Innovative Uses for M&V Data; Focusing the Sales Team

Steven Pak, Con Edison, New York, NY
Lucy Neiman and Ryan Bossis, ERS, New York, NY

ABSTRACT

With its 2016 rate case filing, Consolidated Edison Company of New York (Con Edison) has committed to significant increases in energy efficiency (EE) and peak demand reduction (DR) goals over 3 years. To meet these increased goals, the company must be more selective in targeting efficiency and peak reduction programs toward market areas and customers representing the greatest potential for savings. As contrasted with traditional market potential studies that follow a broad research-based approach, this paper describes a more granular approach to market potential based on a measurement and verification (M&V) study. The method identifies high potential areas and customers for future EE and targeted DR programs and characterizes potential energy savings and demand reductions from program implementation in these areas.

Using demographic and customer profile data collected during M&V site visits for Con Edison's Brooklyn Queens Demand Management (BQDM) program, the team categorized metered data to predict results and focus the marketing/sales team on high potential customers and measures. The approach positions M&V as a sales tool, providing quarterly recommendations on customers who are:

1. More inclined to install efficiency measures based on operating hours or business type
2. Most likely to deliver energy and demand reductions at peak hours
3. More likely to participate in programs if offerings are slightly altered such as incentivizing specialized lighting upgrades for restaurants

Other jurisdictions may benefit from this approach to augment and refine traditional market potential studies and provide programs with detailed information on where and when energy is being used.

Introduction

In Con Edison's 2016 rate case,[1] the utility proposed incorporating EE in the rate base and committed to aggressive goals through 2018. As illustrated in Figure 1, 2017 efficiency goals increase by 50% in 2018, and double by 2019 with demand reduction (DR) goals increasing at a similar rate. To support these increased goals, the utility is leveraging data and findings from 7 years of M&V to direct and focus program implementation staff, market partners, and marketing/sales staff on customers and measures with the highest potential EE and DR opportunities. Specifically, Con Edison's Small Business Direct Install (SBDI)[2] and Multifamily Energy Efficiency (MFEE) programs are directing implementation vendors and market partners to concentrate on customers and measures that will deliver the highest demand and energy reductions during critical peak hours based on M&V data.

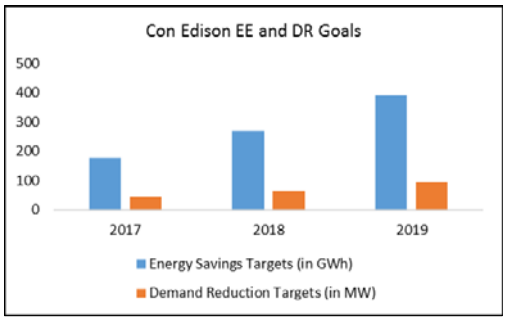

Figure 1. Con Edison energy efficiency and demand reduction goals.

[1] Con Edison Rate Case – Joint Proposal, NY DPS, September 19, 2016.

[2] In late 2016, the Small Business Direct Install Program was renamed the Commercial Direct Install (CDI) program.

A wealth of data has been collected through ongoing M&V for Con Edison. A recent metering and market characterization study collected data from over 325 sites in Brooklyn and Queens to determine 1) what equipment is most prevalent within the target territory, and 2) when the equipment is used during the day. Site inventories collected data on all energy using equipment and surveys gathered demographic information on businesses and occupants. Metered data from over 2,700 loggers was used to determine how equipment operates in a typical day. Table 1 summarizes the data collection efforts for this study.

Table 1. Summary of Data Collection for BQDM Market Characterization Study[3]

Segment	Sites Visited	Loggers Deployed				Pieces of Equipment Inventoried	Customer Surveys Completed
		Lighting	Plug Load	Amperage	Total		
MF In-unit	108	537	416	86	1,039	3,100	62
MF Common Area	42	376	16	117	509	3,400	0
Small Business	127	530	285	397	1,212	4,200	94
Total	**277**	**1,443**	**717**	**600**	**2,760**	**10,700**	**156**

This project has developed methodologies to take existing data and apply it to new networks using translation variables that are lower cost and easier to obtain than metered data, such as business characteristics for the new network population. The results leverage metered data, billing data, and business characteristic information such as business type and operating hours along with customer satisfaction data and other survey efforts to predict the potential energy, demand reduction, and best customers to target before program start.

The data was used to quantify the demand reduction and develop daily load profiles of numerous business sectors and space types within a grid-constrained Con Edison area in Brooklyn and Queens (BQ). Results show that the SBDI program represents almost 90% of the achieved demand reduction during the peak hour due to its rapid deployment and scalability, with the largest 11% of projects providing almost half of the savings. The top half of the performers categorized by business type, space type, and operating hours provide over 80% of the program savings, achieving five times the demand reduction per light fixture over the lower performers.

