Plugging the Holes in Leakage: Methods for Calculating the Leakage out of and into Upstream Residential Lighting Programs

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ABSTRACT

As savings from upstream lighting programs diminish with the increasingly-efficient market baseline, program administrators are becoming ever more concerned with maximizing remaining savings. One opportunity is to limit the sales of program-discounted bulbs to customers of other program administrators, commonly known as leakage. Though it is nearly impossible to eliminate leakage in most upstream lighting programs, program administrators attempt to limit it by excluding retailers close to their territory borders. Program administrators can also account for leakage "in" of bulbs from other upstream lighting program service areas. While many assumptions used to estimate lighting program savings are well-established, leakage is not of one them.

In this paper, we review leakage methods from 11 TRMs. We then examine two methods used to estimate leakage. The primary method, in-store customer intercept interviews, provides an estimate of leakage out of a utility territory but is not typically used to estimate leakage into a territory. The second method, which relies on Geographic Information Systems (GIS) analysis, can be used to estimate both leakage out as well as leakage in. We assess the strengths and weaknesses of these two methods using recently completed lighting program evaluations of two utilities that neighbor one another. We find that in-store customer intercept interviews are better suited for estimating overall territory leakage but yield unreliable leakage estimates at a single specific territory border. The GIS analysis method is suitable for estimating leakage at a specific border, but we find that analysis assumptions may greatly impact the estimates.

Introduction

As savings from upstream lighting programs diminish with the increasingly-efficient market baseline, program administrators are becoming ever more concerned with maximizing remaining savings. One opportunity is to limit the sales of program-discounted bulbs to customers of other program administrators, commonly known as leakage. Though it is nearly impossible to eliminate leakage in most upstream lighting programs, program administrators attempt to limit it by excluding retailers with locations close to their territory borders. Program administrators can also account for leakage "in" of bulbs from other upstream lighting program service areas. While many assumptions used to estimate lighting program savings are well-established, leakage is not of one them. There is little consistency in the measurement or application of leakage across the industry. Most state Technical Reference Manuals (TRMs) give little guidance as to how leakage should be estimated.

We reviewed the lighting savings assumptions from 11 TRMs from states across the country and the methods outlined by the Uniform Methods Project (UMP). We found that only 6 of 12 mention leakage at all and only 2, the Arkansas TRM and the UMP, provide methods for estimating leakage as seen in Table 1 (Arkansas TRM 2014; Connecticut Program Savings Document 2013; Efficiency Vermont 2015; Illinois Statewide TRM 2017; Indiana TRM 2015; Massachusetts TRM 2014; Minnesota TRM 2016; NY State Joint Utilities 2016; NREL 2015; Pennsylvania PUC TRM 2016; Texas TRM 2014; Wisconsin TRM 2014). For those TRMs that did provide guidance, the primary method suggested is in-store customer intercept interviews at participating retailers. The main evaluation objective of intercept interviews is estimating lighting program free-ridership and the sample designs are drawn with that purpose in mind. Evaluators use intercepts to estimate leakage, but as we will show in greater detail below, intercepts are particularly susceptible to coverage bias when estimating leakage out to a single utility and therefore are not suitable for estimating leakage in from a single utility. Another method for calculating leakage suggested by the Arkansas TRM and the UMP utilizes Geographic Information Systems (GIS) analysis (Arkansas TRM 2014; NREL 2015). This method avoids the coverage bias associated with in-store intercepts and can produce estimates of both leakage out of and into a territory. However, the method requires many simplifying assumptions, which threaten its internal validity.

