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COST ALLOCATION TO DIFFERENT TYPES OF STREET LIGHTING CONFIGURATIONS

EB-2012-0383

Prepared for:

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EXECUTIVE SUMMARY

Navigant Consulting Ltd. (Navigant) has been retained by the Ontario Energy Board (OEB) to review the existing cost allocation methodology used in the allocation of costs to street lighting systems. Specifically, Navigant's investigation focused on 1) the "daisy-chain" and 2) the one-to-one street lighting system configurations to determine what alternative allocation methods could be used to address the potential disparity observed by the OEB between the costs allocated to the respective street lighting systems configurations when compared to the expected level of costs to serve street lighting.

The existing cost allocation methodology uses the number of connections to allocate costs to each of the various customer classes. Customer costs are allocated based on the number of connections, and demand related costs are indirectly affected through an adjustment mechanism - the peak load carrying capacity (PLCC). Whereas other customer classes typically have one connection per customer, street lighting systems can be installed in a 1:1 configuration with one device (e.g. luminaire, lamp, or streetlight) per connection, or a daisy-chain configuration with multiple devices per connection.

In the existing cost allocation model (CAM), the type of configuration, i.e. whether daisy-chain or not and the extent of daisy-chain, has a significant impact on the allocation of costs to the street lighting class due to the number of connections allocator. A simple example to demonstrate this is to assume two LDCs with a given number of streetlight devices, the first LDC's streetlights are configured 1:1 and the second configured as daisy-chain with 15 devices per connection (15:1 connection ratio). The resulting cost allocation to street lighting will be higher for the LDC with the 1:1 configuration than the daisy-chain configuration because it will have a higher number of connections and will therefore attract more costs, even though the street lighting load characteristics are no different. Navigant's has verified findings from earlier Consultant Reports[1] which indicate a disparity between the 1:1 and daisy-chain configurations can be as much as 300% to 400% in allocated costs.

Based on a review of the background information (which included OEB and Consultant Reports), the CAM model analysis, and LDC and Municipality interviews conducted by Navigant, a number of conclusions were drawn, and Navigant is able to offer the following recommendations to address the disparity in cost allocation between the various street lighting configurations.

[1] Review of Cost Allocation Policy for Unmetered Loads (Elenchus Report)

Navigant recommends that:

1. The allocation of the primary and line transformer assets and related costs to street lighting be calculated using a newly devised "street lighting adjustment factor" instead of the existing allocation that is based on number of street lighting connections.
2. The street lighting adjustment factor is calculated as the ratio of i) the four highest monthly non-coincident peak demands (NCP4[2]) for the residential customer class divided by the number of residential customers, and ii) the NCP4 for the street lighting customer class divided by the number of streetlight devices.
3. No change for the allocation of the secondary assets and related costs, which is based on the number of connections.

The resulting adjustment factor is independent of the number of streetlight connections and would not vary with the street lighting connection ratio, and eliminates much of the disparity between the 1:1 and daisy-chain street lighting configurations. The calculated adjustment factor is also LDC-specific and can be calculated using information that is available in the existing CAM model.

The expected change in cost allocation for each of the various customer classes is provided in Table ES - 1 below. Navigant estimates that LDCs with connection ratios of 3:1 or less could potentially see reductions in distribution cost allocations to the street lighting class ranging from 50% to 70%, with the offsetting increase to other customer classes ranging from 0% to 4%. High connection ratio LDCs (greater than 10:1) could potentially see an increase in cost allocation to the street lighting class ranging from 0% to 15% and no material decrease is expected for the other customer classes.

As a cautionary note, Navigant reiterates that the cost allocation changes indicated are only estimates and actual changes may vary considerably depending on the specific characteristics of individual LDCs.

[2] The Cost Allocation Model decides whether to use a 1 NCP or 4 NCP method for allocating demand costs based on a test described in *Board Directions on Cost Allocation Methodology for Electricity Distributors*, EB-2005-0317, p.61, dated September 29, 2006. All distributors except one had an NCP4 test result in their Cost Allocation filings.

Table ES - 1: Change in Cost Allocation

Change in Cost Allocation	LDC Connection Ratio		
	Below 3:1	3:1 to 10:1	Above 10:1
Customer Class *			
Residential	**0% - 2%**	**0% - 1%**	**(0)%**
GS <50	**1% - 3%**	**0% - 2%**	**(0)%**
GS>50-Regular	**1% - 3%**	**0% - 2%**	**(0)%**
Large Use	**2% - 4%**	**0% - 3%**	**(0)%**
Street Lighting	**(70)% - (50)%**	**(50)% - (0)%**	**0% - 15%**
Other	**2% to 4%**	**0% - 3%**	**(0)%**

* The cost allocation to each customer class varies with the proportion of primary/ secondary and line transformer assets needed to provide service.

Although Navigant is not recommending any change to the existing allocation methodology used for the secondary assets in this Report, there was consideration towards allocating some components of the secondary system using the methodology recommended for the primary and line transformer assets. Navigant recommends distributors be permitted to file for the use of a separate adjustment factor with respect to secondary assets if there is evidence that it would result in a more suitable allocation of the secondary assets, or a component of the secondary assets to street lighting.

This report seeks to address the cost allocation methodology for street lighting which is used in the OEB CAM. The Report does not address the subsequent stages of the rate-making process which impacts rates ultimately billed to customers. These other processes include rate design and the requirement for revenue-to-cost ratios to be within an acceptable OEB policy range for each rate class.

1 INTRODUCTION

Navigant Consulting Ltd. (Navigant) has been retained by the Ontario Energy Board (OEB) to review the existing cost allocation methodology used in the allocation of electricity distribution costs to street lighting systems. Specifically, Navigant's investigation focused on 1) the "daisy-chain" and 2) the one-to-one street lighting system configurations to determine what alternative allocation methods could be used to address the potential disparity observed by the OEB between the costs allocated to the respective street lighting systems configurations when compared to the expected level of costs to serve street lighting.

1.1 Study Objectives

The key objectives of this project are:

1. Examine the utility and municipality assets and the portion of utility assets required to serve the various street lighting system configurations and associated costs;

2. Examine the existing methods of cost allocation and assessing their appropriateness for application to the various street lighting system configurations;

3. Examine and classify the determinants relevant to the allocation of costs to common connection street lighting systems and one-device-per-connection systems; and

4. Update the Cost Allocation Model, as required, with respect to the cost allocation to various street lighting system configurations.

1.2 Background

Prior to this study, the cost allocation potential disparity issue for the various street lighting system configurations was identified in two OEB documents[3] and one Consultant Report[4]. The relevant findings from each of these documents are briefly summarized below.