The models for lighting and other measures enable sales, planning, and implementation teams to target specific customers who will provide the most cost-effective, reliable, and timely reductions at specific hours of need. The models are used to produce a ranked list of targeted businesses and customers for specific networks; for example, as discussed in the Small Business section below, restaurants and groceries provide the best potential for demand reduction in the late evening peak hours[4] through lighting upgrades as compared to office and industrial. Heat maps indicate the greatest density of high potential businesses in the BQ area and can be used by market partners to target participant recruiting. As customers are added to the program, the team uses predictive models to provide an estimated kW reduction potential for each site and hour during a peak demand day.

These models are actively informing decision-making for network planning purposes and future program development to achieve growing EE goals. This paper presents some of the overall findings and tools and then is divided into customer segments presenting model results and tools developed for small business and multifamily programs.

[3] Con Edison BQDM Metering and Market Characterization Study, ERS, February 2016.

[4] The BQDM peak is from 9:00 P.M. to 10:00 P.M.

Overall Findings

A substantial portion of the ERS M&V work for Con Edison was in support of the BQDM program. The results are being used to guide program staff and implementation contractors on areas of focus to achieve the remaining demand reduction goals for this constrained network by 2018. Some innovative uses for the M&V data include the following:

- Measuring hourly program reduction – Load shapes by business type, space type, end use, or other indicative variables are used directly to compute measure demand reduction in tracking systems. Using these factors to calculate demand reduction in real time leads to more accurate tracking estimates, giving program implementers a more accurate indicator of actual program savings in real time.
- Estimating remaining potential – M&V data, equipment saturation data and load curves can be used to estimate the potential for energy savings or demand reduction in an area. The BQDM service territory has significant untapped potential for demand reduction. The BQDM lighting programs have only begun to tap the potential, with an estimated 12% penetration of potential demand reduction from lighting at the end of 2015. Furthermore, savings potential can be optimized through creative and information-based program design, such as targeting small business customers with high lighting use in the constrained hours of need.
- Building load shape database – Con Edison is using the load shapes from this study to build a comprehensive load shape data set for implementing data-driven demand management in the BQDM territory and other future constrained networks.

The BQDM M&V effort produced numerous load curves divided by business type, measure type, and space type. To deliver this information in a useful format for Con Edison program implementation staff, ERS developed an interactive Tableau based dashboard shown in Figure 2. The dashboard includes interactive toggle switches that allow program staff to pick and choose various installation goals for current programs such as SBDI lighting or Multifamily In-Unit (MFIU) and predict the achieved demand reduction across a 24-hour period. Staff can mix and match from various programs or specific measures within programs to achieve needed results. The dashboard also provides expected energy savings from the measure and program mix and the ability to track program performance over specific time intervals.

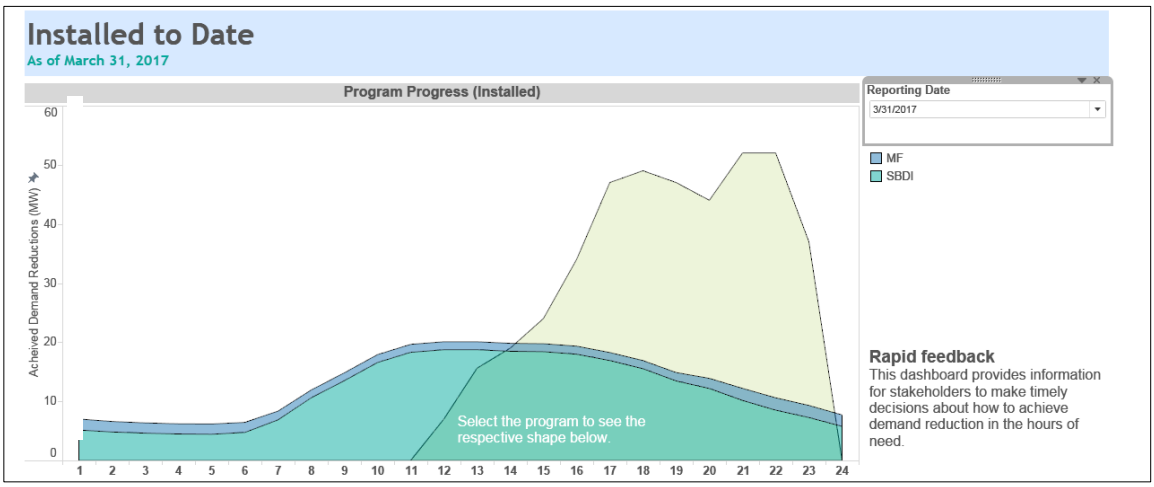

Figure 2. Interactive dashboard provides predictive program results using M&V-based load curves.

