Roadway Lighting Electrical Service Evaluation: Unmetered vs. Metered Services

Technical Memorandum

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Prepared by:

The Arizona Department of Transportation

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ROADWAY LIGHTING ELECTRICAL SERVICE EVALUATION:
UNMETERED VERSUS METERED SERVICES TECHNICAL MEMORANDUM

Arizona Public Service (APS) and Salt River Project (SRP) are the two primary electrical service providers in the metro-Phoenix area. APS and SRP energy rates vary depending on the type of electrical service. One of the primary benefits of Light Emitting Diode (LED) roadway lighting is energy savings and the dollar savings that result. However, a large proportion of the roadway lighting electrical energy charges to ADOT are associated with unmetered service accounts. The charges on these accounts are based on assumed power loads for each luminaire and assumed hours of operation. Conversion to LED roadway lighting on these accounts will not result in dollar savings for ADOT without changes in these assumptions or conversion to metered services. The effective rates[1] may be higher for metered services. Therefore, energy savings may not result in dollar savings for ADOT, depending on the effective rates for the two service types. The actual power load versus assumed power load and hours of operation of the luminaires are also important factors in the cost calculation. A greater understanding of these factors is needed to better assess the potential dollar savings and better define the best course forward to maximize return on investment for ADOT as part of the conversion to LED luminaires.

Method of Analysis

This technical memorandum was prepared by the Arizona Department of Transportation (ADOT) to evaluate the efficacy of converting from unmetered to metered services as part of the proposed LED roadway lighting public private partnership (P3). The evaluation is based on an unmetered to metered service conversion implemented in 2012 and examines three measures before and after conversion:

- energy use,
- energy rates, and
- actual costs.

There are currently two types of accounts used by utility companies to charge ADOT for energy use. The following provides a description of each.

The dollar charges on *unmetered accounts* are calculated based on four factors:

- number of fixtures on the account (n),
- assumed power load (P) for each fixture when energized (or "on") measured in kilowatts (kW),
- assumed number of hours (h) each fixture is energized, and
- energy charge rate (r) measured in dollars per kilowatt-hour ($/kWh).

The calculation is as follows: Unmetered service charges ($) = $\sum_{i=1 \text{ to } n} (P_i * h_i) * r$

The agreement with the utility company is based on an assumed power load for each luminaire. For example, the 250 W high pressure sodium luminaire is assumed to have a load of 313 W to account for the power load of the lamp and electronics of the luminaire. The agreement is also based on the

[1] See discussion that follows and page 3 for a definition of effective rate.

assumption all the fixtures are energized 350 hours each month, which is equal to approximately twelve hours each night, on average. This assumption is applied to unmetered services, even if the luminaires are not actually energized due to luminaire outages as a result of such things as luminaire failures, wire theft, knock downs, power outages, and circuit failures. Therefore, with unmetered services, ADOT is generally paying for energy that is not actually consumed.

The dollar charges on *metered accounts* are calculated based on:

- actual energy used based on the meter reading,
- energy charge rate, and
- fixed charges associated with the metered service.

The description above provides the background information on electrical charges for the two different service account types. The common perception is that metered services generally result in lower monthly costs to ADOT because the assumed energy use for unmetered accounts is higher than the actual energy use. However, there are additional charges associated with metered accounts that can influence the total cost to ADOT. For example, metered accounts include added charges associated with the time and effort for the utility company to read the meter and other charges that are not well understood at this time.

In order to evaluate the value of metered services, the study team applied the concept of *effective yearly rate* (r_{eff}). The effective yearly rate is determined by dividing the total cost to ADOT for the year (C_{year}) by the total amount of energy used over the year (E_{year}):

$$\mathbf{r_{eff}} = C_{year} \ / \ E_{year}$$

The effective yearly rate takes into account all charges associated with each account type (i.e. the energy use rate and service charges associated with metered accounts). The calculations of energy usage, total cost, and effective rate are applied below to evaluate the potential cost savings associated with conversion from unmetered to metered accounts for roadway lighting.