Table 1. Review of TRMs for Recommended Upstream Residential Lighting Leakage Methodologies

State	TRM Publication Month and Year	Upstream Residential Lighting Leakage Mentioned?	Estimation Methods Described?
Arkansas	August, 2014	Yes	Yes
Uniform Methods Project (UMP)	February 2015	Yes	Yes
Illinois	February 2017	Yes	No
Pennsylvania	June 2016	Yes	No
New York	April 2016	Yes	No
Massachusetts	June 2014	No	No
Indiana	July 2015	No	No
Texas	April 2014	No	No
Connecticut	October 2012	No	No
Minnesota	December 2016	No	No
Wisconsin	August 2014	No	No
Vermont	March 2015	No	No

In this paper, we conduct an in-depth examination of the two methods that are currently used to estimate leakage. We use data from recent evaluations of Ameren Illinois Company (AIC) and Commonwealth Edison (ComEd) upstream residential lighting programs to illustrate the benefits and drawbacks of each method (Navigant 2015; Navigant 2016; Opinion Dynamics 2015; Opinion Dynamics 2017). Using evaluation data from these bordering Illinois utility territories, we are able to estimate the leakage in and leakage out of utility discounted lighting products across the border between AIC and ComEd.

Utility and Program Background

Both AIC and ComEd run upstream lighting programs—discounting qualifying lighting products at participating retailers in the utility territory. The discounts offered by the program and its retail and manufacturing partners bring the cost of energy-efficient lighting closer to that of less-efficient options. Both programs have hundreds of participating retail locations across their territories. In selecting retail locations to include in their programs, the utilities must balance serving all their customers with minimizing leakage by excluding participating retail stores that are close to their territory borders. For ComEd, the borders most susceptible to leakage are the northern border with Wisconsin, the eastern border with Indiana, and the southern border with AIC, as seen in Figure 1.[1] The Mississippi River may

[1] Program territory shape files are not openly accessible for ComEd or AIC. To determine the program territory, we plotted the addresses of ComEd and Ameren customers. We defined a census block group as being part of a utility's

provide a natural barrier to leakage on a small portion of ComEd's western border, and Lake Michigan forms a barrier on the northeastern side of the territory. For AIC, municipal utilities present a larger leakage challenge as AIC territory envelopes many municipal utilities. A large border with Missouri, Indiana, and Kentucky also present leakage challenges, though the Mississippi River restricts leakage to participating retail stores located near bridges. ComEd is about one-third the size of AIC Territory, at about 12,123 square miles versus 37,457 square miles, and therefore the AIC upstream lighting program must manage leakage along exponentially larger borders than the ComEd program. While program administrators typically exclude participating retail store locations that are close to the border, given these border constraints, it is impossible to exclude all participating retail stores that are susceptible to leakage for either ComEd or AIC territory.[2] For ComEd in 2014 and 2016, participating retail stores were an average of 9 miles from any given border, while in AIC, participating retail stores were an average of 7 miles from any given border.

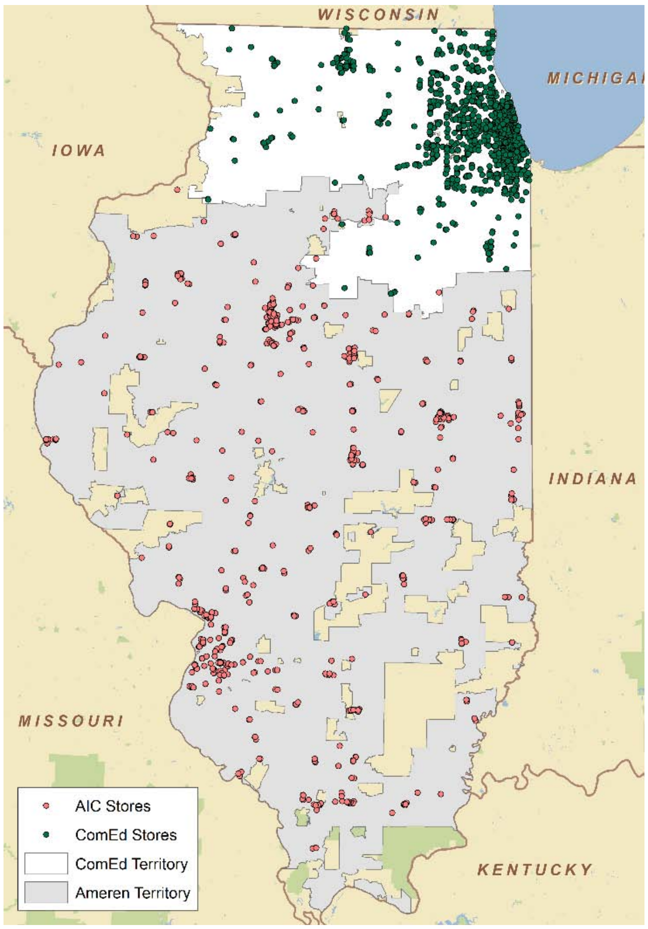

Figure 1. 2016 AIC and ComEd Residential Upstream Lighting Program Participating Stores.