Figure 3 presents an example of estimating the demand reduction potential from lighting measures: MFIU lighting, Multifamily Common Area (MFCA) interior and exterior lighting, and small business (SB) interior and exterior lighting and represents the program's technical potential if 100% of Con Edison customers participated. Reduction per customer is based on savings of current participants of the BQDM SBDI, and MF EE programs. Table 2 provides the associated statistics derived from M&V data .

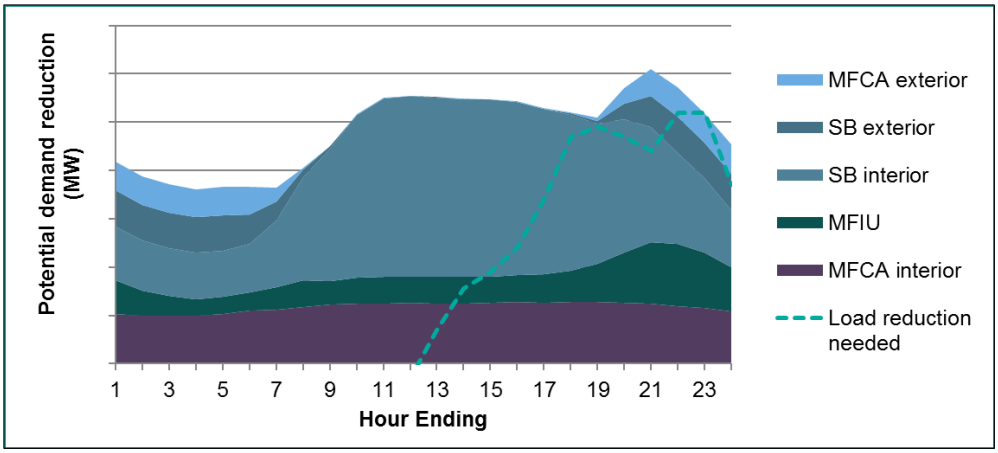

Figure 3. Lighting demand reduction potential from SBDI and MF programs in the Brooklyn Queens network.

Table 2. BQDM lighting demand reduction potential

Segment	Number of Customers	Rated Reduction per Customer (kW)[1]	Total Rated Reduction (MW)	9 – 10 P.M. Hour		
				Coincidence Factor	Demand Reduction Potential (MW)	Percent of Total Reduction
MFIU interior	170,000	0.27	46	28%	13	17%
MFCA interior	13,759	1.58	22	55%	12	22%
MFCA exterior	13,759	0.45	6	99%	6	10%
SB interior	12,848	3.64	47	41%	19	39%
SB exterior	12,848	0.59	8	99%	7	12%
Total	**N/A**	**N/A**	**129**	**N/A**	**57**	**100%**

[1] Reduction per customer is based on current average savings of the SBDI and MFEE participants.

The table presumes 100% recruitment and implementation, which is not realistic, though high participation expectations are reasonable given that the program covers the full lighting upgrade costs in the BQDM area; however, it does indicate that the programs have only begun to tap the potential savings available in these three segments with the current 12% penetration for lighting replacements. Increasing penetration to 58% from these programs would provide sufficient demand reduction to meet Con Edison's current BQDM goals. Data from these findings is being provided to Con Edison market partners to target further demand reduction projects.

The following sections address specific findings for the small business and multifamily programs and provide recommendations on the greatest potential for EE and DR savings in each program area.

Small Business

The small business sector represents a large percentage of the potential energy and demand reduction opportunity in BQDM and in many other Con Edison networks. Information gathered from M&V of this sector can be translated to other networks using typical known variables such as business type and operating hours. In Brooklyn Queens (BQ) with approximately 14,000 small business service addresses, there is a demand reduction potential of approximately 25 MW at the 9:00 p.m. peak hour. The SBDI M&V effort for Con Edison was divided into small businesses between 110 and 500 kW and businesses less than 110 kW. Up until early 2016, the SBDI program was offered to customers with peak demand less than 110 kW but in 2016 was expanded to include customers up to 300 kW.

<110kW

This population was divided into five business type sectors: grocery, industrial, office, restaurant, and retail. Together, these five largest sectors comprise over 96% of the total billed peak demand of this small business segment. Figure 4 illustrates the hourly kW contributions of key end uses for the <110kW average small business customer based on end-use metering.