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[3] Cost Allocation Review EB 2005-0317, and Report of the Board EB-2012-0383

[4] Review of Cost Allocation Policy for Unmetered Loads (Elenchus Report)

1.2.1 Cost Allocation Review EB 2005-0317, Board Directions on Cost Allocation Methodology for Electricity Distributors

Certain aspects of the existing cost allocation methodology that relate to street lighting are derived from this review. This includes:

- **Peak Load Carrying Capability (PLCC)** – this adjustment reduces a portion of the demand related costs which are covered in the customer/connection minimum system allocation. The cost allocation incorporates a common PLCC adjustment of 0.4 kW per customer, or 0.4 kW per connection. For street lighting and unmetered scattered loads, the number of connections will be used to determine the PLCC adjustment for these customers. It is expected that when these customers are in a separate rate classification, in some cases the PLCC adjustment will reduce the demand allocator to zero and thus no demand-related costs associated with the minimum system will be allocated to the rate classification. This is considered a reasonable outcome, as there are a number of cases where the connection will use less than 0.4 kW of load.[5]
- **Definition of Customer and Connection for Filings** - For unmetered loads, the number of connections will be used to allocate some customer-related costs. For streetlights, sentinel lights and unmetered scattered loads, the number of connections will be the actual number of devices. In the case of streetlights, one "connection" frequently links a number of fixtures to the distribution system and simply using the number of devices may overstate the number of physical connections to the distributor's system. Therefore, where better information is available, distributors must apply a connection factor to the number of streetlight fixtures for the purpose of determining the customer allocation factor.

1.2.2 Report of the Board - EB-2012-0383, Review of the Board's Cost Allocation Policy for Unmetered Loads

Among the issues addressed in this Report was a review of the Cost Allocation Model (CAM) and the cost allocation methodology. Specific statements include:

- The Board remains concerned with the allocation of costs to daisy-chain configured systems. The disparity in the cost allocation result between a street lighting customer configuration with multiple devices per connection and a street lighting customer with a device to connection ratio close to 1:1 appears to be disproportionate when compared to actual costs to serve the street lighting rate class. The Board believes that further

[5] The default PLCC value is 0.4 kW, but LDC's may adopt a unique value that can be supported.

investigation is necessary before making a determination. The Board will issue a letter shortly to begin a consultation process for this single issue.
- The Board does not believe that there is sufficient evidence at this time to narrow the revenue to cost ratio range for the street lighting class (i.e. the revenue to cost ratio range is to remain at 0.7 to 1.2).

1.2.3 Review of Cost Allocation Policy for Unmetered Loads (Elenchus Report)

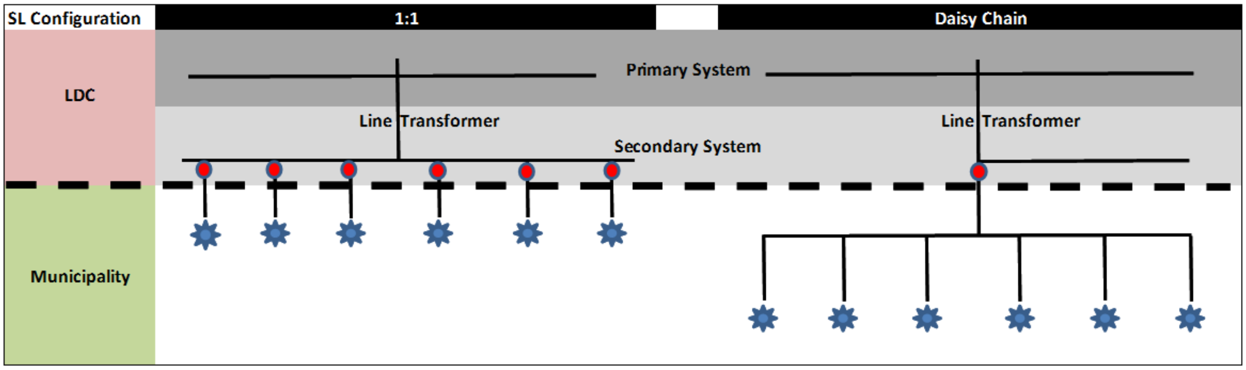
This Consultant Report preceded and informed the EB-2012-0383 Report of the Board referenced above. The key findings and recommendations from this report include:

- A critical assumption with respect to the inputs for Street Lighting is the number of devices per connection. This assumption has the most significant impact on the revenue requirement for the Street Lighting customer class. The difference in revenue requirement between a device per connection ratio of 15:1 and a 1:1 is over 400%.
- Communication (Distributors' Responsibility) - The actual configuration used by the distributors in connecting Unmetered Loads should be reflected in their Cost Allocation Methodology. This leads to different cost allocation study results from one utility to another as the connection configuration of Unmetered Loads varies.

1.3 Street lighting Configurations

A key objective of this Navigant study is to review the cost allocation methodologies for one-to-one (1:1) and daisy-chain street lighting configurations. As depicted in Figure 1 below, a 1:1 configuration is where there is one LDC connection for each streetlight or device, and daisy-chain is where there are multiple streetlights or devices connected to a single connection. For the daisy-chain example depicted in Figure 1, the number of devices per connection, or connection ratio would be 6:1 i.e. six devices for one connection.

Figure 1- One-to-one (1:1) and Daisy-chain Street lighting Configurations



Assets	Underground (1:1)	Overhead (1:1)	Underground (Daisy Chain)	Overhead (Daisy Chain)
LDC Primary	Station Equipment (T&D)	Station Equipment (T&D)	Station Equipment (T&D)	Station Equip. (T&D)
		Poles/ Towers		Poles/ Towers
	P Conductor/ Conduit	P Conductor	P Conductor/ Conduit	P Conductor
LDC Secondary	Line Transformer	Line Transformer	Line Transformer	Line Transformer
	S Conductor/ Conduit	S Conductor	S Conductor/ Conduit	S Conductor
		Poles/ Fixtures		Poles/ Fixtures
	Services Wires	Services Wires	Services Wires	Services Wires
Municipality	Poles		Poles	
			Secondary conductors	Secondary conductors
	Luminares/ Brackets	Luminares/ Brackets	Luminares/ Brackets	Luminares/ Brackets
Comments/ Usage	Less common	Older Sub-d Arterial roads Utilize Primary poles SL makes greater use of secondary	Common (new sub-d) SL makes less use of secondary	Older Sub-d Arterial roads Utilize Primary poles

Streetlight Device (lamp/ luminaire) — Streetlight Connection

A connection is the physical link, or demarcation point between the LDC-owned distribution infrastructure and the customer-owned infrastructure. A daisy-chain configuration will require the customer, which in the case of street lighting is typically a municipality, to own additional distribution infrastructure beyond the connection compared to a 1:1 street lighting configuration. Conversely, an LDC with a daisy-chain configuration would require less secondary assets relative to a 1:1 configuration.