service territory if more than 75 customer addresses were plotted within the census block group (U.S. Census Bureau 2015). We merged these census block group shapes together to constitute each individual utility territory.

[2] An alternative program design that avoids penalizing utilities for leakage while still serving all customers is the Simple Steps Smart Savings program in Montana, Idaho, Oregon, and Washington. A secondary program administrator manages the program at stores located along the border of two utilities.

Methodology

For this paper, we examine upstream residential lighting program evaluation data from AIC and ComEd for both the 2014 and 2016 program years.[3] Each program had approximately 1,000 participating retail locations in 2014 and 2016. By focusing on sales of program-discounted bulbs at participating stores near the AIC and ComEd border (i.e. leakage susceptible stores), we provide an apples-to-apples comparison of lighting program leakage estimates from the in-store customer intercepts and the GIS analysis. We define a store as being susceptible to leakage if it lies within 15 miles of a utility border. In the case of the AIC/ComEd border, there were a total 54 AIC and 90 ComEd stores susceptible to leakage in 2014 and 47 AIC and 106 ComEd stores in 2016. Much of our analysis focuses on these stores.

In-Store Customer Intercept Methods

In-store customer intercept interview methods were nearly identical for AIC and ComEd program evaluations. Evaluators interviewed 539 and 335 customers who purchased program-discounted bulbs for the 2014 and 2016 AIC evaluations, respectively. For the ComEd evaluations, field staff conducted 382 interviews with customers purchasing program-discounted bulbs in 2014 and 400 interviews in 2016. Interviews took place at between 23 and 26 do-it-yourself (DIY) stores, warehouse, and other big box program-participating retailers. Evaluators used a convenience sample of stores conducting interviews at top-selling retailers that would allow access to their customers. Evaluators attempted to address potential coverage bias by selecting stores that reflected the overall population of participating stores and by selecting stores that provided reasonable coverage of the utility service territory.

Evaluators attempted to interview all customers purchasing lighting, including CFLs and LEDs discounted through the program, CFLs and LEDs not discounted, and incandescent and halogen light bulbs. Interviewers asked customers to complete a short survey in exchange for a gift card to that particular retail store. To identify purchases that would qualify as leakage, customers purchasing lighting at ComEd participating retailers were asked if they were ComEd electric customers. Customers at AIC participating retailers were asked to name their electric service provider. Both the ComEd and AIC questions can quantify leakage but only the AIC question can identity the utility the bulbs are leaking to.

Leakage calculations for in-store intercepts. We define leakage **out** as the number of program-discounted bulbs sold to customers of an opposing utility territory. In this paper, we focus only on stores that are within 15 miles of the AIC/ComEd border.

We calculate the program leakage **out** rate for each utility using the following formula:

$$\%LeakageOut = \frac{\sum_{y=1}^{y} LeakageOut_y}{\sum_{y=1}^{y} Sales_y}$$

Where:

$LeakageOut_y$ = Sum of all program-discounted bulbs sold to in-store intercept participants that were customers of another utility at individual program participating store *y*, and

$Sales_y$ = Sum of all program discounted bulbs sold to in-store intercept participants at an individual program participating store *y*.

[3] The program years for AIC and ComEd run from June through May. We examine two program years in this paper that run from May 2013 to June 2014 and May 2015 through June 2016. For ease of description, we refer to these program years as 2014 and 2016.