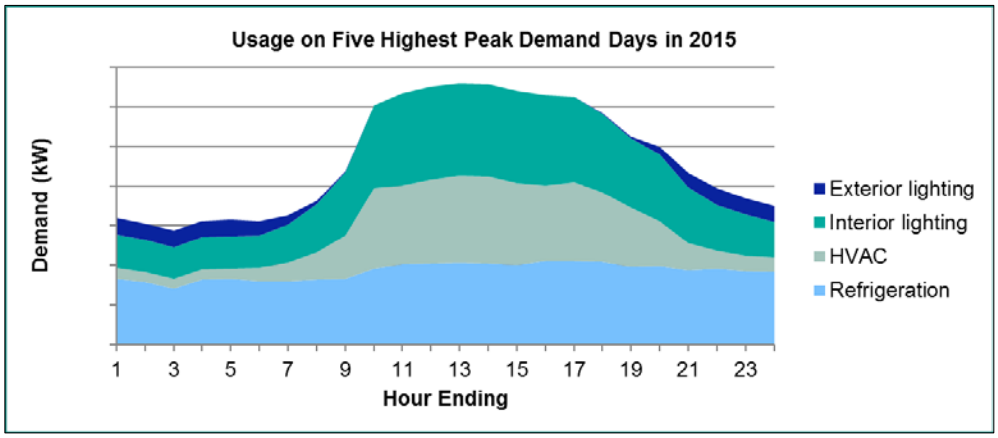

Figure 4. BQDM small business peak day load profile per customer – by end use.

Lighting. A key measure for this sector is lighting, which the team further segmented by business type. Figure 5 emphasizes that grocery and restaurant sectors should be targeted because they experience the highest coincidence factor (CF) not only during the late evening peak but also during the midday and nighttime hours. Retail and industrial sites offer the next highest potential, with late evening CFs between 20% and 40%. Offices present the least peak savings potential with declining CFs in the evening hours. Besides focusing on the restaurant and grocery business types, program recommendations from findings in this sector include adding specialized Light-emitting diode (LED) lighting offerings for restaurants that have high usage during the BQ late evening peak period.

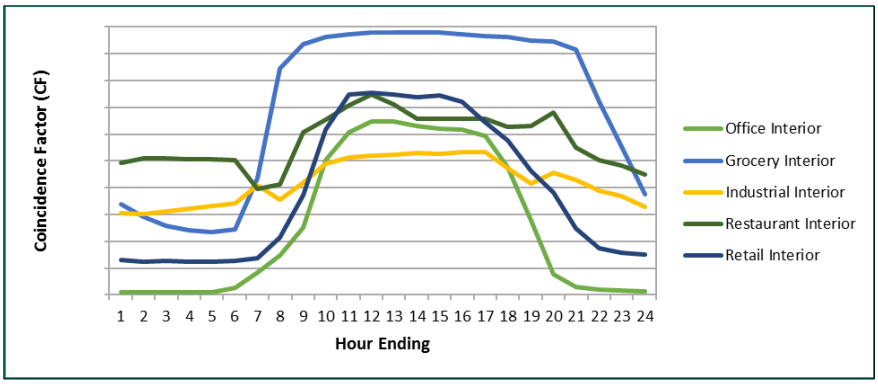

Figure 5. BQ small business interior lighting load shapes by business type.

HVAC. Field engineers determined that most cooling at sampled small businesses was provided by central systems[5]. Figure 6 presents the load profiles for central HVAC equipment as well as for window air-conditioning (A/C) units. Table 3 presents the results of the on-site inventories of the metered sites indicating the distribution of cooling types by business type across SBDI locations. Findings suggest a program focus on upgrades to aging RTUs and window ACs would contribute to reducing the evening peak demand in BQ.

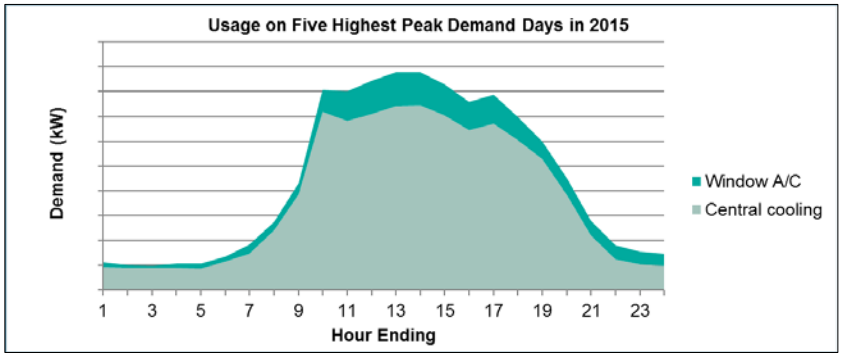

Figure 6. BQDM small business HVAC load profiles.