1.4 Structure of Report

Section 1 provides background information and states the objective of this Report. Section 2 provides a review of the CAM model and cost allocation methodology for both the daisy-chain and one-to-one street lighting system configurations, and Section 3 summarizes the findings from the interviews with LDCs and municipalities. Navigant's findings and recommendations are provided in Section 4.

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2 REVIEW OF COST ALLOCATION MODELS (CAM)

2.1 *Overview*

This section reviews the CAM models and highlights the differences between the daisy-chain and one-to-one street lighting system configurations. The review provides a comparison of street lighting data for a range of connection ratios ranging from 1:1 to 15:1, and investigates the allocation of customer related costs and demand related costs.

2.2 *Comparison of Street lighting Data for a Range of Connection Ratios*

Navigant's investigation was based on a review of the Cost Allocation Models (CAMs) for a sample of seven LDCs. Select data for each of the LDCs is presented in Table 1 below.

Table 1- Select Data for Sample LDC's

Street lighting Connection Ratio (Devices/Connection)	1.0	1.1	1.3	1.8	3.0	8.0	15.0
Street lighting (SL) Demand Data							
1. Demand / Device (NCP4* kW /Device)	0.64	0.78	0.72	0.68	0.85	1.24	0.61
2. SL NCP4 (kW) /System NCP4 (kW)	0.74%	0.99%	0.90%	0.60%	1.09%	0.70%	1.16%
LDC Asset Cost Breakdown							
3. Primary Assets %	59%	60%	54%	56%	74%	58%	66%
4. Secondary Assets %	22%	16%	23%	23%	2%	7%	14%
5. Line Transformer %	19%	25%	23%	21%	25%	35%	21%
Street lighting Cost Allocation							
6. Cost Allocation./ Device	$115	$75	$64	$128	$20	$81	$16
7. Cost Allocation./Connection	$115	$83	$84	$231	$59	$616	$242

* NCP4 is the four highest non-coincident peak demands (kW) and is used in the CAM model to allocate demand related costs

Navigant's review of the street lighting demand data did not indicate any material difference or trend when comparing LDCs at various connection ratios, either in terms of average demand per street lighting device (Table 1 – line 1) or the total street lighting demand as a proportion of the total demand for the LDC (Table 1 – line 2). A trend that is apparent is a decrease in the proportion of the LDC secondary assets as the connection ratio increases. This is shown in Table 1, line 4 where the secondary assets for LDCs with a connection ratio below 2.0 ranges from 16% to 23%, whereas LDCs with connection ratios above 2.0 ranges from 7% to 14%. As already noted in Section 1.3, this is not unexpected given that a daisy-chain configuration would require less secondary assets on the LDC side of the ownership demarcation point, but would require additional municipally owned street lighting assets.

A trend that is clearly evident is the decrease in cost allocation per street lighting device as shown in Table 1, line 6, where the revenue requirement decreases from $115 for a connection ratio of 1.0, to $16 per device for a daisy-chain configuration with a connection ratio of 15:1. This difference in cost allocation to 1:1 versus daisy-chain street lighting configurations highlights the concerns of the OEB as noted in the Review of the Board's Cost Allocation Policy for Unmetered Loads (Report of the Board EB-2012-0383).

2.3 *Cost Allocation Methodology*

The existing cost allocation methodology uses the minimum system method to categorize or split the distribution system between customer and demand related costs. This theoretical method is used to determine the proportion of assets and costs that are customer related and do not vary with changes in demand, with the remaining proportion categorized as demand related. The CAM model then uses connections to allocate customer related costs to each of the customer classes. Each connection attracts the same level of customer related costs, regardless of customer class, or in the case of street lighting a connection with a single device (1:1) attracts the same level of customer related costs as a connection with 15 devices (daisy-chain at 15:1).

Demand related costs are allocated on the basis of the non-coincident peak demand (NCP). The customer and demand cost allocation mechanisms are examined in further detail in sections 2.3.1 and 2.3.2 below.

2.3.1 Customer Related Costs

Given the CAM model cost allocation methodology and the use of connections to allocate customer related costs, a key factor impacting the allocation of costs to street lighting is the type of configuration (1:1 or daisy-chain), and correspondingly the connection ratio. In the Elenchus Report (Review of Cost Allocation Policy for Unmetered Loads), it was noted that the allocation to street lighting can vary by over 400% depending on the street lighting connection ratio. An illustrative example of the sensitivity to different connection ratios is provided in Table 2 below.

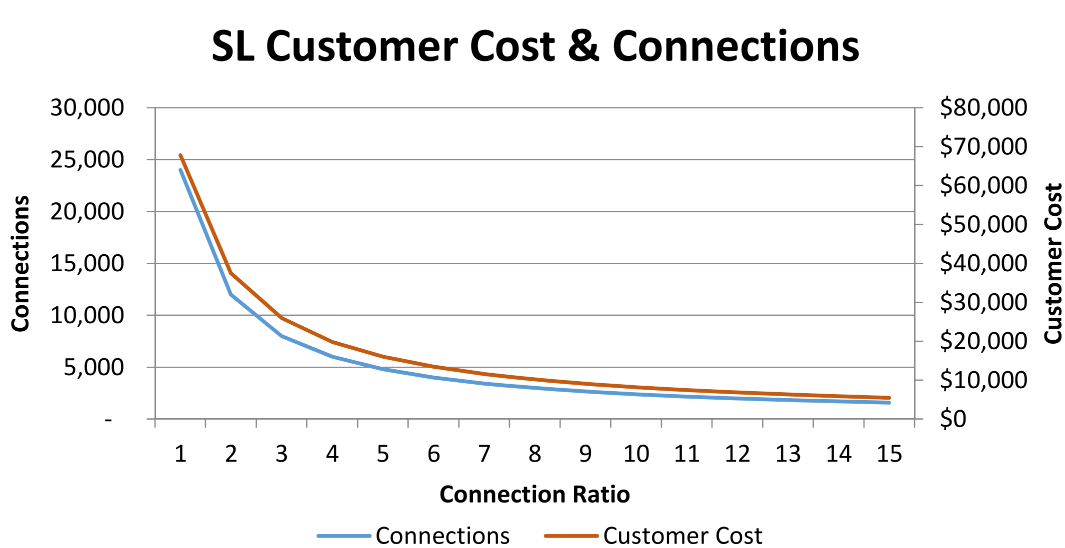
For the purpose of this example, two LDCs are assumed to service the same number of customers and street lighting devices, with the only difference being the street lighting configuration. The first LDC's streetlights are in a daisy-chain configuration with a connection ratio of 15:1, and the second LDC is predominantly a 1:1 configuration with a connection ratio of 1.5:1. As shown in the Table 2, the customer related cost allocation factors for the two LDCs are 1.6% and 14% respectively. The resulting allocation of customer related costs for the first LDC with the daisy-chain configuration will be lower than the LDC with the 1:1 street lighting configuration by a multiple of 8.7 (14%/1.6%).