We define leakage **in** as the number of opposing utility upstream lighting program discounted bulbs sold to in-territory utility customers (i.e. ComEd program-discounted bulbs sold to AIC customers and AIC-discounted bulbs sold to ComEd customers). We calculate the program leakage **in** rate for each utility using the following formula:

$$\%LeakageIn = \frac{\sum_{z=1}^{z} LeakageIn_z}{\sum_{y=1}^{y} Sales_y}$$

Where:

$LeakageIn_z$ = Sum of all program discounted bulbs sold to in-store intercept participants determined to be leakage customers at individual opposing-utility program participating store *z*, and

$Sales_y$ = Sum of all program discounted bulbs sold to in-store intercept participants at an individual program participating store *y*.

We finally calculate **total** program leakage for each utility using the following formula:

$$\%TotalLeakage = \%LeakageIn - \%LeakageOut$$

Where:

%LeakageOut = Calculated program percent leakage out rate, and

%LeakageIn = Calculated program percent leakage in rate.

Most evaluators only conduct intercepts at retailers participating in the program they are evaluating so they are only able to estimate leakage out of the territory using the intercept method. Because we were able to obtain in-store intercept data from both sides of the AIC and ComEd border during the same program years, we can calculate total leakage in as well. To facilitate comparison to the GIS method, we focus on the intercept interviews that the evaluations teams conducted at stores within 15 miles of the AIC/ComEd border.

GIS Method

Though the 2014 and 2016 AIC and ComEd evaluations did not estimate leakage using GIS analyses, we use program sales data from these evaluation efforts to produce a GIS-based estimate of leakage for this paper. We concentrate on the leakage occurring on the border between AIC and ComEd. By focusing on this border, we can calculate both the leakage out of a given territory and the leakage into a given territory and directly compare the GIS and in-store intercept estimates of leakage.

A key assumption underlying the GIS analysis is the definition of a participating store's customer territory. We define that territory as including all customers who live within a 15-mile radius (buffer zone) of each participating store. The border between AIC and ComEd runs through a rural area. It is likely that customers are willing and often required to drive longer distances to have access to retailers selling products they need. We feel that, on average, 15-miles is a reasonable estimate for the furthest distance a customer would drive to purchase a lighting product in a rural location. Research on customer sales patterns for each participating store would give further fidelity to this assumption, as customers may be willing to drive varying distances for certain retailers and products. Road networks and proximity to other retail stores are also likely to impact purchase behaviors. We lack the data needed to determine how these other factors impact store territories, and thus, use the simplifying territory definition of a 15-mile radius. We compare our results using different territory definitions to demonstrate the sensitivity of the results to this assumption.

Leakage calculations for GIS analysis. We focus only on stores that are within 15 miles of the AIC/ComEd border, and using the ComEd and AIC customer databases, we identify the customers that live within a 15-mile radius of each store.

We calculate the number of bulbs leaking **out** of each utility's participating stores using the following formula:

$$LeakageOut_i = \left(\frac{Customers_{OP\ i}}{Customers_{OP\ i} + Customers_{IN\ i}}\right) * Sales_i$$

Where:

$Customers_{IN\ i}$	= Total number of in-territory customer address points within the 15-mile buffer zone around an individual program participating store *i*, and
$Customers_{OP\ i}$	= Total number of opposing territory customer address points within the 15-mile buffer zone around an individual program participating store *i*, and
$Sales_i$	= Total yearly program discounted bulb sales at individual program participating store *i.*

We calculate the total program leakage **out** rate by summing the values of the individual stores using the following formula:

$$\%LeakageOut = \frac{\sum_{i=1}^{i} LeakageOut_i}{\sum_{i=1}^{i} Sales_i}$$

Where:

$LeakageOut_i$	= Calculated leakage out value for an individual program participating store *i*, and
$Sales_i$	= Number of program discounted bulbs sold at an individual program participating store *i.*

We calculate the number of bulbs leaking **in** from each opposing utility's participating stores using the following formula:

$$LeakageIn_x = \left(\frac{Customers_{IN\ x}}{Customers_{OP\ x} + Customers_{IN\ x}}\right) * Sales_x$$

Where:

