Unmetered supplies for traffic signal equipment

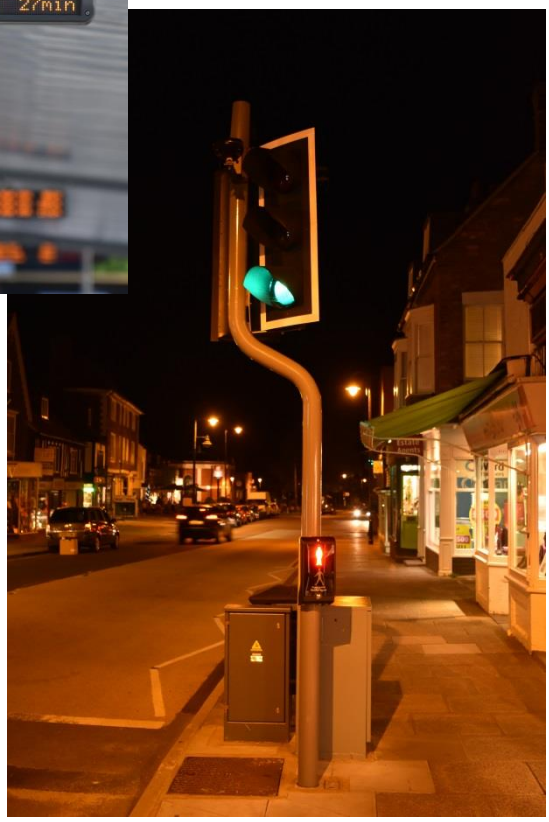
1. Executive Summary

Unmetered supplies are widely used for traffic signal installations. The effective management of the equipment inventory is essential to an accurate energy calculation. This paper seeks to highlight some of the issues related to providing an accurate equipment inventory.

2. Background

Unmetered supplies account for just over 1.1% of the GB electricity consumption. The unmetered proportion of consumption has been dropping in recent years due to energy saving initiatives of LED lighting, LED signals, CMS[1] controls, part night dimming and switch-off.

Power Data Associates is the leading Meter Administrator within GB, we have customers from the north of Scotland, west Wales and the south and east of England. Our basic role is defined in the electricity settlement arrangements where we operate our own bespoke Equivalent Meter that determines half hourly energy consumption for each customer. The majority of our customers are highway authorities, which between them have millions of street lights as well as thousands of traffic signal installations. Our customers have a combined energy consumption worth over £200m/year.



[1] CMS = Central Management System, used to individually control lighting times and levels

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3. Typical traffic signal installation

The following example shows the most simple traffic signal installation.

The equipment includes:

- Vehicle aspects (12) = 4 'heads'
- Pedestrian aspects (4)
- Wait/push button (2)
- Controller (1)
- Communications - modem (1)
- Photocell (1, where dimmed)

The photograph shows the installation with incandescent lamps. However, when preparing an inventory it is important to identify actual equipment in use and circuit watt ratings, particularly if energy efficient alternatives have been installed such as LED aspects and dimming. The following table illustrates the difference in energy consumption between four variants of this simple installation:

	Undimmed Incandescent	Dimmed Incandescent	Undimmed LED	Dimmed LED
kWh/year	2,831	2,427	782	659
Estimated cost/year	£ 340	£ 291	£ 94	£ 79
Cost reduction	*Base*	-14%	-72%	-77%
Average wattage (W)	323	277	89	75

The difference in energy cost per year may appear immaterial for this small single installation, but when multiplied up across all the installations across the country the difference is millions of pounds per year. The reduced energy consumption directly equates to a reduction in carbon emissions.

The continual renewal of physical traffic signal equipment should be reflected in regular updates of the traffic signal inventory. If these updates do not occur then the financial benefits of energy saving investments will not be recouped through on-going reduced energy charges.

An inventory is not a complex dataset, but needs to list the electrical equipment connected at each traffic signal installation. For example a 50W incandescent RAG traffic signal head would have a quantity of 3 aspects, a charge code of 7902050000100 and if dimmed by a 70/35 lux photocell, then a switch regime of 821.

4. National perspective

4.1. Photocell lux levels

We have visibility of the different PECUs used on the traffic signal installations by our customers. These codes identify the type of photocell used to control the bright/dim function in traffic signals. There is a very wide variation across our customers, as shown on the right.