Table 2 – Sensitivity of customer related costs to connection ratio

	Allocator	15:1 LDC	1.5:1 LDC
SL Devices		24,000	24,000
SL Connections	CCP	1,600	16,000
Other Customer Connections		98,400	98,400
Total Connections	CCP Total	100,000	114,400
SL Allocation	CCP/CCP Total	1.6%	14.0%

In order to further understand the impact to the customer related costs to changes in connection ratio, Navigant completed a sensitivity analysis for a range of connection ratios from 1.0 to 15 which is shown in Figure 2.

Figure 2 - Sensitivity of customer related cost to connection ratio



The sensitivity analysis above shows that the allocation of customer costs to street lighting is far more sensitive for connection ratios of 1:1 to 3:1 than for high connection ratios where it is relatively insensitive to changes. For this example, a change in connection ratio from 1:1 to 2:1, decreases the allocation to street lighting for this customer account by approximately 45%. While some differences exist in the cost to connect and maintain street lighting service, in Navigant's view it is difficult to rationalize that the street lighting customer cost curve presented in Figure 2 is a true reflection of the expected level of costs for LDCs to provide street lighting service.

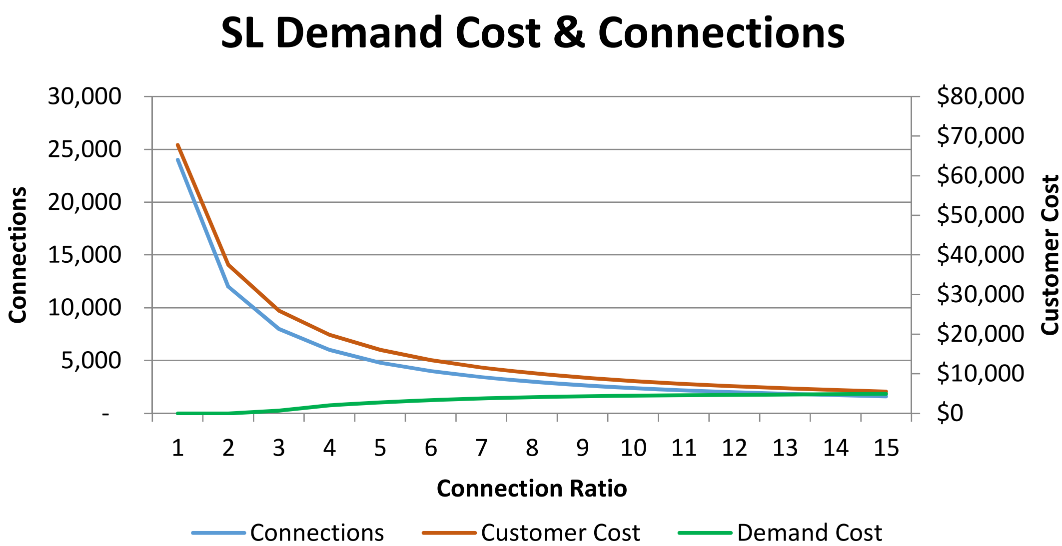
Key Points:

- **The allocation of customer related cost are very sensitive to the street lighting connection ratio, particularly for low connection ratios**
- **It is difficult to rationalize that the customer cost sensitivity to connection ratio as per the existing coast allocation methodology reflects actual LDC costs to provide service**

2.3.2 Demand Related Costs

The CAM model uses the non-coincident peak demand data to allocate demand related costs to each customer class, and in most cases uses the four highest monthly non-coincident peak (NCP4) demands. The sensitivity of the demand related costs to connection ratio for street lighting is provided in Figure 3, which also includes the customer related costs from Figure 2 for comparison. This Figure shows that demand related costs are inversely related to the customer related costs, and less sensitive in connection ratio. The change in the demand allocation is related to the Peak Load Carrying Capacity (PLCC) adjustment for the NCP4, which serves to partially offset the customer related allocation which includes a small demand related cost component. The adjustment results in a zero demand allocation (NCP4) at low connection ratios in the range of 1 to 2.

Figure 3 – Sensitivity of customer and demand related costs to connection ratio



Key Points:

- **The allocation of demand related costs is inversely related and modestly sensitive to the street lighting connection ratio.**
- **Zero demand related costs are allocated to street lighting at low connection ratios.**
- **In relative terms, the impact of the connection ratio on the customer related costs is the key factor driving the street lighting cost allocation**

3 Interviews with LDC's and Municipalities

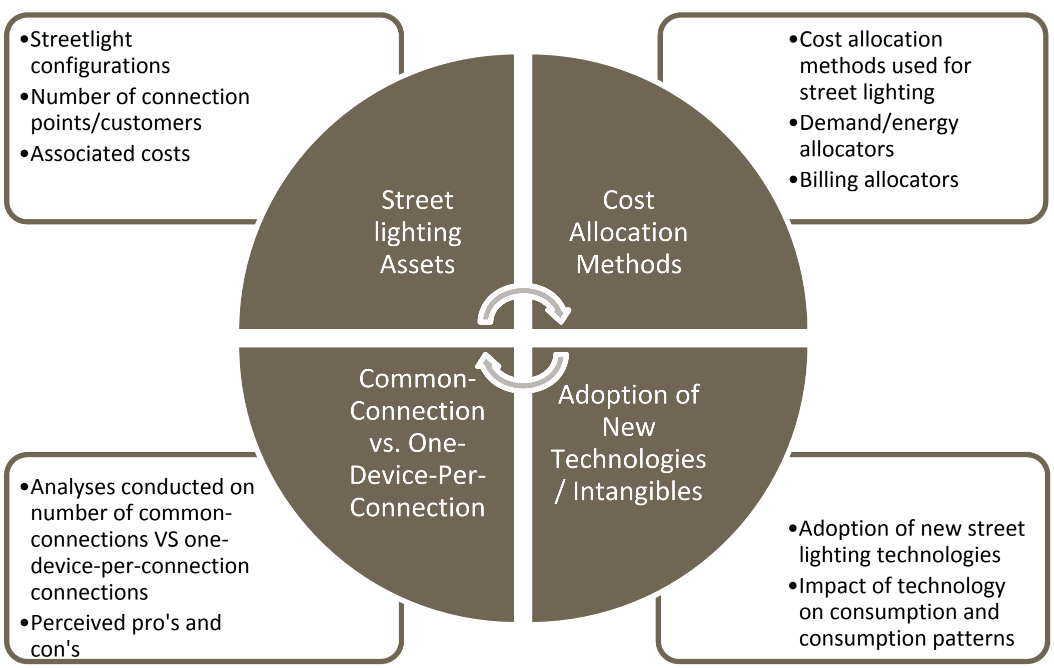
3.1 Overview

Navigant sent out an introductory letter to seven LDCs and their associated municipalities. This letter provided a synopsis of the project objectives, key topics of discussion and how information obtained through the interview would be used in the project and analysis. These interviews consisted of one-on-one interviews and information gathering sessions with both the local distribution companies and their associated municipalities.