$Customers_{IN\ x}$	= Total number of in-territory customer address points within the 15-mile buffer zone around an individual opposing-utility program participating store *x*, and
$Customers_{OP\ x}$	= Total number of opposing territory customer address points within the 15-mile buffer zone around an individual opposing-utility program participating store *x*, and
$Sales_x$	= Total yearly program discounted bulb sales at individual opposing-utility program participating store *x.*

We calculate the total program leakage **in** rate by summing the values of the individual stores using the following formula:

$$\%LeakageIn = \frac{\sum_{x=1}^{x} LeakageIn_x}{\sum_{i=1}^{i} Sales_i}$$

Where:

$LeakageIn_x$	= Calculated leakage in value for an individual opposing-utility program participating store *x*, and
$Sales_i$	= Number of program discounted bulbs sold at an individual program participating store *i.*

We finally calculate total program leakage using the same formula as the in-store intercept method (i.e., %LeakageIn – %LeakageOut).

Results

In-Store Customer Intercepts

Evaluation teams that conduct in-store intercepts must balance competing objectives when selecting a sample of participating retail stores to include in the study. Evaluators typically use non-probability purposeful samples in which they select retailers and locations that are top-sellers and spread throughout the territory. The main evaluation objective is to represent the most common customer purchase situations to produce a representative estimate of free ridership. Evaluators use intercepts to gain other information such as leakage, but these topics are secondary to free ridership. Evaluators typically attempt to select a sample that, as a whole, is representative in terms of participating store location relative to utility borders, but sample sizes are not large enough to draw a sample that is representative of each border. It is likely that intercept-based estimates of leakage to any single utility suffer from coverage bias. Coverage bias can occur when the sample systematically excludes members of the target population in a manner that is correlated with the study variables of interest.

The in-store intercepts that were conducted in 2014 and 2016 to evaluate the AIC and ComEd residential lighting programs demonstrate the strengths and weaknesses of using intercepts to estimate leakage. The in-store intercept samples for AIC and ComEd in 2014 and 2016 closely mirrored the population in terms of the distance of participating stores to territory borders. Because AIC territory is riddled with municipal utilities and ComEd territory has two municipal utilities near the heart of Chicago (Naperville and Winnetka), many participating stores are within 15 miles of a territory border. The percent of participating retail stores within 15 miles of any border (border stores) closely aligns to the percent of sampled participating stores within 15 miles of a border, with between 89% and 91% of participating stores within 15 miles of the border compared to between 84% and 100% of sampled participating stores (Table 2).

Table 2. Participating Stores and Sampled Stores Compared to Participating Stores Within 15 Miles of Any Border[4]

		Population			Sample		
Utility	Year	Count of Stores within 15 Miles of Any Border	Total Participating Stores	Border Stores as Percent of Total Stores	Count of Sampled Stores within 15 Miles of Any Border	Total Sampled Participating Stores	Border Stores as Percent of Total Sampled Stores
AIC	2014	770	862	89%	25	25	100%
AIC	2016	651	725	90%	24	26	92%
ComEd	2014	813	900	90%	21	25	84%
ComEd	2016	1046	1151	91%	22	23	96%

Looking just at the AIC/ComEd border, about 6% of all AIC participating stores in 2014 and 2016 were within 15 miles of ComEd territory (border stores), as seen in Table 3. A greater percentage of ComEd participating stores were within 15 miles of the AIC border (10% in 2014 and 9% in 2016), though the smaller size of ComEd territory may have more to do with this difference than any conscious

[4] The ComEd border along Lake Michigan not included in this analysis.

programmatic decision. The in-store intercepts performed for the 2014 and 2016 evaluations were conducted at few, if any, border stores (between zero and two stores). For AIC and ComEd in 2014, the percent of sampled participating border stores (0% for AIC and 4% for ComEd) did not accurately reflect the population of participating border stores (6% for AIC and 10% for ComEd). But even for the 2016 ComEd intercepts when the percentage of sampled border stores matches the population (both 9%), the results are based on 6 days of interviews with 24 customers at 2 stores. It is difficult to justify extrapolating a leakage estimate from such a small number of cases to 106 retailers that are open nearly every day of the year. With an overall sample of approximately 25 stores, an oversample would be required to accurately estimate leakage to any single utility using intercepts and would likely be cost-prohibitive for most evaluations.[5]

