Local Law 87 Annual Report

Fiscal Year 2017

December 2017

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Introduction: DCAS Energy Management: Local Law 87 Annual Report

Local Law 87 of 2009 ("LL 87") calls for energy auditing and retro-commissioning of public and private sector buildings over 50,000 gross square feet to aid the City in meeting its greenhouse gas emissions reduction goals as reflected in *OneNYC*, *One City: Built to Last*, and *Executive Order 26* ("EO26").

DCAS Energy Management ("DEM") commissions qualified energy consultants to prepare Energy Efficiency Reports ("EERs") for City buildings as part of the City's compliance with LL 87. As of June 30, 2017, DEM has filed a total of 215 EERs with the Department of Buildings ("DOB"). Thirty-seven (37) EERs were filed in Fiscal Year ("FY") 2017, the period covered by this report; thirteen (13) EERs were filed in FY 2016; six (6) EERs were filed in FY 2015; and the remaining 159 EERs were filed in FY 2014 in an early compliance period.

This report reviews the FY 2017 EERs and summarizes the following: 1) analysis of the most common energy efficiency improvements recommended by the energy audits for these buildings; 2) analysis of the accuracy of the energy audits in predicting the costs of the recommended capital improvements; 3) post-installation analysis of the accuracy with which the audits predicted the actual savings achieved by the capital improvements; and 4) recommendations as to appropriate legislative and administrative actions.

This Annual Report is submitted to the Speaker of the City Council and the Mayor pursuant to LL 87's requirement for reporting on capital improvements to base building systems for the period July 1, 2016 through June 30, 2017 (FY 2017).

Section 1. Energy Efficiency Reports Submitted Pursuant to LL 87

The 215 EERs submitted to DOB represent buildings managed by 14 City agencies in all five boroughs, as summarized in **Tables 1 and 2** below.

Table 1: EERs Submitted by Borough

Borough	*# of EERs*	*% of Total*
Bronx	48	22%
Manhattan	52	24%
Brooklyn	66	31%
Queens	38	18%
Staten Island	11	5%
Total	**215**	**100%**

Table 2: EERs Submitted by Fiscal Year and Agency

Agency	*FY 2014*	*FY 2015*	*FY 2016*	*FY 2017*
Brooklyn Public Library	2	0	0	0
Department of Citywide Administrative Services	25	0	4	2
Department of Homeless Services	9	0	2	3
Department of Correction	7	0	0	0
Department of Education	80	6	7	30
Department of Health and Mental Hygiene	1	0	0	0
Department of Transportation	2	0	0	0
Department of Parks and Recreation	7	0	0	1
Department of Sanitation	9	0	0	0
New York Fire Department	2	0	0	1
Human Resources Administration	2	0	0	0
New York Police Department	11	0	0	0
New York Public Library	1	0	0	0
Taxi and Limousine Commission	1	0	0	0
Total	**159**	**6**	**13**	**37**

A list of these reports is included in **Appendix A**. Actual reports are provided by DEM to DOB upon DOB's request.

Reasonable Energy Conservation Measures (ECMs)

LL 87 calls for an energy audit to identify, "at a minimum, all reasonable measures including capital improvements that would, if implemented, reduce energy use and/or the cost of operating the building." Furthermore, the law stipulates that "reasonable capital improvements to the building's base building systems that are recommended in the building's energy audit shall be completed including, at a minimum, all those improvements of the base building systems having a simple payback of not more than seven years…"

In compliance with LL 87, the City has implemented all reasonable measures with a simple seven (7) year payback or less. These reasonable measures are termed Energy Conservation Measures ("ECMs") in the

EER, as opposed to Retro-Commissioning Measures or Operations and Maintenance Measures ("RCMs"), and are referred to as such for the remainder of this report. The ECMs follow the definition of "simple payback" contained in LL 87. Where ECMs meet the capital eligibility requirements set forth in the New York City Comptroller's Directive 10 and are confirmed by the Office of Management and Budget, the City implements them through its energy efficiency capital improvement programs. Where ECMs do not meet capital eligibility requirements, the City funds them through its expense-funded programs in coordination with retro-commissioning measure implementation.

Most Common EER Improvement Recommendations

There were 183 recommended measures in the 37 EERs filed with the DOB in FY 2017. Almost a third (31%) met the seven (7) year simple payback, and almost the same proportion (29%) had paybacks of 20 years or more. **Table 3** shows all recommended measures by payback period, and **Table 4** has detail on ECMs with paybacks of seven years or less.

Table 3: Measures by Payback Period

Payback Period	*Number of Measures*	*Percentage of Measures*
Paybacks of 7 years or less	57	31%
Paybacks from 7 years to 20 years	74	40%
Paybacks of 20 years or more	52	29%
Total	**183**	**100%**

Table 4: Measures with Paybacks of Seven Years or Less

Measures Fully Implemented (ECMs)	
Funded by DEM	25
Agency Funded	5
Measures Not Implemented	
Measure Not Feasible to Implement Due to Field Conditions (*)	10
Measure Had Proposal Cost Exceeding Payback Criteria (>7 yrs.)	11
Equipment Owned by Tenants	3
Measures Being Rolled Into FY 2018 for Implementation	
Measure Unable to Be Completed by End of FY 2017	3
Total Measures	**57**

Field conditions (*) that made measures not feasible to implement included lack of compatibility with current equipment components; lack of compatibility with building operation profile as required by agencies; and the requirement for an in-depth engineering study/design in order to implement.