- 411 Thermal PEC 55/110
- 421 Thermal PEC 70/140
- 431 Thermal PEC 100/200
- 621 Hybrid PEC 70/35
- 807 Electronic PEC 35/35
- 808 Electronic PEC 35/18
- 811 Electronic PEC 55/28
- 821 Electronic PEC 70/35
- 824 Electronic PEC 70/140
- 831 Electronic PEC 100/50

The higher lux cells mean that the traffic signals are dim for longer (=lower annual energy use) whereas the lower lux cells switch to bright earlier in the morning and dim later in the evening. However, energy is probably not the key driver, the key driver is safety to ensure they are bright enough to be seen at dawn/dusk whilst not dazzling the driver by being bright too late into dusk.

The following question was posted on the IHE traffic signal[2] forum back in Nov 2015. It has been read by many people but no-one has answered the question: *Is there any official industry guidance or advice on the appropriate lux levels to use?*

This variation might mean that the quoted lux levels are arbitrary values, perhaps derived from 'what was on the van' for use on lighting equipment within the same highway authority. It would be interesting to learn if there is any research or guidance into the appropriate lux levels for traffic signal installations.

4.2. How many inventories are dimmed?

Across our customers, there is a considerable variation of dimmed and non-dimmed traffic signal installations. Some highway authority's report all their installations are dimmed others that all are undimmed. Most authorities have some of each.

Nationally some 86% of the installations are reported as dimmed. It could be that this figure should be nearer 100%.

[2] IHE Traffic Signals (TSG) Forum

4.3. How many installations are LED?

Across our customers there is a considerable variation of incandescent (halogen or tungsten) and LED traffic signal aspects. Some highway authorities' report all their installations are incandescent, others that all are LED. Most authorities have some of each.

Nationally some 41% of the installations are reported as LED vehicle aspects. It is suspected that this figure should be higher.

Nationally only 11% of the installations are reported as LED pedestrian aspects. It is suspected that this figure should be higher.

Nationally some 37% of the installations are reported as LED wait/push button unit. It could be that this figure is higher because of near side R/G LED units replacing far side incandescent aspects.

4.4. Age of inventories

Within our customer base we are aware that some of the traffic signal inventories have not been updated for many years, some 5-10 years. Whilst the traffic signal equipment may not be changing each month, an ideal management framework might well expect the inventory to be updated at least several times a year dependent on the level of change. Any new traffic signal controlled junctions, new roads/development or energy improvements are only included in the energy calculation *after* a new inventory is provided to the DNO[3] and Meter Administrator. Without an inventory update identifying a change from incandescent to LED aspects the energy will continue to be determined on the higher wattage incandescent equipment. Without the energy saving the cost benefit of the investment will be not actually be recouped through the energy bill.

4.5. Quality of inventories – number of aspects

In preparing this analysis, it has revealed a wide variation between customers in the number of vehicles aspects per traffic signal controller. On average, this is 24 aspects (say 8 heads) per controller, but varies from zero (not logical!) to 80 (really?) within a single highway authority. A figure above 20 is probably the more correct outcome.

This probably highlights the ongoing confusion across the industry between vehicle 'aspects' vs. vehicle 'heads' and therefore the quantity to be reported within an inventory. So some further explanation of the calculation is provided:

- Under the Elexon coding a 50 watt incandescent aspect is given a circuit watt rating for energy consumption purposes of 18 watts. This is because each aspect in a 3 three aspect signal head will normally have one aspect lit at any time, so the continuous power is one third of the rated power. There is a slight adjustment to account for a short period the red & amber aspect are lit together.
- A similar approach applies to R/G men where a quantity of 2 is reported in the inventory and each of the aspects is rated at 50% of the lamp's actual circuit watts, allowing for the operating cycle.

It can be seen that the asset databases identifies a RAG head is recorded as a single item, but needs to be reported in the energy inventory as 3 aspects. Many asset databases do not hold the charge code and/or switch regime that applies to the equipment, these being added to the report manually. To reduce these potential errors the inventory report should be generated from the database with these important data items already included for each asset and the correct quantities reported.