Table 3. Program Stores and Sampled Stores Compared to Participating Stores Within 15 Miles of AIC/ComEd Border

		Population			Sample		
Utility	Year	Count of Stores within 15 Miles of AIC/ComEd Border	Total Participating Stores	Border Stores as Percent of Total Stores	Count of Sampled Stores within 15 Miles of AIC/ComEd Border	Total Sampled Participating Stores	AIC/ComEd Border Stores as Percent of Total Sampled Stores
AIC	2014	54	862	6%	0	25	0%
AIC	2016	47	725	6%	1	26	4%
ComEd	2014	90	900	10%	1	25	4%
ComEd	2016	106	1151	9%	2	23	9%

The results of the AIC and ComEd intercepts demonstrate this point. For AIC, the intercept sample did not include any border stores in 2014 so AIC leakage out and ComEd leakage in is unknown (Table 4). For ComEd in both years and AIC in 2016, none of the customers interviewed at the three border stores included in the samples were customers of the other utility. Estimated leakage out and leakage in was zero in all cases. It is highly unlikely that there was no leakage between the two utilities, but the small sample sizes did not pick it up.

Table 4. Leakage Estimates Using In-Store Intercept Method

	2014	2016
AIC		
Leakage Out	NA	0.00%
Leakage In	0.00%	0.00%
Total AIC Leakage	0.00%	0.00%
ComEd		
Leakage Out	0.00%	0.00%
Leakage In	NA	0.00%
Total ComEd Leakage	0.00%	0.00%

Overall, the sample of participating AIC and ComEd stores in 2014 and 2016 made legitimate attempts to provide coverage of the entire geographic area of the utility territory. To clearly illustrate this

[5] Historically, the number of daily customers at rural participating stores is lower than in more urban areas.

coverage, we focus on participating stores sampled for the 2016 ComEd evaluation. Evaluators balanced stores in population-dense areas with stores that represent smaller communities further outside the urban centers (Figure 2 below). Chicago contains the bulk of ComEd customers, and therefore the sample drew many participating stores from the area. By sampling many stores in the greater Chicago area, evaluators were able to reduce the cost of in-store intercepts. The sample also attempted to reach customers in other smaller Illinois communities such as Rockford, Sterling, and Plano. To increase the sample size of stores along the extensive AIC/ComEd border would either require reducing the number of stores that sell the majority of program-discounted bulbs or increasing the overall sample size with an oversample of stores along the AIC/ComEd border. In-store intercepts are a costly evaluation activity and oversamples to estimate leakage along individual borders would be difficult to justify in most cases.