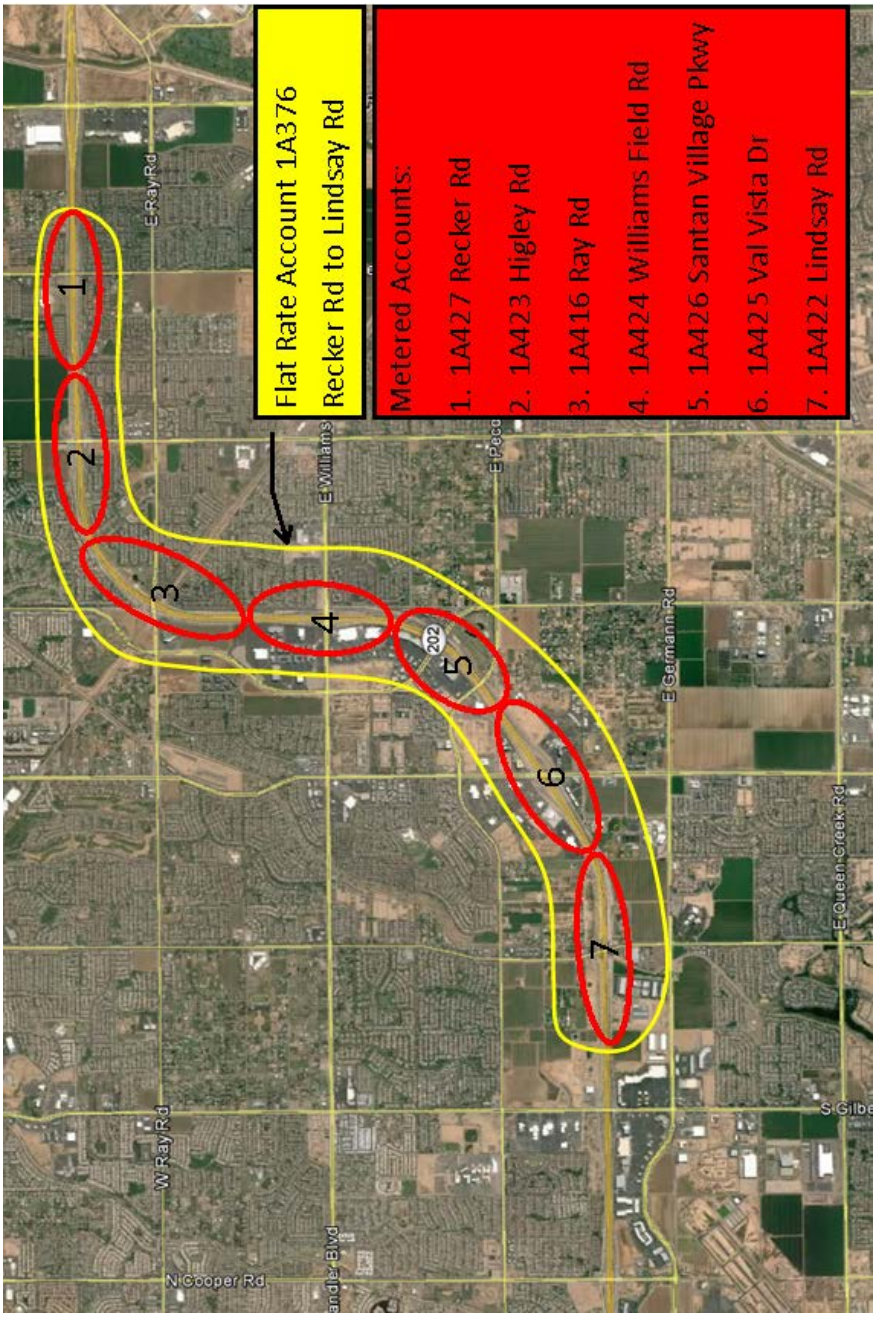
SR 202L (Santan), Recker Road to Lindsay Road Study Area

At the end of 2012, roadway lighting on SR 202L (Santan) from Recker Road to Lindsay Road was converted from a single unmetered account to multiple metered accounts. An unmetered account may be comprised of several lighting load center cabinets; whereas, metered accounts are generally comprised of a single load center cabinet due to the need to have a meter at each point of service. The following before-after analysis examines these accounts to compare the unmetered account data to the current metered account data. The study area shown in Figure 1 is in the SRP service area.

Table 1: **Before-After Account Summary**

	Unmetered Account	Metered Accounts
Period of Analysis	7/2006 to 12/2012	12/2012 to 9/2015
Average Monthly Cost	$3,520.08	$3,243.28
Average Monthly Usage (kWh)	45133	33754
Calculated Effective Rate	**$0.08**	**$0.10**

Figure 1: **Unmetered to Metered Accounts Study Area**



The unmetered account and the metered accounts were analyzed for 5 years and 2 years, respectively. The data indicates that while the effective energy rate ($/kWh) is higher for the metered accounts, there is a reduction in cost due to the apparent reduction in energy use. This phenomenon can be seen in Figures 2, 3, and 4 on the following page.

