org.au/.

2.2 Australian Government Commission

This paper, and its consultative outcomes, have been commissioned by the Commonwealth Government's Department for the Environment and Energy (DEE) on behalf of the COAG Energy Council's Equipment Energy Efficiency Program, to identify the potential changes needed to public lighting metering arrangements to enable data from smart controls to be used for billing purposes, and to consult on these proposed changes to inform a possible rule change request for submission to the Australian Energy Market Commission (AEMC) on this matter.

The AEMO is responsible for operating Australia's National Electricity Market (NEM)[3]. Its responsibilities include administrating compliance with the metering framework. At the officials' level, IPWEA understands that AEMO have indicated their support for the need to review street lighting metering arrangements in the context of new technology that can provide greater accuracy of billing to public lighting customers.

2.3 SLSC Programme Roadmap

The SLSC Programme published a Roadmap in December 2016 which identified several barriers to accelerated uptake of the new LED street lighting and control technologies including regulation. These were identified in Chapters 4 and 11 in the Roadmap which is available for free at http://www.slsc.org.au/slsc/slsc-programme/slsc-roadmap. One of the identified regulatory barriers was the limitations of the current Unmetered Load Tables used to determine street lighting energy consumption. The Roadmap also includes an overview of public lighting smart control technology and benefits.

3. The Current Type 7 Metering Approach and its Limitations

3.1 Overview of Current Type 7 Metering Approach

Currently, it is a requirement for street lights in the NEM that are utility owned and managed and not on separate metered circuits to comply with a Metering Classification called a Type 7 Meter as described by the National Electricity Rules (NER) in Chapter 7.

The Type 7 Meter is not a meter *per se* but rather, it is a compliance process that ensures the electricity used by a street light can be calculated and paid for with reasonable accuracy. Broadly, the Type 7 compliance process involves assigning an assessed load for each light based on:

1. Calculation of energy consumption based on the luminaire manufacturer's specifications (rather than measuring energy used *in situ* over time);

3 Including the interconnected power system in Australia's eastern and south-eastern seaboard, and the Wholesale Electricity Market (WEM) and power system in Western Australia. (Source AEMO website accessed 20-8-2017)

2. Independent verification of the luminaire manufacturer's stated electrical load by a NATA[4] accredited test laboratory of a sample of new luminaires in lab conditions and then inclusion of that light and its assessed load on the Unmetered Load Table;
3. A lighting inventory managed by the DNSP to determine how many lights of each type are to be charged for; and
4. Assumptions about fixed switch-on and switch-off times based on sunset and sunrise times as published by Geosciences Australia.

The Type 7 metering approach described above was entirely appropriate for the previous generations of lighting and lighting controls where lighting technology was stable and loads were, for all practical purposes, fixed.

3.2 Limitations of Type 7 Metering Approach

While appropriate for previous generations of technology, there are a number of challenges with the Type 7 metering approach which have been identified in consultation with industry stakeholders (and which a new Small Load metering approach should be able to better address). These include that:

1. Luminaire energy consumption changes over time meaning that highly accurate lab tests of initial energy consumption many not accurately represent long-term consumption;
2. Photocell switch on and off times drift over time as their optical sensitivity changes and airborne dirt accumulates, meaning that assumed hours of operation may not be accurate;
3. Underlying inventory accuracy may not always be robust (with respect to both the number and type of lighting), particularly in older areas that have been subject to successive generations of lighting replacement.

Looking forward, the Type 7 metering installation framework is not able to support the enhanced capabilities of the new smart controls technologies entering the market. Specifically, the Type 7 metering approach:

1. Is unable to accommodate adaptive[5] variable load in a street light (e.g. that would result from constant light output settings, trimming, dimming and brightening); and
2. Is unable to accommodate additional load being connected to a street light (e.g. as a result of additional sensors or other smart city devices being embedded in, on or co-located with street lighting luminaires with power supplied to these devices either directly from the same supply via the smart control node or via the power supply within the luminaire)[6].