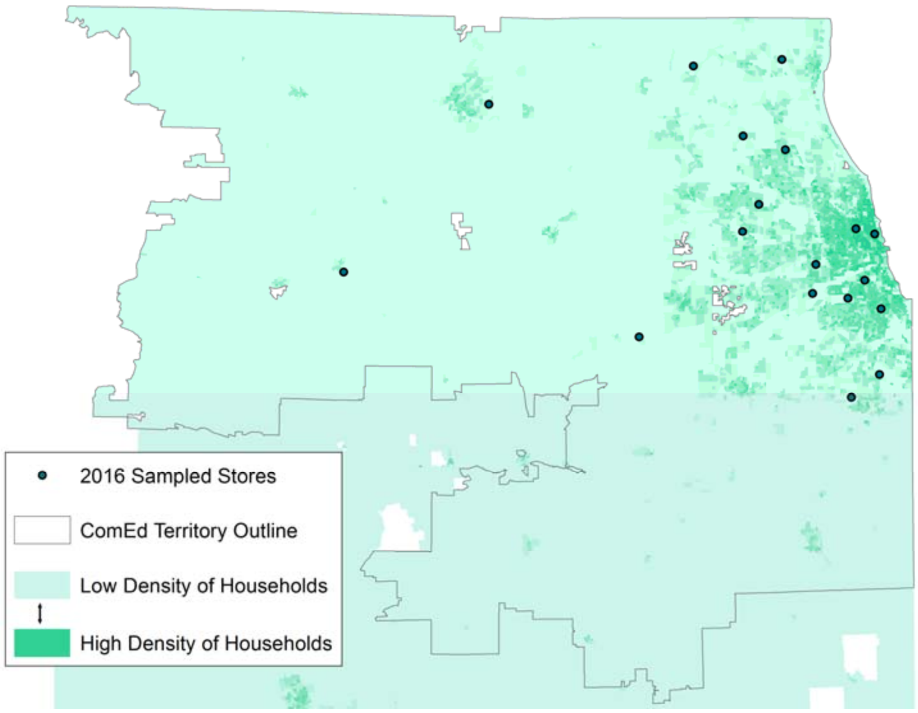

Figure 2. 2016 ComEd Sampled Participating Stores.[6]

GIS Analysis

A less expensive method for calculating leakage to specific territories would be a GIS estimate, though the GIS analysis has other potential issues, mainly internal validity. We cannot say that that the cause and effect relationship that underlies the analysis is true. We assume a fairly simplistic relationship between customer proximity to participating retailers and likelihood to purchase program-discounted light bulbs. The GIS analysis assumes that customers living within a given distance of a store will purchase bulbs at that store and that customers outside the radius will not. Although we believe that customers are more likely to purchase bulbs at stores that are closer to their homes, we suspect that other factors such as road networks, traffic, and proximity to other retailers also play a factor and are not accounted for in our GIS analysis.

For the GIS method, we were able to calculate leakage out and leakage in for both utilities for both years. Having both components also allowed us to calculate the total leakage rate at the AIC/ComEd border. Table 5 displays the results assuming a store territory of 15 miles. For AIC in both 2014 and 2016,

[6] The density of households represented in the figure is calculated using the square miles of each census block group divided by the count of utility customers in the census block group.

we found a positive total leakage rate because there are more program-discounted bulbs leaking into the territory than there are program-discounted bulbs leaking out of the territory. Conversely, for ComEd we found a negative total leakage rate because there are fewer program-incentivized bulbs leaking into the territory than there are program-discounted bulbs leaking out of the territory. The positive AIC and negative ComEd total leakage is due in part to the fact that ComEd has more stores that are susceptible to leakage and they sold more program-discounted bulbs than leakage-susceptible AIC stores.

Table 5. Leakage Estimates Using GIS Method

	2014	2016
AIC		
Leakage Out	1.85%	2.51%
Leakage In	2.31%	3.16%
Total Leakage	0.46%	0.65%
ComEd		
Leakage Out	0.80%	1.68%
Leakage In	0.64%	1.33%
Total Leakage	-0.16%	-0.35%

Though the GIS method calculates leakage estimates to specific territories, the method makes use of some simplifying assumptions regarding customer purchase behavior. We calculated the total leakage rate at the AIC/ComEd border using a 10, 15, and 20-mile radius to test the sensitivity of the results to these assumptions. We found that the leakage estimates can vary significantly using different buffer radii, ranging from a total leakage rate of 8.53% to -4.92% for AIC, and ranging from -7.41% to 1.74% for ComEd (Table 6). By selecting a particular radius parameter, a program could go from negative leakage at a border (more program-discounted bulbs are exported to the opposing territory) to positive leakage (more opposing program-discounted bulbs are imported). The GIS-calculated leakage estimates vary by up to 13 percentage points between the 10-mile buffer radius and the 20-mile radius due to the irregular shape of the AIC/ComEd border, the varying communities on either side of the border, and sporadic shifts in household density.