In the case of LDCs that serve more than one municipality, Navigant initially targeted the largest municipality served by the LDC and followed with contacting the second-largest municipality if it appeared that an interview was not likely to proceed on a timely basis with the largest municipality. Navigant also included both regulatory and engineering staff in the interviews to cover both the cost allocation and network configuration applicable to the LDC.

Prior to the interviews, Navigant prepared discussion guides for both the LDCs and the municipalities based on the discussion guide outline in Figure 4 below. The discussion guides were provided to the Board for review and comments prior to finalization.

Figure 4 – Discussion Guide Outline



3.2 *Discussion Guide*

Navigant developed a Discussion Guide to assist with the interviews. The questions were split up into sections for street lighting assets, cost allocation methods, adoption of technologies, and whether street lighting configurations are common-connection or one device per connection. Each question was categorized to be targeted towards either a LDC or municipality. This guide was used as a baseline for the interviews, however is not an exhaustive list of what was discussed. Navigant generally conducted the interviews based upon the pace and direction of interview responses. The Discussion Guide is provided in Appendix A.

3.3 *Summary of Findings*

From the interviews it was found that the majority of the LDCs do not own street lighting assets, with the exception of one LDC having recently purchased street lighting assets. As most of these assets are not LDC owned, operations and maintenance (O&M) is typically performed by the municipality and the number of streetlights that are overhead or underground connected is not tracked by the LDC. However, further discussions with LDCs and municipalities revealed that some of these jurisdictions have tracked the number of bulbs in geographic information systems. Most LDCs have a combination of both 1:1 and daisy-chain configurations throughout their systems, with most new residential subdivisions being configured as underground daisy-chain. Daisy-chain configurations with the LDCs interviewed were typically between 6-12 connections per mainline connection.

Subsequent to the initial interviews, Navigant conducted follow-up calls with engineering and technical staff (distribution system planning staff) from a number of the LDCs to ask further questions about street lighting and the design of the various components of the distribution system. Navigant's findings with respect to asset utiliziation were the following:

Primary and Line Transformer Assets

- The assets are designed for peak load (normal peak + contingency backup)
- Street lighting peak load is not considered for design purposes (too small)
- For a given number of devices, the street lighting configuration (1:1 or daisy-chain) has an identical impact on planning of primary and line transformer assets. For both the 1:1 or daisy-chain configurations there is a single connection from the secondary to the primary/ line transformer assets.

Secondary Assets

- The secondary system design is not dependent on the size of individual customer loads.
- Typically a standardized equipment specification using the same size or capacity of lines, poles, equipment etc. is deployed regardless of customer type. Voltage drop is typically the limiting factor for streetlight design.
- The purpose of the secondary system is to connect all customers taking power at secondary voltage levels to the distribution system.
- Secondary assets (below the line transformer) are not the same for a daisy-chain and 1:1 street lighting configuration. There are generally more LDC assets for 1:1 street lighting configuration.

Navigant's detailed findings are provided in Appendix A.

4 Conclusions and Recommendations

Based on a review of the background information (which included OEB and Consultant Reports), the CAM model analysis, and LDC and Municipality interviews conducted by Navigant, a number of conclusions were drawn, and Navigant is able to offer recommendations to address the daisy-chain issue.

Navigant's general conclusions are provided below, and are followed by the conclusions and recommendations that apply specifically to the secondary assets, and the primary and line transformer assets.

4.1 General Conclusions

- Street lighting differs from other customer classes in that the number of connections per device can vary significantly between LDCs, and the number of connections may not equal the number of devices. For most other rate classes the number of connections is typically equal to the number of customers.
- The existing connection based cost allocation methodology results in a disproportionate share of costs to 1:1 street lighting configurations compared to daisy chain configurations.
- Based on the findings in the interviews, a number of LDCs did not know precisely the number of physical street lighting connections on their system, and as such used an estimate for the purpose of their cost allocation study. Each of the LDCs interviewed kept accurate records of the number of devices which is typically used for billing purposes.
- Street lighting configurations and demarcation points from one LDC to the next, as well as within a single LDC, can vary widely given that the distribution system infrastructure may be composed of equipment of various vintages or LDC consolidations etc.

Recommendation – modify the existing connection based cost allocation methodology for street lighting with a street lighting adjustment factor that is independent of the actual number of streetlight connections.

In order to attract the same level of costs regardless of configuration and the actual number of connections, it is recommended that the street lighting adjustment factor be used in conjunction with the number of devices or lamps to derive the connection factor. As an example, an LDC with 10,000 devices would have 1,000 SL connections using an assumed street lighting adjustment factor of 10. The adjustment factor would be calculated based on the individual LDC load data and is independent of the actual number of street lighting connections.

4.2 *Primary and Line Transformer Assets*

Findings

- Assets are designed for peak load (normal peak and contingency backup).
- Street lighting demand is not considered in peak load (too small).
- For a given number of devices or load, the street lighting configuration (daisy-chain or 1:1) has an equivalent impact on the primary system, and in both cases there is a single primary connection/ line transformer.
- Under the existing cost allocation methodology, a street lighting connection is equivalent to any other connection on the system and attracts the same level of costs, regardless if it is a 1:1 or daisy-chain configuration.
- A street lighting connection is not equivalent to a residential connection in terms of load and the impact on the primary distribution system.

Conclusions:

- For a given number of devices, both daisy-chain and 1:1 street lighting configurations should attract the same level of costs given that the effect on the primary distribution system and line transformers is the same for both configurations.

Recommendation: For the allocation of the primary and line transformer assets and related costs to street lighting, Navigant recommends that the existing methodology based on the physical number of connections be replaced with a street lighting adjustment factor. The recommended street lighting adjustment factor is calculated as the ratio of 1) the four highest monthly non-coincident peak demands (NCP4) for the residential customer class divided by the number of residential customers, and 2) the NCP4 for the street lighting customer class divided by the number of streetlight devices. The CAM model would be updated to calculate the street lighting adjustment factors for both the primary and line transformer assets respectively.