3.3. Compelling need for an additional new Small Load metering approach

For the reasons noted above, IPWEA has concluded that the current Type 7 metering approach is no longer "fit for purpose" as it makes it impossible to realise the full energy efficiency and economic potential offered by LEDs and smart controls.

Left unaddressed, sole reliance on the Type 7 metering approach may hinder not just the timely adoption of LEDs and smart controls but also hamper the adoption of other new smart city technologies that 'piggy back' on top of smart lighting controls and help facilitate achievement of smart cities goals and reduce any adverse environmental or social impacts of lighting.

---

[4] NATA stands for National Association of Testing Authorities, whose website is at https://www.nata.com.au/nata/about-us/our-role

[5] While discrete or prescriptive dimming can be accommodated under the current type 7 metering framework, for example, as used for NSW traffic signal dimming, there is no ability to account for dynamically altering light output.

[6] SA/SNZ TS 1158.6 already suggests the use of 7-contact photocell receptacles meeting NEMA C136.41 with two contacts reserved for the addition of smart controls sensors. Street lights using NEMA C136.41 photocell receptacles are now being widely deployed by Australian utilities as their default approach but at present there is no way to facilitate the addition of smart city sensors to luminaires via these devices because such devices would change the power consumption of the luminaire.

The need for a new Small Load metering approach is both compelling for the range of societal benefits outlined in the next section but, if implemented effectively, can substantially improve metering accuracy by addressing the accuracy challenges raised in the previous section (e.g. measuring actual rather than calculating load, measuring the actual and not assessed start/stop times and measuring the actual number of luminaires and not relying on an inventory that may have not been maintained).

Implementing a new Small Metering approach would allow Australia to gain full advantage of the technological benefits on offer and improve the accuracy of load measurement. The accurate measuring of dynamic loads and charging accordingly, would provide cost savings to road authorities, and subsequently to the community.

4 Proposal for a New 'Small Load' Metering Regulatory Framework for Street Light Metering

In order to meet the challenges described, this paper proposes the addition of a new Small Load metering regulatory framework for measuring the electricity use of street lights and other small energy consuming devices in the public domain where energy consumption can be accurately measured via smart controls overseen by Central Management Systems (CMSs).

The purpose of the new Small Load metering framework would be to allow for the introduction of simpler and more accurate metering of energy consumption for *each individual* light and other very small loads. This will, in turn, allow users to take full advantage of the new technologies, delivering a range of enhanced services as well as delivering energy and cost efficiencies.

Following stakeholder consultation, it is envisaged that this paper will inform the basis of a proposal to the AEMC for a rule change to have the NER recognise and regulate a new type of metering system.

Further consultation will also be progressed with NMI, as the trade measurement framework is prescribed in the National Measurement Act. It is considered that smart control technology, as a remote meter, provides the “equivalent” service to a physical meter and legislative change to the National Measurement Act will not be required. This is on the basis that the individual luminaire can be identified via an IP address and GPS location and the metered data can be made available to the customer online through appropriate access and security protocols. This provides a high level of confidence to the customer that the metering data relates to the individual luminaire energy consumption. This assumption needs to be tested with NMI, as well as determining the steps needed to formally accept smart control meters into the National Measurement Institute’s framework.

4.1 Why smart street lighting controls and accurate metering are important

LED lighting and smart street lighting control technologies have advanced greatly in recent times, providing many features and advantages that offer significant improvements compared with older technologies. These include:

- greater energy efficiency (more than 50 per cent energy use reduction on average) with the ability of smart controls to provide variable lighting (saving another 10-20 per cent in energy use);
- maintenance of lumen output for the life of the luminaire;
- lower environmental impact (lower GHG emissions, lower light pollution, no mercury use);
- higher amenity (better quality lighting with increased lighting levels when required);
- improved road safety (through adaptive high visual-performance white lighting);
- better asset management (automatic population of asset registers including GPS location, condition monitoring, predictive maintenance and energy reporting);
- lower maintenance costs (reduced by more than 50 per cent); and

- a digital infrastructure providing a foundation for smart cities.