Figure 2. Billed Energy Use per Year

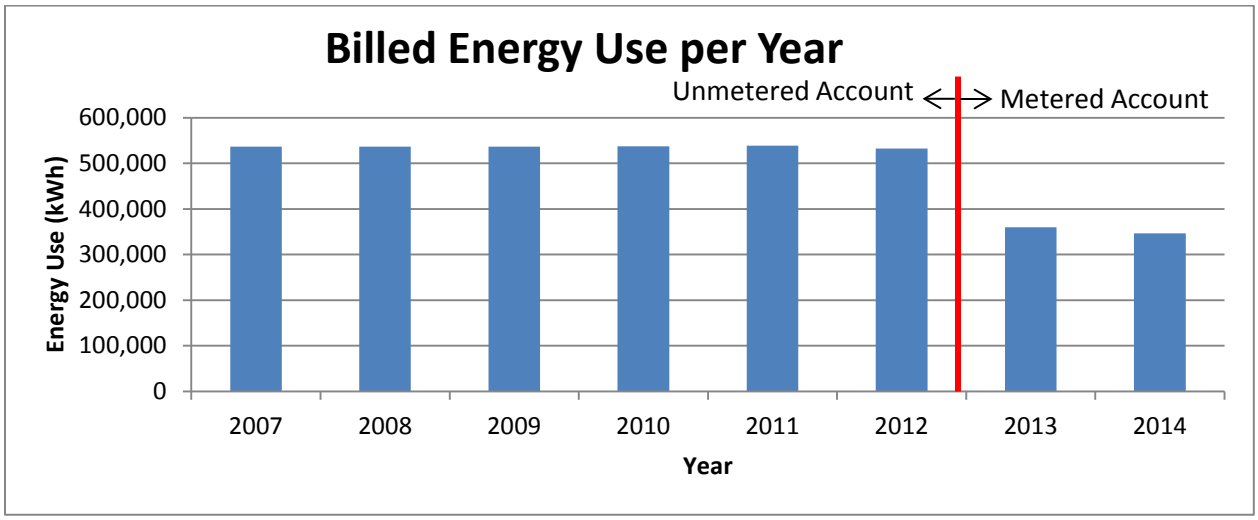


Figure 3. Total Cost Per Year

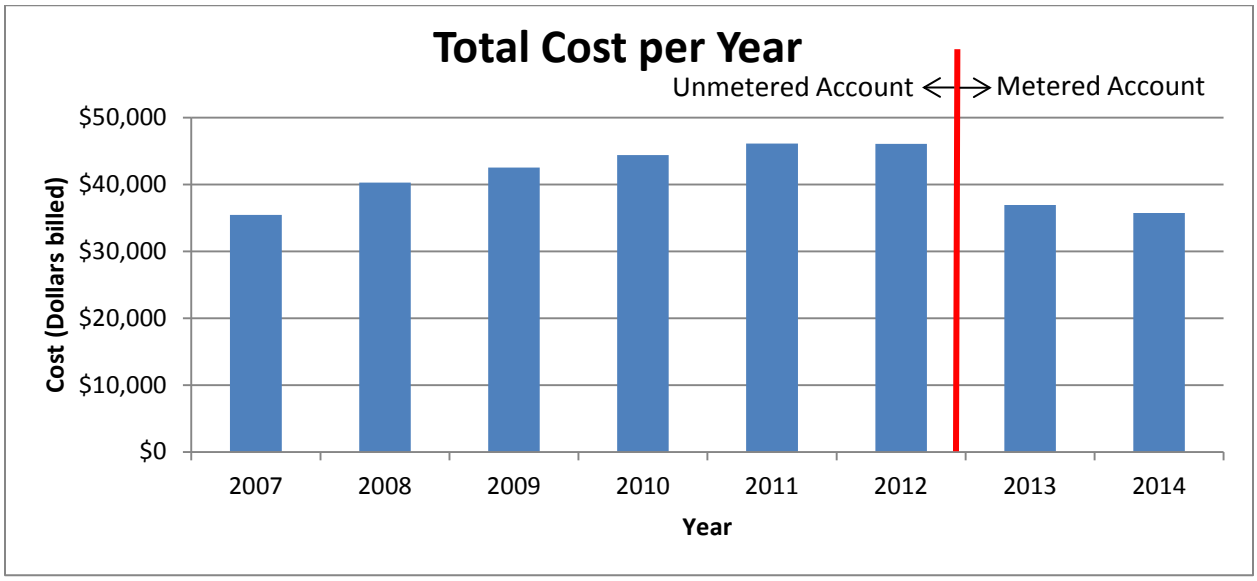
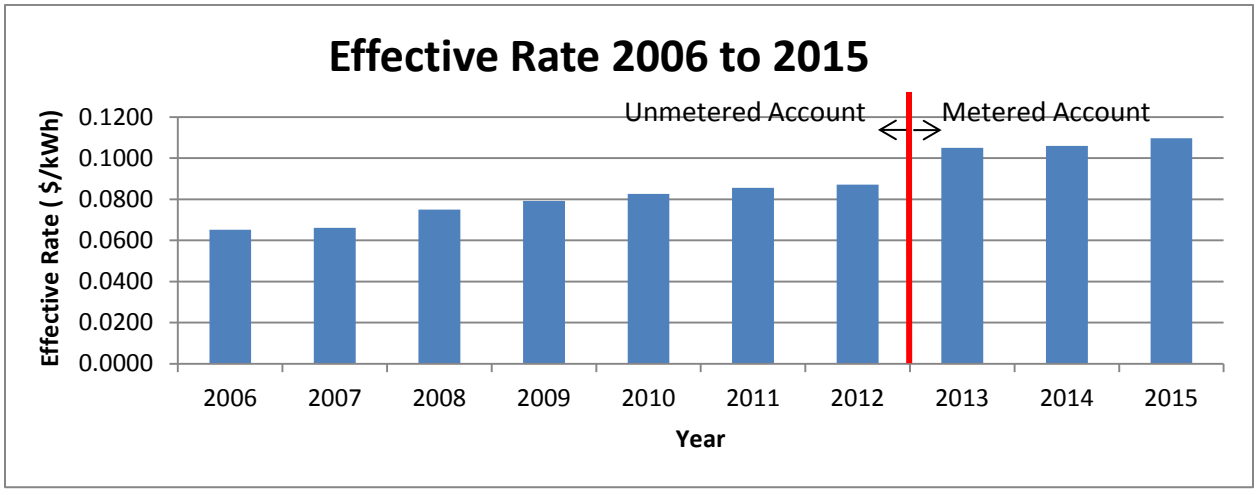