Table 6. GIS-Calculated AIC/ComEd Border Leakage Rate Estimates at Varying Distances

Utility	Year	10-Mile Radius	15-Mile Radius	20-Mile Radius
AIC	2014	7.29%	0.46%	-4.83%
AIC	2016	8.53%	0.65%	-4.92%
ComEd	2014	-7.41%	-0.16%	1.74%
ComEd	2016	-6.35%	-0.35%	1.13%

To illustrate how the overall leakage rate at the AIC/ComEd border can vary so widely, we examine one 2016 AIC program-participating store on the AIC/ComEd border. This participating store is in the town of Ottawa, IL, which is almost surrounded by ComEd territory (Figure 3). A 10-mile search radius includes most of the AIC households in and around the town, and includes a few ComEd households on the southern edge of the buffer zone. More ComEd households are included when using the 15-mile search radius, including the town of Seneca, located on the eastern perimeter of the buffer zone. More still are included when using the 20-mile search radius, including the town of Streator on the southern end of the buffer zone.

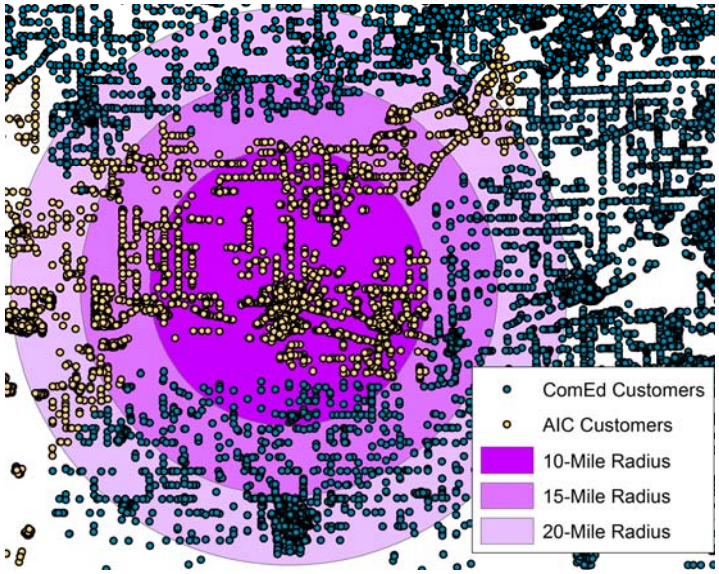

Figure 3. Example of 10-Mile, 15-Mile, and 20-Mile Radius Around Single 2016 AIC Participating Border Store

Not surprisingly in this case, the number of ComEd households increases significantly as the buffer radius increases, as does the percent of bulbs leaking out to ComEd from this particular AIC program-participating store. As seen in Table 7, the count of AIC households also increases going from 13,784 to 23,301 as the radius increases from 10-miles to 20-miles. However, the count of ComEd households increases even more— going from 453 households to 20,544 households. This disproportionate increase in ComEd households results in a huge shift in the percentage of bulbs leaking out to ComEd at this store, increasing by 44 percentage points from 3% to 47% as the radius increases from 10-miles to 20-miles.

Table 7. Household Counts and Percent Leakage Out to ComEd Based on Varying Radii Around Single 2016 AIC Participating Border Store

Radius	AIC Customers	ComEd Customers	% Leakage Out to ComEd
10-mile	13,784	453	3%
15-mile	19,537	2,531	11%
20-mile	23,301	20,544	47%

Conclusion

Our results show that in-store intercepts are better suited for estimating free ridership and overall territory leakage than for estimating total leakage rates to a single specific territory border. As leakage is a rare event and leakage to a specific bordering upstream residential lighting program is rarer still, the sample sizes required to estimate leakage to every bordering upstream residential lighting program is not financially practical for most evaluations. Even if an evaluator were to sample sufficient stores to estimate leakage to a single bordering upstream residential lighting program, the resulting research may not be able to capture this rare event without spending a large number of days conducting interviews in the sampled stores. Intercepts are also typically not used to estimate leakage into a territory because evaluators rarely share in-store intercept interview data for active evaluations.

The GIS method is suitable for calculating total leakage at any single border if a justifiable buffer radius assumption can be determined. The method requires having access to the number of bulbs sold by the opposing program, ideally at the store level. The method is much less expensive than the in-store intercept method. However, the GIS method requires some simplifying assumptions about customer behavior in terms of the distance that people will drive to purchase bulbs. We have shown that changing this assumption can have a large impact on results.

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