These significant policy benefits are explained in the SLSC Roadmap. In the context of this paper, it is important to note that many of the above benefits are inter-related. Specifically, it is the digital power supplies of the LED luminaires coupled with smart controls that allow variable lighting output together with a wide variety of asset management and other benefits. And, it is only through the use of the metering capabilities of smart controls systems that confidence can be brought to variable load measurement.

4.2 Change that integrates proportionately with current metering framework

Accurate and reliable metering ensures that electricity used is correctly assessed and paid for. Australia has made substantial investments in a framework designed to provide regulatory surety in an economy that was required to meter 248 Terawatt Hours of electricity in 2014[7] representing a total turnover for all electricity costs (distribution, transmission, energy and levies) of $69.4 billion. Consumption figures provided by the Chief Economist for all three electricity markets in Australia (the NEM, Western Australia and Northern Territory) show this $69.4 billion sector allocates its costs across about 11.5 million[8] customers. Within the jurisdiction of the NEM, the National Electricity Rules (NER) utilise seven different types of metering frameworks to cope with the task of measuring electricity consumption across the NEM for various types of loads.

The Type 7 metering installation framework, used exclusively for street lighting and traffic signals[9], is based on a load calculation and not a meter as explained above in section 3.1. The convention is to treat street lighting as a static load, so the NER provide an approximate means of determining the total street lighting electricity load and how it should be applied to the NEM's council and main road agency customers.

In brief, the NER Type 7 regulatory framework determines how a total of 1.1 Terawatt hours per year used in street lighting (corresponding to 0.4 per cent of Australia's total load and worth about $177 million/yr[10]) is paid for by approximately 560 main road authority and local government council customers based on old technology assumptions.

While playing a vital societal role, the street lighting sector is a relatively small and easily-defined sector of the Australian electricity market comprising 0.005 per cent of the total customer base and 0.4 per cent of the total electricity load. This means that a highly targeted approach can be taken to design new regulations that will integrate with the existing framework.

These proposed new regulations should not only provide for the systematic introduction of new street lighting and smart control technologies, but also should allow for the introduction of a new metering framework - that treats street lighting as a dynamic and variable load - so that the regulatory and pricing signals will ensure users will make the most of the new technologies for the benefit of Australia overall.

Compliance with a proposed new Small Load metering regulatory framework for metering the electricity usage for street lighting should be simple, easy, economical and practicable. In particular, any regulatory framework should be:

- 'compliance-friendly' for local councils and main road agencies which are working for the public good, and which have wide responsibilities, budgets under pressure, and little expertise in the electricity sector; and

7 Energy in Australia 2015, Chief Economist, Department of Industry, Innovation and Science, page 47.

8 Note that every customer must have a meter (a Type 7 meter in the case of public lighting) so the minimum number of meters in existence is the number of customers. However, many customers have several meters.

9 Type 7 metering installation framework only applies to traffic signals in NSW and SA.

10 Institute of Public Works Engineering (IPWEA), Dec 2016, *Street Lighting and Smart Controls (SLSC) Roadmap*, for the Department of the Environment and Energy, Australian Government.

- practicable in terms of the small amount (and cost) of electricity used by LED street lighting, and the use of control technology that provides inbuilt accurate metering capabilities.

Smart street lighting control systems are being widely adopted overseas but take-up in Australia has been limited to date at well under 1 per cent. In contrast, more than 35 per cent of the street lights in the UK are now estimated to be controlled by smart controls while large municipal and utility smart street lighting controls deployments are currently underway in the US (e.g. Los Angeles at over 150,000 and Georgia Power USA at over 400,000 and Florida Power & Light at over 500,000). While not considered as a solution suitable for Australian circumstances, IPWEA suggests that the UK's Elexon system for metering dynamic street lighting loads using street lighting Central Management Systems and the example set by Georgia Power's use of street lighting Central Management Systems for metering and billing of dynamic street lighting loads be considered as useful input.

4.3 Maximum load and load range is a critical metering parameter

The first key attribute is the maximum load that each type of meter is designed to measure. This is because accuracy demands are greatest when the electrical loads are at a maximum. Thus, accuracy requirements are set to ensure that errors are at their smallest acceptable level when the loads are at the maximum permitted level.