Table 3. BQDM small business cooling system observations based on inventory of 127 sites

A/C Unit Type	Average Size (Ton)	Quantity of A/C Units Observations per Site by Sector				
		Grocery	Industrial	Office	Restaurant	Retail
Window A/C	1.16	0.61	0.80	0.68	0.10	0.76
PTAC[1]	2.00	0.00	0.00	0.04	0.00	0.24
Rooftop DX	9.43	0.39	0.28	0.40	1.43	0.65
Split system	4.45	0.18	0.08	0.32	0.14	0.88
Chiller	N.D.	0.00	0.00	0.04	0.00	0.00

[1] Packaged terminal air conditioner

N.D. = No data

Refrigeration. The other major end use in the <110kW small business segment is refrigeration. ERS engineers metered the primary refrigeration end uses and developed load curves, as shown in Figure 7. Table 4 includes the inventory of refrigerated cases, the primary small business refrigeration load, and is

[5] Defined as rooftop units [RTUs], split systems, and zonal-controlled systems

available to market partners. As expected, grocery stores and restaurants have the highest penetration of refrigerated cases – between eight and nine cases on average per facility. Key findings from this segment suggest that a focus on refrigeration measures such as refrigerator lighting, refrigerator controls and refrigerated case doors would provide demand reduction during the late evening peak in the BQ area.

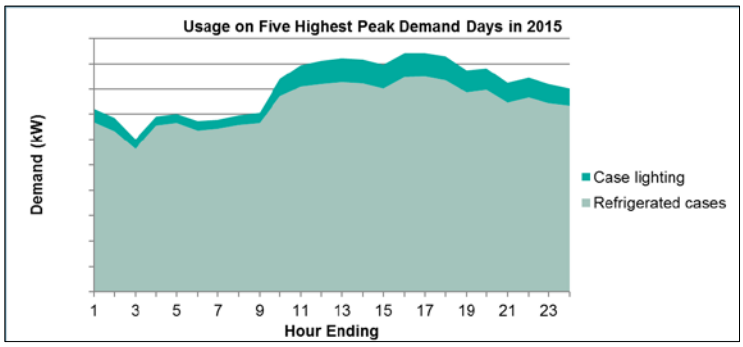

Figure 7. BQDM small business refrigeration load profiles

Table 4. Small business refrigerated case observations based on inventory of 127 sites

Case Type	Average Rated Power (kW)	Quantity of Cases Observed per Site by Sector				
		Grocery	Industrial	Office	Restaurant	Retail
Island (<3' width)	1.6	0.8	0.0	0.1	0.5	0.2
Island (>3' width)	10.5	0.5	0.0	0.0	0.8	0.0
Reach in, vertical	1.4	4.6	0.1	0.1	2.5	0.9
Reach in, under counter	0.9	1.4	0.0	0.0	2.3	0.3
Walk in	3.0	1.2	0.3	0.2	2.0	0.3
Total (kW)		**17.8**	**0.7**	**0.9**	**20.8**	**2.8**

110–500 kW – This sector was divided into the three predominant business types: industrial/ware-house, grocery, and retail. This sector was traditionally underserved by Con Edison programs until 2016 when the SBDI program was extended to businesses up to 300 kW.

Using M&V-generated load curves for the most prevalent measure, lighting, ERS estimated the remaining demand reduction potential for customers who have not participated in Con Edison's SBDI lighting programs. Figure 8 shows the opportunity by primary business type for the 110–500 kW sector. Retail interior lighting presents the greatest remaining potential in this network.

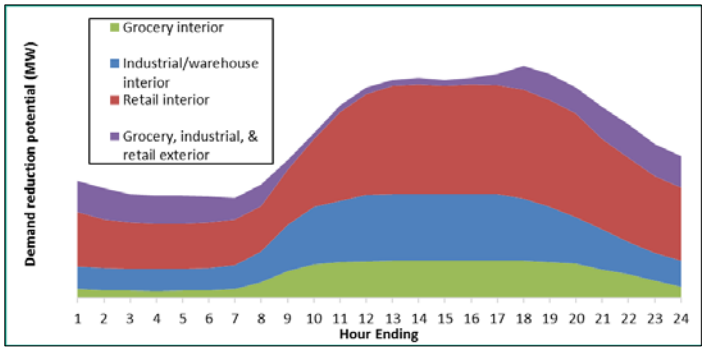

Figure 8. Outstanding small business lighting demand reduction potential for 110 – 500 kW sector

The outstanding demand reduction potential was calculated under a hypothetical scenario that lighting upgrades were completed at all grocery, industrial/warehouse, and retail sites with an average billed demand between 100 kW and 500 kW that have not already participated in the SBDI Adder program.