4.3 *Secondary Assets*

Findings:

- Municipal asset ownership is higher for daisy-chain than 1:1 i.e. the lines and poles on the municipal side of the demarcation point.
- Typically a standardized equipment specification using the same size or capacity of lines, poles, equipment etc. is deployed regardless of customer type. Voltage drop is typically the limiting factor for streetlight design.
- Street lighting configurations are typically a mix of 1:1 and daisy-chain and the connection ratio will vary from one LDC to the next depending on the vintage of the equipment, design standards etc.
- Secondary assets (below the line transformer) are not the same for daisy-chain and 1:1 street lighting configurations. LDCs with 1:1 street lighting configurations typically have a higher proportion of secondary assets (as indicated in Table 1 - line 4).
- The secondary system design is not dependent on the size of individual customer loads and a standardized equipment specification for lines and poles etc. is used regardless of customer type.

Conclusions:

- The purpose of the secondary system is to connect all customers taking power at secondary voltage levels to the distribution system.
- **The existing cost allocation methodology and the use of connections to allocate secondary costs (below the line transformer) is reasonable.**

Recommendation - For the allocation of the secondary assets and related costs to street lighting, Navigant does not recommend any change to the existing connection based cost allocation.

Although no specific recommendation is included in this Report, it should be noted that there was consideration during the course of the study towards allocating some components of the secondary system using the methodology recommended for the primary and line transformer assets. Navigant recommends distributors be permitted to file for the use of a separate adjustment factor with respect to secondary assets if there is evidence that it would result in a more suitable allocation of the secondary assets, or a component of the secondary assets to street lighting.

4.4 Street lighting Adjustment Factor

As indicated above, Navigant is recommending a Street lighting adjustment factor using the ratio of 1) the residential customer class NCP4 divided by the number of residential customers, and 2) the street lighting NCP4 divided by the number of street lighting devices. A sample calculation is provided in Table 3.

Table 3 - Sample calculation of street lighting adjustment factor

Primary System	NCP4	Customers or Devices	Average NCP4 (per customer or device)
Residential	42,000	5,000	8.4
Streetlighting	800	1,000	0.8
Streetlighting Adjustment Factor (for Primary System)			**10.5**

The primary system street lighting adjustment factor is 10.5 in this example and is calculated by dividing the average NCP4 for a residential customer (8.4) by the average NCP4 of a streetlight (0.8).

The adjustment factor would be calculated for both the primary assets and line transformer assets, and the required input data is currently available in the CAM model (NCP4 and customers/ devices for both the residential and street lighting customer classes).

The average, minimum and maximum adjustment factors for the seven sample LDCs are provided in Table 4 below. For comparison purposes the ratio of the energy (kWh) for a residential customer and the energy for a street light has also been provided in this Table. This illustrates that a residential customer uses from approximately 10 times to more than 15 times the consumption of a streetlight.

Table 4 - Street lighting Adjustment Factors

Basis for Adjustment Factor	Average	Min	Max
Demand - NCP4			
Primary Assets			
Residential/ SL	**10.8**	**9.1**	**14.3**
Line Transformer Assets			
Residential/ SL	**10.7**	**9.1**	**13.5**
Energy - kWh/ customer			
Residential/ SL	12.6	9.8	15.8

A secondary argument for using the residential to street lighting ratio as the basis for the adjustment factor is that the need for street lighting is predominately driven by the residents of a community, or residential customers.

4.5 *Change in Cost Allocation by Customer Class*

The impact of Navigant's recommended cost allocation methodology and the use of the street lighting adjustment factor have been estimated using fictional data for street lighting connection ratios ranging from 1:1 through 15:1. The potential change in cost allocation for the street lighting customer class is the most significant for LDCs with low connection ratios, as illustrated on the left side of the Figure 5. The change in cost allocation for LDCs with a high connection ratio (i.e. greater than the street lighting adjustment factor of ~10) is shown on the right side of Figure 5. In this situation there would be a cost allocation increase to the street lighting customer class, and an offsetting decrease for the other customer classes.

Figure 5 – Street lighting Cost Allocation

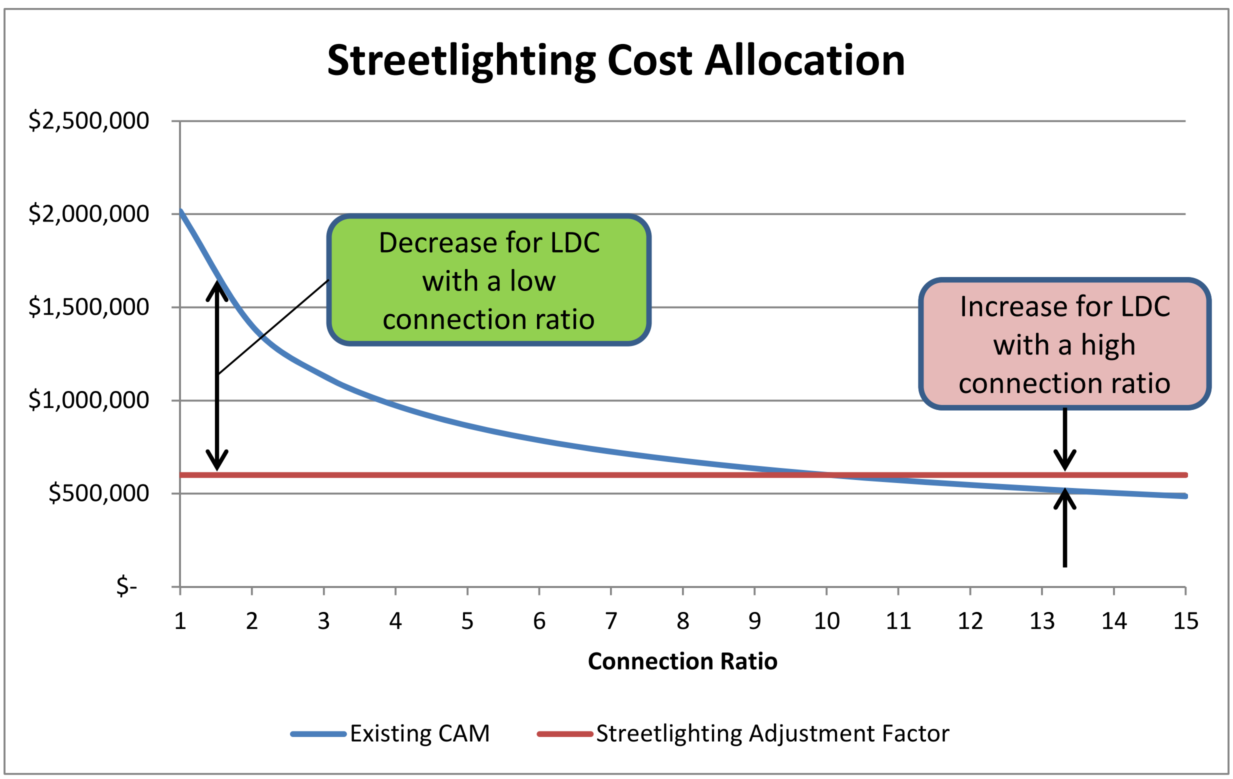


Table 5 provides a summary of the change in cost allocation expected for each of the various customer classes. Navigant estimates that LDCs with connection ratios of 3:1 or less could potentially see reductions in distribution cost allocations ranging from 50% to 70%, with the offsetting increase to other customer classes ranging from 0% to 4%. High connection ratio