Furthermore, a meter's accuracy (and other performance parameters) must be acceptable across the *range* of operating energy loads. A meter expected to be accurate to 1.5 per cent for a maximum load of, say, 750 MWh per year (as in Type 4 interval[11] meters that are remotely read) must also be verified as achieving a measurable level of accuracy at all load points required of it leading up to that maximum. Meter accuracy for large loads is verified across many different loads to ensure compliance with requirements.

However, it is more difficult to manufacture a meter that can operate with a similar level of accuracy across a wide range of loads than it is to make one which is accurate across a narrow load range. So, this important performance requirement for metering large electricity loads is not relevant to street lighting where the *maximum load*, and the load *range*, is extraordinarily small compared to the requirements of "normal" NEM-compliant meters. Therefore, performance measures of both accuracy at maximum load, and accuracy across the range of the loads, are not difficult to satisfy and do not warrant such close scrutiny.

4.4 Maximum load and load range for street lights

As identified in the SLSC Roadmap, in Australia there are 2.4 million street lights of which about 0.9 million are 50-125W Mercury Vapour (MV)[12]. In the next few years, most of these luminaires will be replaced by much more efficient 20-30W LEDs that correspond to a yearly electrical load of about 0.1 MWh. This is in line with the proposed ratification by the Commonwealth Government of the Minamata Convention on Mercury that would result in an import ban on mercury vapour street lamps from 1 January 2020.

Metered individually, a 20-30W LED street light electricity load of 0.1MWh will cost about $19 per year (4 cents per night) with electricity costs at say 15c/kWh. Further reductions due to part-night switch-off, trimming and dimming are made possible by smart controls which also have the ability to deliver accurate metering.

4.5 Current processes used to ensure Type 1 to 6 meters facilitate an efficient NER market

As identified previously, the current metering regulatory processes ensure that more than 11.5 million customers using about $70 billion worth of electrical energy is done so efficiently in the economic

11 An "interval" meter is one that measures the electrical energy used every ½ hour interval as required by the NER

12 Street Lighting and Smart Controls (SLSC) Roadmap, Institute of Public Works Engineering Australia (IPWEA), December 2016, Table 13, page 49

interests of Australia. Figure 1 shows how a new meter can be introduced to the market by a manufacturer in order that it satisfies the NER. This complex system operates regardless of the amount of electricity being used and metered, and this paper argues that some aspects may be unnecessarily complex for the small size of the controlled LED street lighting loads (and for the similarly small loads of smart city devices that will be soon be ubiquitous in the public domain).

There are two distinct requirements under the National Measurement Act:

a. Pattern Approval: This is required before a meter model can be sold or installed. The meter model is assessed for compliance against a standard under various environmental conditions.
b. Verification: Once a certain meter model is pattern approved, then the individual meters (for a particular model) need to be verified by utility meter verifiers appointed by NMI, before installation and use. This step ensures that each meter is operating accurately.

Once an electricity meter has been installed, the NER charges AEMO with the responsibility to ensure that the electricity market is well served with continuous and accurate metering that ensures the cost of electricity is fairly paid for. This is illustrated in Figure 2 below.