M&V efforts in the small business sector yielded some key recommendations for program and market partner staff to achieve greater EE and demand reductions.

Recommendations and tools. Based on the above findings, we have developed the following recommendations for opportunities with the greatest potential to achieve cost-effective and reliable demand reduction for the small business population. The sales staff/implementation vendor focus areas are as follows:

- Target interior lighting focusing on LEDs.
- Concentrate on grocery and restaurant lighting with a high CF at the peak hour; then retail and industrial lighting with a peak CF near 40%; office lighting should not be a major target.
- Provide specialized product offerings, such as high quality, low-color-temperature LEDs for restaurants; higher-efficiency LEDs for grocery stores.
- Offer lighting controls for all projects, especially in variable-occupancy spaces in industrial and grocery.
- Target facilities with staircases or intermittently used hallways, such as industrial and office buildings, for bi-level, occupancy-based control upgrades.
- Focus on exterior fixtures for upgrades to LEDs because of the consistent late evening operation.
- Offer occupancy-based controls for exterior fixtures to turn off or dim when no motion is detected.
- Replace refrigerated case lighting with LEDs and add advanced case lighting controls.
- Provide a full suite of refrigerated case measures including lighting upgrades, case doors and controls.
- For networks with more traditional peaks focus potential HVAC replacement upgrades for inefficient rooftop direct expansion (DX) systems and supplemental window A/Cs.
- Target behavioral or controls measures to turn off unused IT equipment.

To aid in executing the above focus areas, ERS developed heat maps for program and market partner staff highlighting geographic areas with the highest potential for savings in the critical network peak hours. Figure 9 provides examples of those maps, which include business locations and allow contractor teams to group and target their efforts in the most productive geographical areas.

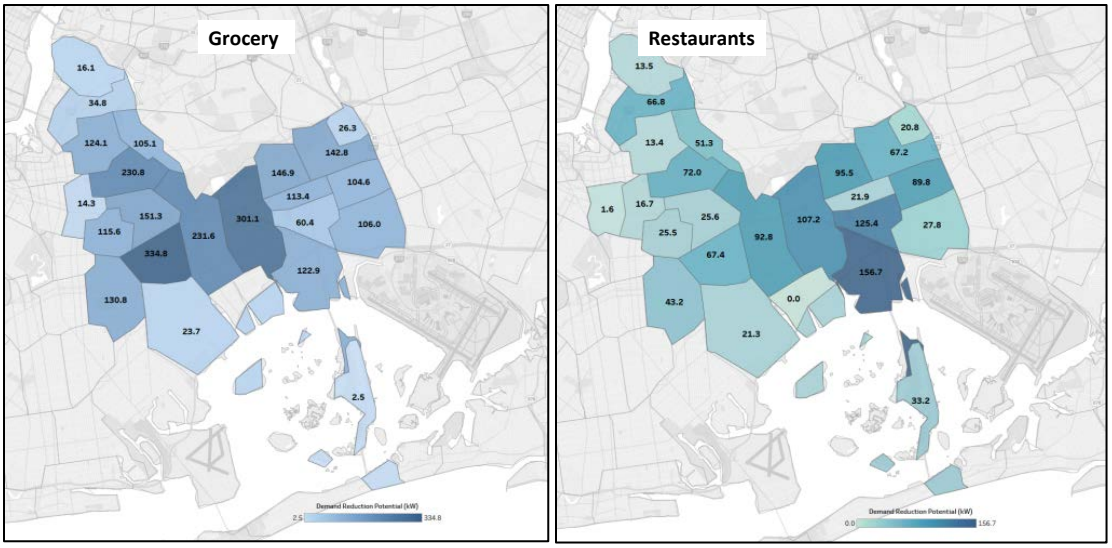

Figure 9. Grocery and restaurant small businesses – concentration of demand reduction potential – darkest area is highest concentration of potential kWh savings

Multifamily

ERS divided M&V of the multifamily customers into Multifamily Common Area (MFCA) and Multifamily In-Unit (MFIU) efforts.

Multifamily Common Area

The team determined that interior and exterior lighting accounts for over 90% of the summer energy use in common areas of BQDM multifamily buildings with fewer than 50 apartments. Since larger multifamily buildings are often eligible for broader energy savings opportunities through the Large Commercial and Industrial (LCI) program, the lighting category is the focus of the MFCA load profile analysis.

Figure 10 provides a 24-hour load profile of interior and exterior lighting, the key end uses within common-area spaces. Motors and other miscellaneous equipment were omitted due to their insubstantial contribution to the overall load.