LDCs (greater than 10:1) could potentially see an increase in cost allocation ranging from 0% to 15% and no material decrease is expected for the other customer classes. Taking a closer look at the residential customer class, an increase of 0% to 2% is expected for LDCs with low connection ratios, and 0% to 1% for LDCs with connection ratios between 3:1 and 10:1. As noted above, no material change is expected for the residential customer class for LDCs with high connection ratios (above 10:1). The maximum change in cost allocation to other customer classes as a result of the change in street lighting is estimated to be an increase in the range of 2% to 4%.

As a cautionary note, Navigant reiterates that the cost allocation changes indicated above are only estimates and actual changes may vary considerably depending on the specific characteristics of individual LDCs.

Table 5 - Change in Cost Allocation

Change in Cost Allocation	LDC Connection Ratio		
	Below 3:1	3:1 to 10:1	Above 10:1
Customer Class *			
Residential	0% - 2%	0% - 1%	(0)%
GS <50	1% - 3%	0% - 2%	(0)%
GS>50-Regular	1% - 3%	0% - 2%	(0)%
Large Use	2% - 4%	0% - 3%	(0)%
Street Lighting	(70)% - (50)%	(50)% - (0)%	0% - 15%
Other	2% to 4%	0% - 3%	(0)%

* The cost allocation to each customer class varies with the proportion of primary/secondary and line transformer assets needed to provide service.

This report seeks to address the cost allocation methodology for street lighting which is used in the OEB CAM. The Report does not address the subsequent stages of the rate-making process which impacts rates ultimately billed to customers. These other processes include rate design and the requirement for revenue-to-cost ratios to be within an acceptable OEB policy range for each rate class..

4.6 Other Issues and Considerations

In developing the recommendations above, there were a number of other issues that were considered by Navigant which are reviewed below.

The first consideration is that the disparity between the two system configurations could create an economic incentive for municipalities (who currently own street lighting assets that are configured as 1:1) to invest in new infrastructure and convert to a daisy-chain configuration in order to attract a lower level of allocated costs. Stated another way, the cost distortion between the various configurations could create a perverse economic incentive, that in Navigant's view does not appear to result in a rational use of capital. The street lighting adjustment factor would have a considerable influence in addressing this potential issue.

The second consideration is that the recommended solution is pragmatic and fits within the confines of the existing cost allocation methodology and CAM model, but also addresses the street lighting cost distortion. All the data required for the street lighting adjustment factor calculation is available and is supplied as part of the existing inputs to the CAM model. It should also be noted that that the LDCs interviewed typically estimated the number of street lighting connections as accurate data does not exist. The recommended approach reduces the importance and use of the number of street lighting connections which would only be used for the allocation of the secondary assets and related costs, if the recommendations are adopted.

Navigant believes that the proposed recommendations effectively address much of the cost allocation disparity between 1:1 and daisy-chain street lighting configurations, and on balance is a significant improvement relative to the existing cost allocation methodology. The proposed recommendations are pragmatic and provide a timely solution that fits within the structure of the existing cost allocation methodology and can easily be incorporated into the existing CAM model.

If these recommendations are accepted the CAM model will need to be updated.

4.7 Summary

Navigant recommends that the allocation of the primary and line transformer assets and related costs to street lighting be calculated using a newly devised "street lighting adjustment factor". The recommended street lighting adjustment factor is calculated as the ratio of 1) the four highest monthly non-coincident peak demands (NCP4) for the residential customer class divided by the number of residential customers, and 2) the NCP4 for the street lighting customer class divided by the number of streetlight devices. The resulting adjustment factor is independent of the number of connections and would not vary with the street lighting device-to-connection ratio, and would serve to eliminate much of the disparity between the 1:1 and daisy-chain street lighting configurations. The calculated adjustment factor would be LDC-specific and the required data is available in the existing CAM model.

In summary, Navigant recommends that:

1. The allocation of the primary and line transformer assets and related costs to street lighting be calculated using a newly devised "street lighting adjustment factor" instead of the existing allocation that is based on number of street lighting connections.
2. The street lighting adjustment factor is calculated as the ratio of i) the four highest monthly non-coincident peak demands (NCP4[6]) for the residential customer class divided by the number of residential customers, and ii) the NCP4 for the street lighting customer class divided by the number of streetlight devices.
3. No change for the allocation of the secondary assets and related costs, which is based on the number of connections.

[6] The Cost Allocation Model decides whether to use a 1 NCP or 4 NCP method for allocating demand costs based on a test described in *Board Directions on Cost Allocation Methodology for Electricity Distributors*, EB-2005-0317, p.61, dated September 29, 2006. All distributors except one had an NCP4 test result in their Cost Allocation filings.

Appendix A: Discussion Guide

Data / Information Request	LDC	Municipality
Street lighting Assets		
Streetlight configurations →What is the demarcation point for street lighting in your jurisdiction? →What configurations of street lighting do you have in your jurisdiction? →Who owns the street lighting assets in your jurisdiction?	Yes	Yes
Number of connection points/customers →1:1 VS daisy-chain configuration (e.g. lights connected via pedestal) Do you have both configurations in your system? →Excluding the end-of-line connection assets, how does the set-up of LDC assets necessary to serve an equal number of streetlights in the two configurations differ, if at all? Feel free to comment on the nature of the connection assets involved, in terms of price and assets, esp. for 1:1 configurations. In addition, how does this differ from connection of other LV assets? →Do you keep track of these assets (i.e., database) including the cost and extent of connection assets required for the different connections/configurations	Yes	Yes
Associated costs **→Do you keep track of the costs in regards to capital costs, installation costs, O&M etc.**	Yes	Yes