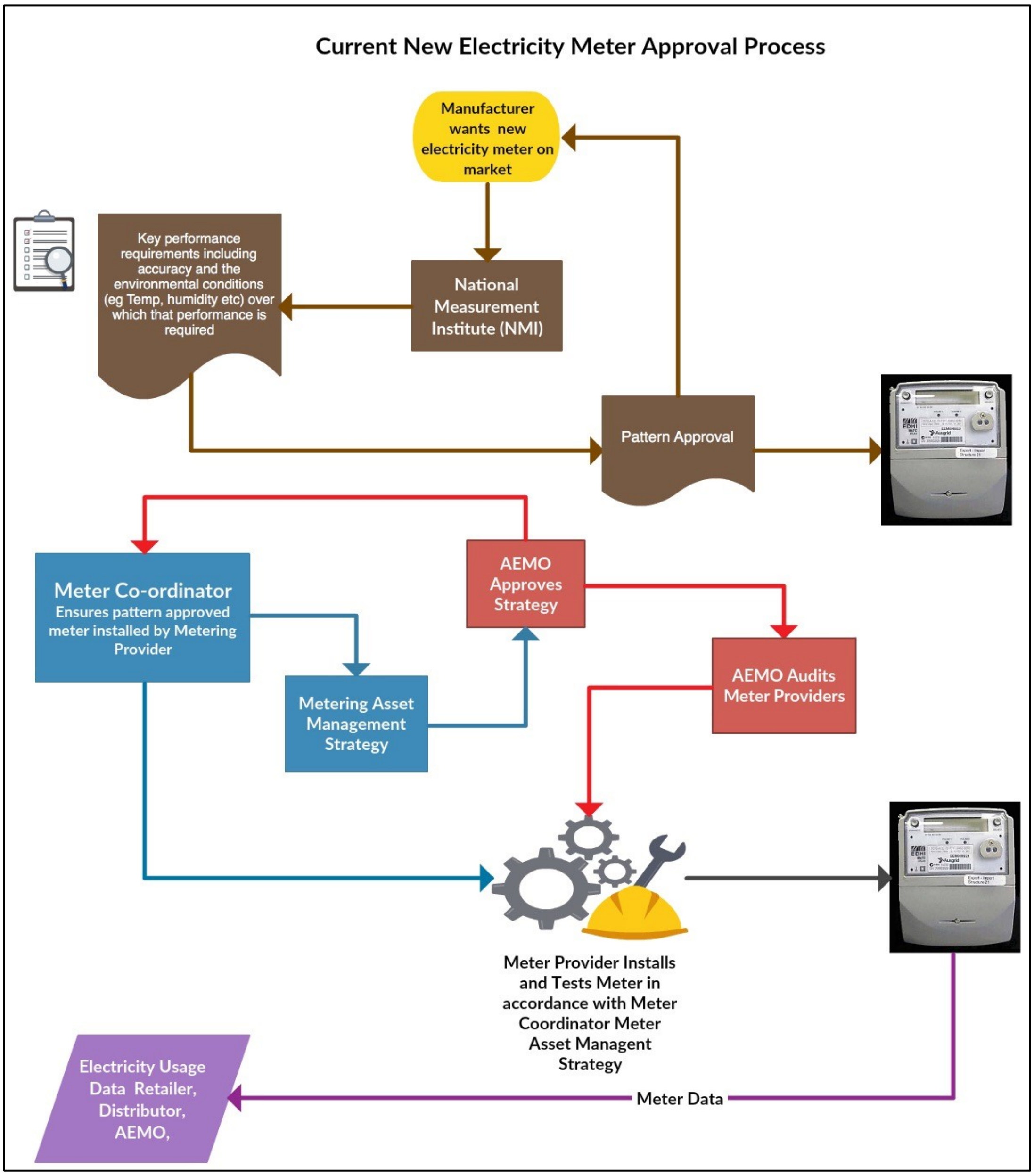


Figure 1: Process to introduce a new Electricity Meter to NEM

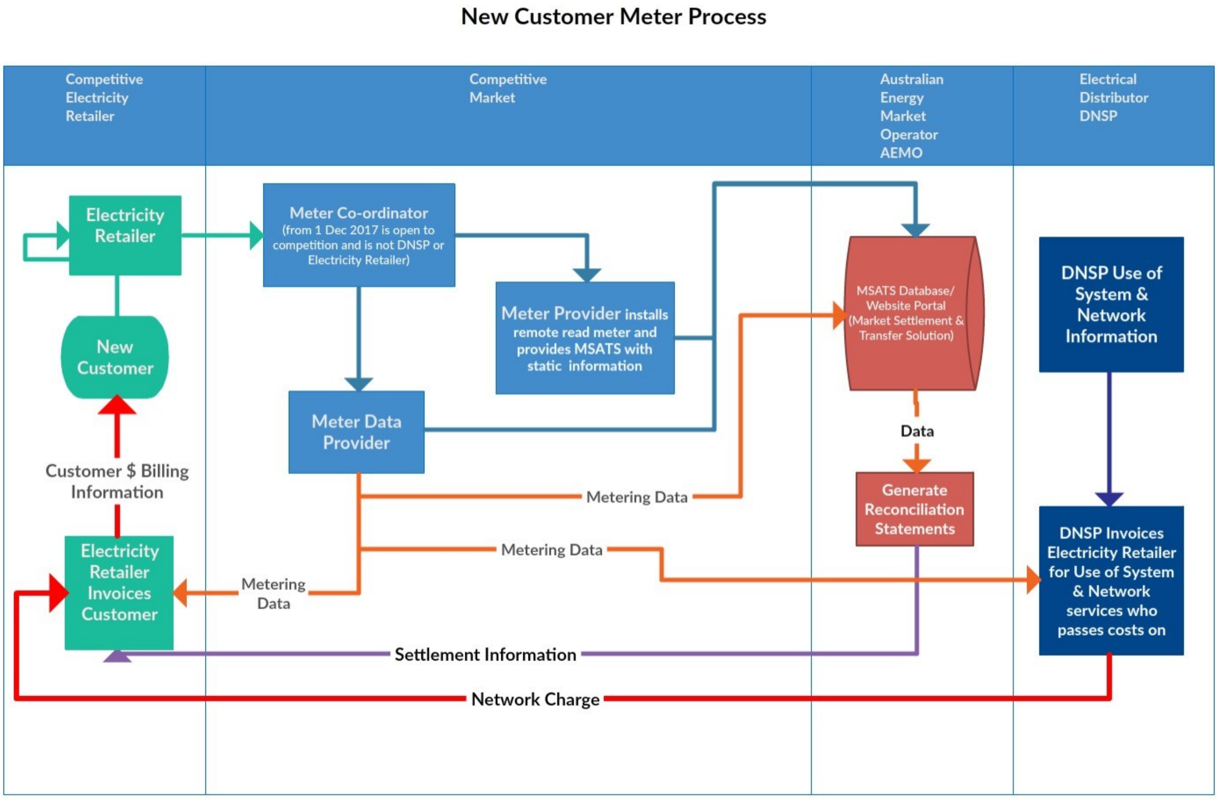


Figure 2: NER compliant process to operationalise a new customer with a new electricity meter

5. Conclusion

The purpose of this short paper is to outline the reasons why a review of street lighting metering arrangements for small loads in the public domain is needed and to enlist support for a new metering regime that is more appropriate for the small amount of variable electrical energy being used by a small number of customers (~550 councils and 8 main road agencies) who are focussed on providing a vital public service.

The current Type 7 street lighting metering arrangements are not able to accommodate rapidly emerging technology and in particular, its variable loads.

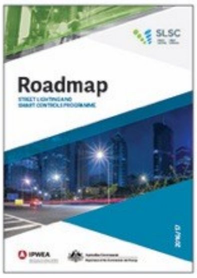
A new Small Load metering approach is required to allow road authorities and Councils to take full advantage of emerging street lighting smart control technology that is able to not only provide a range of important societal benefits but also more accurately measure electricity consumption of each luminaire for billing purposes.

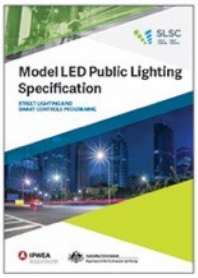
While the underlying principles used for other metering types remain valid, some of the processes for regulating the metering of large electricity loads do not appear suited to metering the small, dynamic and variable loads of modern LED street lighting and smart control technologies.

Having studied the issue and consulted widely, IPWEA is an advocate of a new metering approach and wishes to work productively with regulators and other stakeholders so that Australia can gain full advantage of the new technologies on offer at the earliest opportunity.

In responding to this document, stakeholders are requested to advise if your organisation would like to be added to the list of supporting organisations to be included in an AEMC rule change request.

Following receipt of a rule change request, the AEMC undertake consultation on the proposed rule change. Further information on this process is available at https://www.aemc.gov.au/our-work/changing-energy-rules/making-rule-change-request/consultation-paper





Download from the SLSC website

www.slsc.org.au