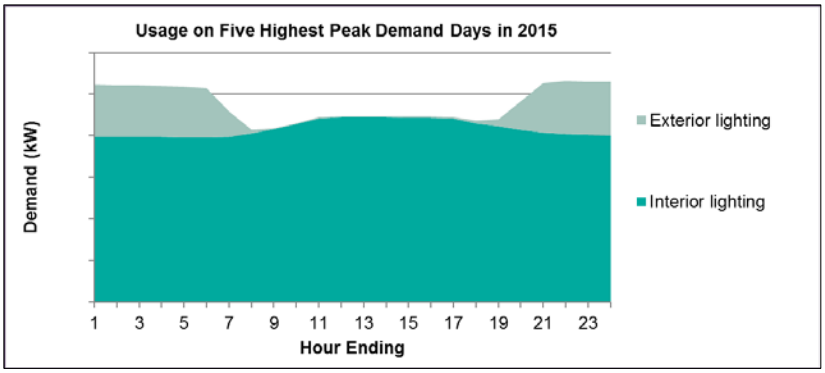

Figure 10. Multifamily common-area load profiles by end use category

The number of apartment units per building is a strong predictor of the rated interior lighting load, as illustrated in Table 5. Although the buildings with fewer than 10 units have a small rated load, the large number of these types of multifamily buildings leads to significant savings potential. Conversely, targeting the largest multifamily buildings would likely result in cost-efficiency through economies of scale at the site level. Con Edison is supplying this information to market partners along with maps showing the location and number of apartments per building.

Table 5. MFCA interior lighting statistics by number of tenant units per building in BQDM territory

Number of Apartments	Total Number of Buildings	Average Post-Installation Rated kW	Total Post-Installation Rated kW	Potential Rated Savings (kW)[1]	Potential Savings in kW at 9:00 - 10:00 P.M. hour
4–9	11,314	0.48	5,376	17,424	9,530
10-24	1,340	0.63	843	2,732	1,494
25–49	571	2.15	1,226	3,974	2,174
50+	534	4.25	2,270	7,357	4,024
Total	**13,759**	**0.71**	**9,715**	**31,488**	**17,223**

Multifamily In-Unit

Figure 11 presents the major end uses and load profiles from metering and inventories of MFIU apartments.

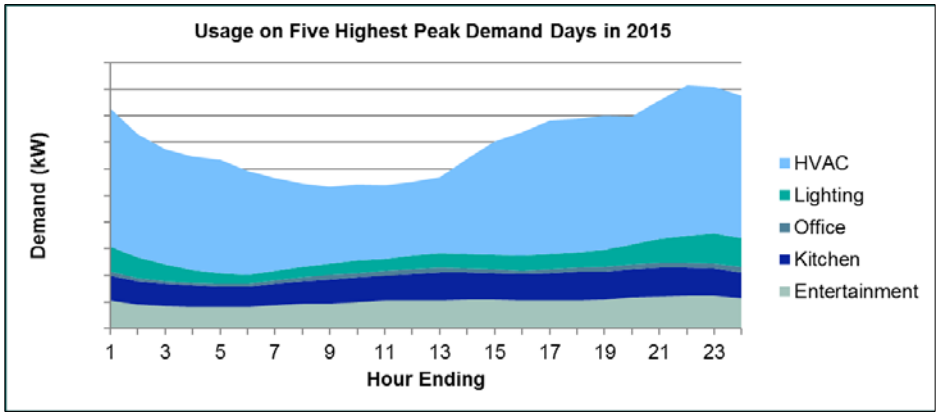

Figure 11. MFIU peak day load profiles per customer – by end-use category.

Table 6 compares the average summer rated load for each of the six end-use categories as well as the kW contribution of each category to the summer peak hour for the typical BQDM apartment. As is evident from the table, kitchen appliances account for almost half of the summer rated load in the average apartment, but only 11% of the apartment load at the summer peak hour. Peak hour contributions are primarily of interest in the grid-constrained BQ network. In that respect, HVAC equipment is by far the largest contributing end-use category, comprising 62% of the peak summer load. Although it represents a small overall load, the entertainment category presents a constant load throughout the day. An upstream focus on efficiency improvements in cable boxes could represent a cost effective and constant savings to the utility with fairly low effort.

Table 6. Multifamily in-unit average load by end-use category from 108 units across 42 buildings in BQ

End-use Category	Rated Load (kW)		Peak Hour 9:00 10:00 P.M.	
	Summer[1] Rated Load (kW)	Percentage of Total	Summer[1] Demand (kW)	Percentage of Total
Lighting	0.37	5%	0.10	11%
HVAC	1.38	19%	0.56	62%
Kitchen appliances	3.64	49%	0.10	11%
Entertainment	0.60	8%	0.12	14%
Office/IT	0.28	4%	0.02	2%
Other[2]	1.15	15%	N.D.[1]	N.D.
Total	7.42	100%	0.91	100%

[1] Only loads connected during the summer were considered (e.g., space heaters are excluded).