Data / Information Request	LDC	Municipality
Cost Allocation Method(s)		
Cost allocation methods used for street lighting →Functionalization, categorization, allocation methods →How do you use the CAM to account for single/multi streetlights (i.e., max of either # connections, # customers, weighted connections vs. residential, etc.) with respects to the USofA accounts? →Have you considered/explored other CAM's? Has there been any internal review of the current CAM template, and if so, are there issues or concerns? →How does the definition of number of street lighting customers change for a daisy-chained vs. 1-1 connection scheme? →Is street lighting being treated equitably? Are you (or the OEB tool) artificially doing under-or-over recovery specifically for street lighting? →Do you review how CP/NCP allocators are impacted by demand/consumption, number of connections and number of customers? →Do your subject matter experts see any issues with the way street lighting is currently being treated →Is your LDC aware of what others are doing and if they are applying consistent methodologies for gathering data inputs?	Yes	NA
Demand/energy allocators →How do you estimate the demand/energy required for street lighting and does this change from a 1:1 to daisy-chained connection scheme? →How are LDCs generating input data? Load forecasts? Actual metered data? Are streetlights metered in your jurisdiction? →What is your process for determining the 1/4/12 CP and NCP scenarios? →Do you actively review how recovered revenue is divided between demand allocators and customer contribution allocators in the CAM output?	Yes	NA
Billing allocators →How do you bill your customers? For municipal owned assets, how do LDC's bill municipalities? →Are you aware of your municipal customers having any concerns/questions regarding the cost allocation that impacts street lighting billing? →Can you comment towards the breakdown of your customer base and the billing methodology/number of bills you generate?	Yes	NA

Data / Information Request	LDC	Municipality
Adoption of New Technologies / Intangibles		
Adoption of new street lighting technologies →Have there been discussions/studies into the adoption of new street lighting technologies? (i.e., LED's) →Were these discussions primarily driven by the LDC or the municipality? →How does the current policy framework and cost allocation model affect your decisions regarding the connection of new street lighting assets? →How does the current policy framework and cost allocation model affect your decisions regarding upgrades to existing street lighting assets? →Does the distributor typically allow for the installation of whatever system you choose (be it 1:1 or common connection), or are you restricted in this choice? →How has the uptake of smart metering impacted the estimation of demand/energy forecasts for street lighting?	Yes	Yes
Impact of technology on consumption and consumption patterns →How will new technology affect load forecasts? →Has the roll-out of smart meters affected the way street lighting is being treated with regards to cost allocations →Is there a trend of moving towards a specific configuration? →Does your municipality quantify and assess the non-distribution cost savings from replacement and installation	Yes	Yes
Common-Connection vs. One-Device-Per-Connection		
Analyses conducted on number of common-connections VS one-device-per-connection connections	Yes	Yes
Perceived pros and cons	Yes	Yes

Appendix B: Details of Interviews with LDC's and Municipalities

LDC	Service Territory & Size of LDC	Ownership & Configuration of Street lighting Assets	Cost Allocation Model Feedback
A	Urban/Rural – M	• No specific SL assets • Combination of both 1:1 and daisy-chained (up to 10) configurations; split is unknown • 1:1 typically is overhead and daisy-chained is underground, with new subdivisions mostly using daisy-chain • # of bulbs tracked in GIS database, however no numbers were provided	• Does not perform O&M • Load profile of streetlight used to determine billing (wattage, # of bulbs, technology etc.) • Primarily using CAM as a "blackbox" • Connection ratio used = 1.1-1.5 (estimation; LDC did not provide)
B	Urban – L	• No specific SL assets • Combination of both 1:1 and daisy-chained (up to 8) configurations; majority of which is 1:1 • 1:1 typically is overhead and daisy-chained is underground, with new subdivisions mostly using daisy-chain • Transformer, secondary line, poles and lights used to be tracked until City took over O&M contract • # of bulbs tracked as a result of a joint audit with City showed ~36,000 streetlights connected	• Does not perform O&M • Load profile of streetlight used to determine billing (wattage, # of bulbs, technology etc.); legacy profiles from 2006 scaled up • Primarily using CAM as a "blackbox", however has done extensive research into the inputs/outputs and is confident about LDC CAM inputs • Connection ratio used = 1.3
C	Rural – XL	• No specific SL assets • Combination of both 1:1 and daisy-chained (typically 6-12) configurations; majority of which is daisy-chained • No distinction for overhead VS underground however majority of	• Does not perform O&M • Load profile of streetlight used to determine billing (wattage, # of bulbs, technology etc.); new smart meter data used for profiling • Has done extensive research into the inputs/outputs and is

LDC	Service Territory & Size of LDC	Ownership & Configuration of Street lighting Assets	Cost Allocation Model Feedback
		system is overhead • # of bulbs tracked in GIS database shows ~155,000 streetlights connected	confident about LDC CAM inputs • Connection ratio used = 1.8
D	Urban/Rural – M	• No specific SL assets • Combination of both 1:1 and daisy-chained (up to 10) configurations; majority is daisy-chained (>95%) • # of bulbs tracked in GIS database shows ~24,000 streetlights connected	• Does not perform O&M • Load profile of streetlight used to determine billing (wattage, # of bulbs, technology etc.) • Primarily using CAM as a "blackbox" however 2013 filing involved re-analyzing weighting of street lighting services/billing compared to residential service/billing costs • Connection ratio used = 15.5:1 (estimation; LDC did not provide)
E	Urban/Rural – S	• No specific SL assets • LDCs entire system is 1:1 • Overhead/underground split is not tracked • # of bulbs tracked, however the specific number was not provided	• Regulated wires company performs O&M on behalf of the City, however the City is in the process of converting all streetlights to LED technology, and it is expected that O&M will be very minimal in the future • Load profile of streetlight used to determine billing (wattage, # of bulbs, technology etc.); legacy profiles from 2006 scaled up • Primarily using CAM as a "blackbox", however has done a analysis into housing VS street lighting costs • Connection ratio used = 1.0
F	Urban – L	• No specific SL assets • Combination of both 1:1 and daisy-chained (typically 6-12) configurations; majority of which is	• Regulated wires company performs O&M on behalf of the City • Load profile of streetlight used to

LDC	Service Territory & Size of LDC	Ownership & Configuration of Street lighting Assets	Cost Allocation Model Feedback
		daisy-chained • All overhead is daisy-chained however underground is both 1:1 and daisy-chained • # of bulbs tracked, however the specific number was not provided	determine billing (wattage, # of bulbs, technology etc.) • Connection ratio used = 1.1-1.5 (estimation; LDC did not provide)
G	Urban – XL	• LDC owns the majority of the street lighting assets; the City sold off the assets to the LDC • Combination of both 1:1 and daisy-chained configurations; max # of connections not tracked • Street lighting assets are overhead and underground however this is not tracked • # of bulbs tracked in GIS database shows ~52,000 streetlights connected (40,000 within LDC wires company, 12,000 within affiliate)	• LDC contracts the City to perform O&M • Load profile of streetlight used to determine billing (wattage, # of bulbs, technology etc.) • Primarily using CAM as a “blackbox” however believes that the CAM is skewing costs towards street lighting • Connection ratio used = 1.8; inventory sampling used to obtain this number