Figure 4. Effective Rate



Analysis

Based on 2007 to 2012 data, it appears the billed energy use is consistent from year-to-year, as would be expected. Figure 2 indicates there was a significant decrease in the billed energy use after the conversion to metered accounts. The kilowatt-hours billed decreased by more than 32% in the year following conversion. The decrease in billed energy use leads to a decrease in the yearly cost, as seen in Figure 3. The yearly cost increases are due to increasing effective rates. The unmetered and metered accounts both experienced rate increases over the time period 2006 through 2015. From 2007 to 2012, under the unmetered account, the average increase in cost was approximately $2,125 per year. The largest increase occurred in 2008, when unmetered rates increased more than 13% over 2007 values. Nonetheless, the unmetered effective rate in 2012 is still more than 20% less than the metered effective rate in 2013. Approximately $46,000 was billed in 2012 and $37,000 in 2013. This $9,000 reduction represents a near 20% savings in the year following conversion. The cost analysis shows the conversion from unmetered to metered services was beneficial to ADOT with respect to ongoing utility costs, indicating the decision to convert from unmetered to metered services was a sound decision given the actual (metered) energy used in the after period.

Discussion

It should be noted, the analysis does not examine the capital costs associated with the conversion from unmetered to metered accounts and does not examine if these same savings may be realized on APS service accounts. Nor does the analysis examine the reasons for the differences between the unmetered and meter billed energy use.

It could be that the assumptions used to develop the power load for unmetered services are poor assumptions. A closer examination of actual power load for the various luminaires would provide insight into this issue. This will be an important factor in assessing the expected net present value associated with conversion from unmetered to metered services as part of the LED P3. The study team understands APS and SRP have established assumed power loads for various LED luminaires. The study team does not know (at this time) which luminaire models were used or methods applied to establish these power loads. Additional communication with APS and SRP is needed to gain a better understanding of this issue of assumed power loads. These communications also need to include discussion of ongoing (and rapid) improvements in the energy efficiency of LED luminaires. If ADOT is to take advantage of future improvements in LED technology, a mechanism must be in place to reduce the assumed power loads over time for unmetered services. Otherwise, it may be best to move forward with conversion to metered services.

It could be that the assumptions regarding hours of operation are incorrect. It seems this could be the primary reason for the large dollar savings in the after condition. It is very likely that some proportion of the fixtures were not energized in the after period. A reduction in luminaire outages is one of the expected benefits of the LED conversion and P3 developer maintenance of the system. An examination of outage reports in 2013 and 2014 may be useful to determine (to the extent possible) the proportion of fixtures not energized in the after period. This data may lead to a more informed decision regarding the expected energy cost savings associated with conversion to metered services as part of the P3.

Thought needs to be given to the possible use of a roadway lighting monitor and control system to record meter quality data in-lieu of utility company metering. This would avoid the capital costs associated with conversion to metered services and allow ADOT to take advantage of the lower effective rates associated with unmetered services. Use of monitor and control system readings for billing purposes would be subject to utility company approval. This is also a possible topic for discussion with APS and SRP. Thought also needs to be given to the possible use of a monitor and control system to support the use of adaptive lighting strategies. Adaptive lighting strategies may be used to further reduce energy use and costs. If ADOT and the successful P3 developer agree to pursue adaptive lighting strategies, then a means to efficiently control and monitor light levels will be needed.