[2] Other equipment is expected to have insubstantial load due to highly intermittent operation.

The largest contributing end-use category during the summer peak period is cooling equipment, largely driven by window A/Cs. Figure 12 presents the average load profile for A/Cs and fans during the five highest-load days. Assuming 170,000 apartments in the BQDM territory, A/Cs and fans are responsible for 87 MW and 10 MW, respectively, at the 9:00 – 10:00 p.m. constrained hour.

The detailed end-use inventory showed that no HVAC equipment other than window A/Cs and fans had a significant contribution to the summer peak load. The study inventoried size and quantity of HVAC equipment by type per apartment and collected window A/C energy efficiency ratio (EER) values.

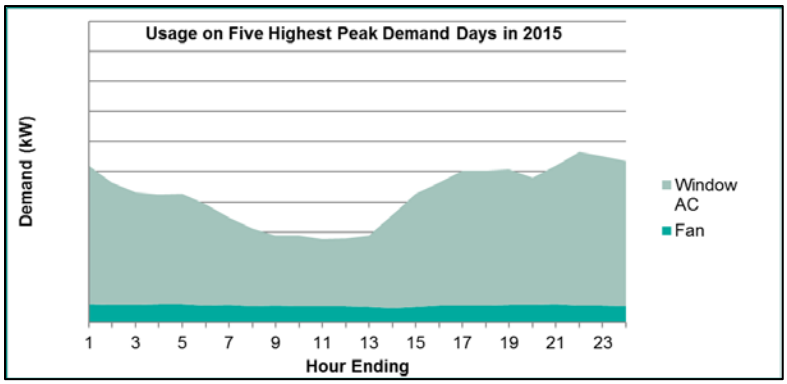

Figure 12. BQDM MFIU HVAC load profiles

The demand reduction potential from a window A/C replacement program can be estimated using the data from the comprehensive equipment inventories. Given the 170,000 apartments in the BQDM territory and the unit size EER distribution determined in this study, replacing all A/C units with new ENERGY STAR units (Combined Energy Efficiency Ratio (CEER) of 12.0) could provide a total of 15 MW of demand reduction at the 9:00 p.m. hour. While a direct-installation, no-cost program may not be cost-effective, other approaches, including A/C turn-in events, in-store coupons, and potentially demand response might be feasible.

Recommendations and tools. Based on the above findings, the team developed the following recommendations for program staff and market partner focus areas in the multifamily area:

- Target replacement of incandescent bulbs in kitchens and bathrooms which have the highest usage during the peak hours.

- Investigate an upstream approach to lighting targeting local hardware and convenience stores.
- Pursue behavioral and demand response programs targeting window A/C use.
- Consider education campaigns to target unnecessary consumption from fans left on as these were another major use in many apartments.
- Target upgrades to cable boxes through providers as inventories identified these in most units.

Conclusions

The overall findings and benefits of this method can be translated to other jurisdictions and programs to improve or refine the results of broad potential studies based on secondary research. The extensive amount of data collected and the inventories by business type and customer type can be very useful granular data for other utilities and programs to mine. Typical inventories and general equipment usage patterns and trends can be translated to program focus areas and more effective offerings. Since ERS gathered demographic information along with the metered and inventory data, these results can potentially be translated to other locations using local demographic profiles and easily obtainable customer information such as business type and operating hours. Other jurisdictions often have metered data from M&V efforts that can be tapped to compare and validate or adjust the load curves developed from this study or additional metering at a reduced sample size can be used to verify or adjust the models.

Con Edison is using the findings and results presented above to develop approaches to achieve the remaining demand reduction needs in the BQ network and the utility plans to use this wealth of information to address the next constrained network. Con Edison has already used this M&V data to improve overall program performance and reporting including:

- Improving the kW reduction impact from the BQ MFIU program by increasing the MFIU coincidence factor from the TRM value of 8% to 23%
- Providing Con Edison with better methods for assessing risk during contract negotiations with implementation vendors by using coincidence factors to more accurately assess projected program savings

Future developments include plans for large commercial and industrial measure load curves and measure targeting information based on the extensive M&V data gathered under Con Edison's territory-wide Demand Management Program (DMP) and other evaluation efforts. Predictive analytics from this approach can be translated to new Con Edison constrained areas or used by other jurisdictions to help estimate market potential at a more granular level, define appropriate program and measure focus areas, develop tools for market partners and the sales staff, and more accurately predict savings results.