[3] DNO = Distribution Network Operator, own and operate the electrical distribution network

5. ELEXON charge code applications

All unmetered equipment should have a charge code and a related switch regime. These codes can be applied for by any organisation that can provide the correct information. Some highway organisations (e.g. Highways England) require equipment to have a charge code as part of their procurement framework. ELEXON[4] manage the process on behalf of the industry with guidance from the Unmetered Supplies User Group (UMSUG). But the continual evolution of traffic signal equipment continues to lead to some challenges to determine a pragmatic approach, a few are identified below.

5.1. Low voltage equipment

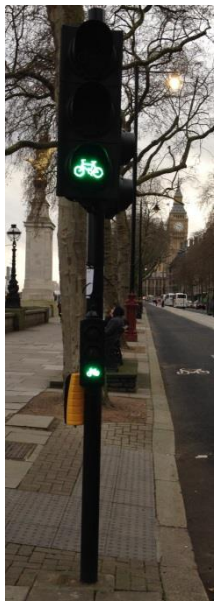
The unmetered arrangements are seeking to determine a kWh consumption equivalent to the consumption measured if a meter were connected at the 230V supply terminals. So where equipment is designed to operate at a lower voltage (12, 24, 48, etc.) then the applied charge code needs to allow for the voltage conversion equipment. However, the losses of a large transformer (designed for a whole traffic signal installation) would probably exceed the consumption of any single item under test. So other approaches need to be agreed. This is a current debate within UMSUG, so proposals are required to establish an appropriate test method.

5.2. Countdown timers

Transport for London have fitted pedestrian countdown timers to an increasing number of traffic signal installations. A recent application for a charge code nearly led to ELEXON giving a charge code that presumed the item was taking full load continuously. After review by ourselves and discussion about its actual operation the charge code was significantly revised down to 2W, which is the continuous load used to monitor the R/G pedestrian aspects. The logic was that as the countdown timer display only displays during the 'blackout period' of the R/G displays the additional consumption is nil. The consumption associated with the R/G has historically always been assumed to be continuous, when in fact it has a blackout phase.

This saved TfL tens of thousands of pounds per year and enabled the manufacturer to market a product more effectively.

5.3. Photocell that dims during the day



Another innovation is a photocell that dims during dull overcast days. With some lateral thinking the unmetered supplies arrangements can reflect the expected energy savings. This work is ongoing.

5.4. Cycle signs

Smaller low level cycle aspects are increasingly common. Yet I am not aware of charge codes being applied for this equipment. I would expect the consumption to be considerably lower that a 'normal' vehicle aspect.

[4] ELEXON - unmetered supplies

6. Metered vs. unmetered connections

With traffic signal installations there is often mention of the '500watt rule' – this is not a rule but a statutory instrument[5] that was introduced to legalise unmetered supplies. 500 watts is mentioned as a threshold of load, but the more relevant factor is predictability. The unmetered arrangements are seeking to give realistic estimate of energy consumption, equivalent to a metered supply, which is achieved through an accurate equipment inventory.

The DNOs have the authority to audit the inventory of any unmetered equipment. Historically this has occurred with lighting equipment but the same approach could be used on traffic signal equipment although it would be harder to audit than lighting equipment. A framework for the audit has been established by the industry[6]. The increasing use of LED equipment has also reduced the total consumption, as illustrated in the example in section 3 which has dropped from 323W to 75W using dimming LED aspects, which co-incidentally makes any error less financially material.

At one time some DNOs viewed traffic signal installations as unpredictable and required them to have a metered supply. This argument can be mitigated by regular and accurate inventory submissions, which demonstrate a good understanding of the energy consumption and which is part of the 'trust' necessary for an unmetered supply. The costs of a metered supply are typically higher than an unmetered supply together with the difficulty of access to the roadside equipment for regular meter reading. Most DNOs are becoming increasingly helpful in their attitude in recent years.

Unmetered supplies can be traded within the electricity settlement arrangements on a non-half hourly or half hourly arrangement. The half hourly arrangement gives a more accurate reflection of the actual consumption.

7. Conclusion

Unmetered supplies are widely used by traffic signal installations. The maintenance of an accurate inventory of unmetered equipment is not difficult, but is absolutely essential for the accurate allocation of energy consumption under the unmetered arrangements.

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[5] The Electricity (Unmetered Supply) Regulations 2001
[6] Managing Unmetered Energy Street Lighting Inventories