The most frequently recommended improvements to base building systems in the EERs, regardless of payback period, are lighting upgrades and controls and heating/boiler controls. Other measures recommended less frequently include other aspects of heating systems upgrades, building controls, and building envelope improvements.

For recommended measures with paybacks of seven years or less, their frequencies for FY 2017 are shown in **Figure 1** below. **Figure 2** shows the relative frequency of specific ECMs in FY 2017, vs. FY 2016 and 2015 combined:

Figure 1: Recommended ECMs with Paybacks of Seven Years or Less, FY 2017 (Count by Type)

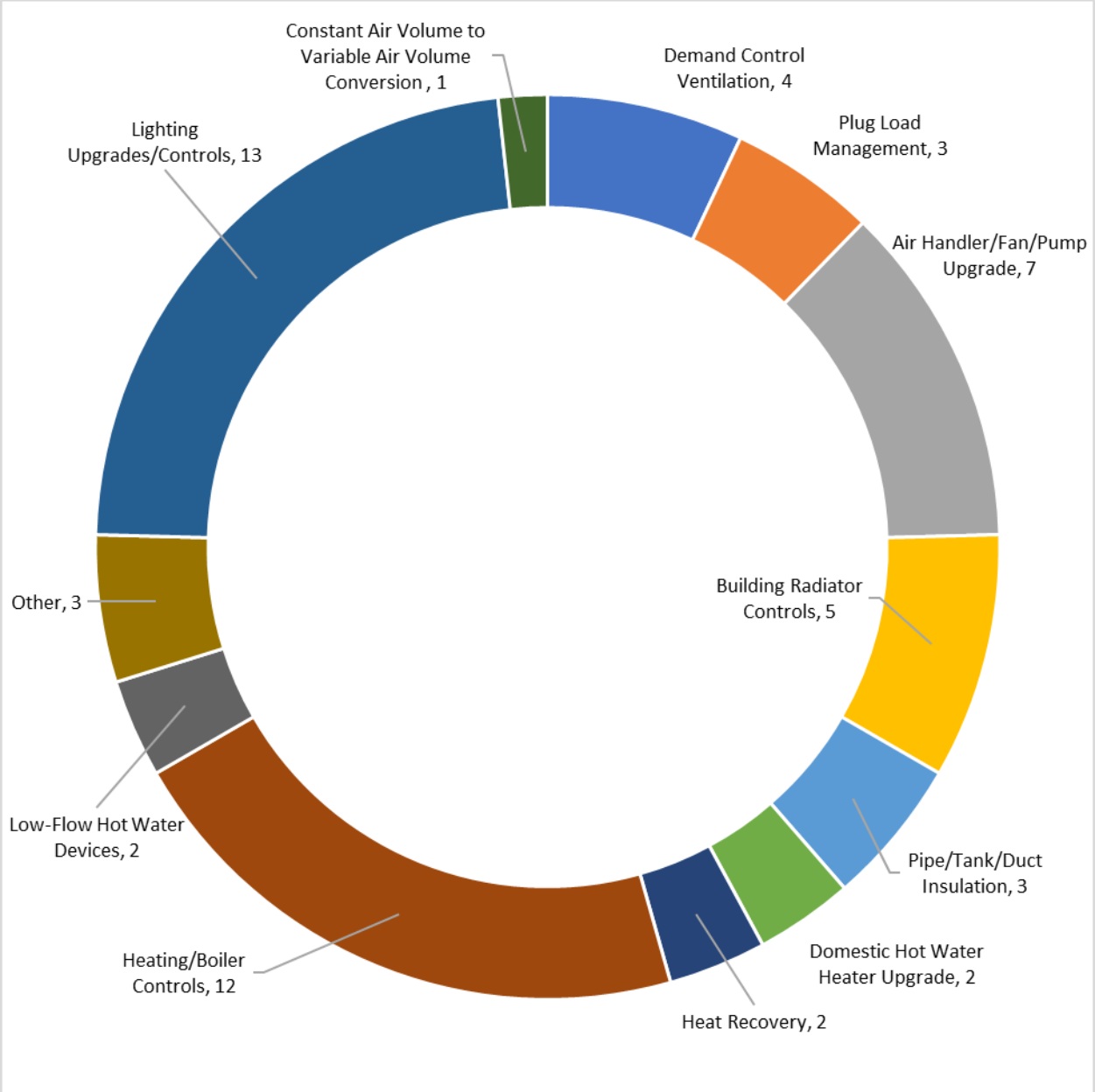
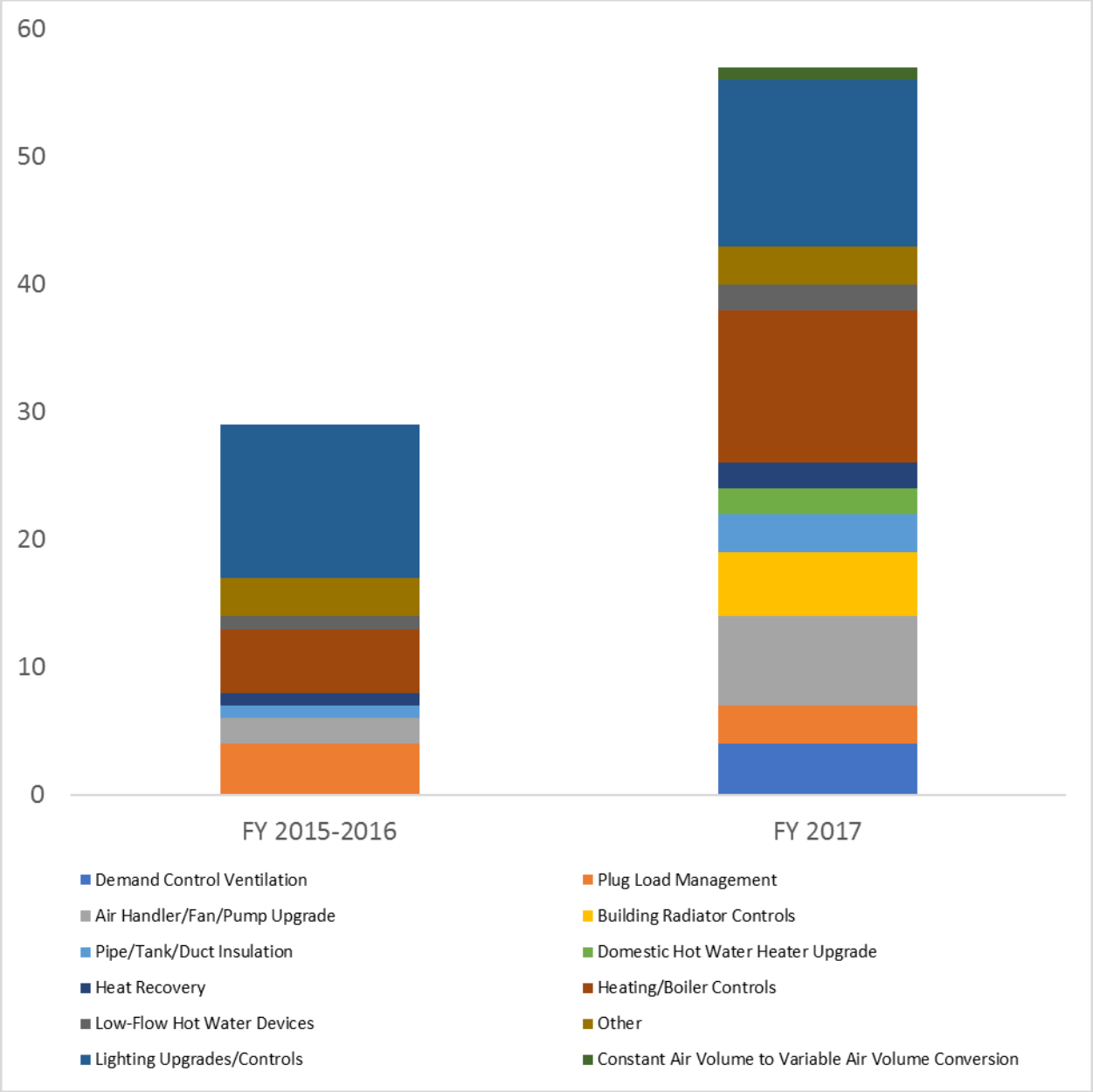


Figure 2: Recommended ECMs with Paybacks of Seven Years or Less, FY 2015-2017 (Count by Type)



Section 2. Cost Prediction Accuracy

Local Law 87 requires DEM to include in its annual report on capital improvements to base building systems an analysis of the accuracy of the energy audits in predicting the recommended capital improvement costs. Substantial lead time is required for capital planning, funding, and project implementation following an energy audit. Over the next two years, a broad range of capital projects identified through EERs are expected to achieve a sufficient post-implementation period that will enable EERs' accuracy in predicting costs and savings to be better assessed.

Until then, DEM has analyzed predictive cost and savings information for the two sets of information that it has. First, 20 ECMs have been implemented along with RCMs in thirteen buildings. For the aggregate portfolio of measures, on average, projected costs were underestimated by almost 22%. As shown in **Table 5**, cost estimates varied widely based on both the type of measure and on the location in which specific types of measures were implemented, but were within a reasonable range in total in the construction environment. The cost estimate variations may have been due to such factors as changes in quantities of a recommended ECM, unexpected field conditions, differences in material and labor cost estimates, and small variations in scope. The cost estimate variations for particular ECMs support DEM's recommendation (see **Recommendation** section) about the need for flexibility in identifying EMCs for implementation.

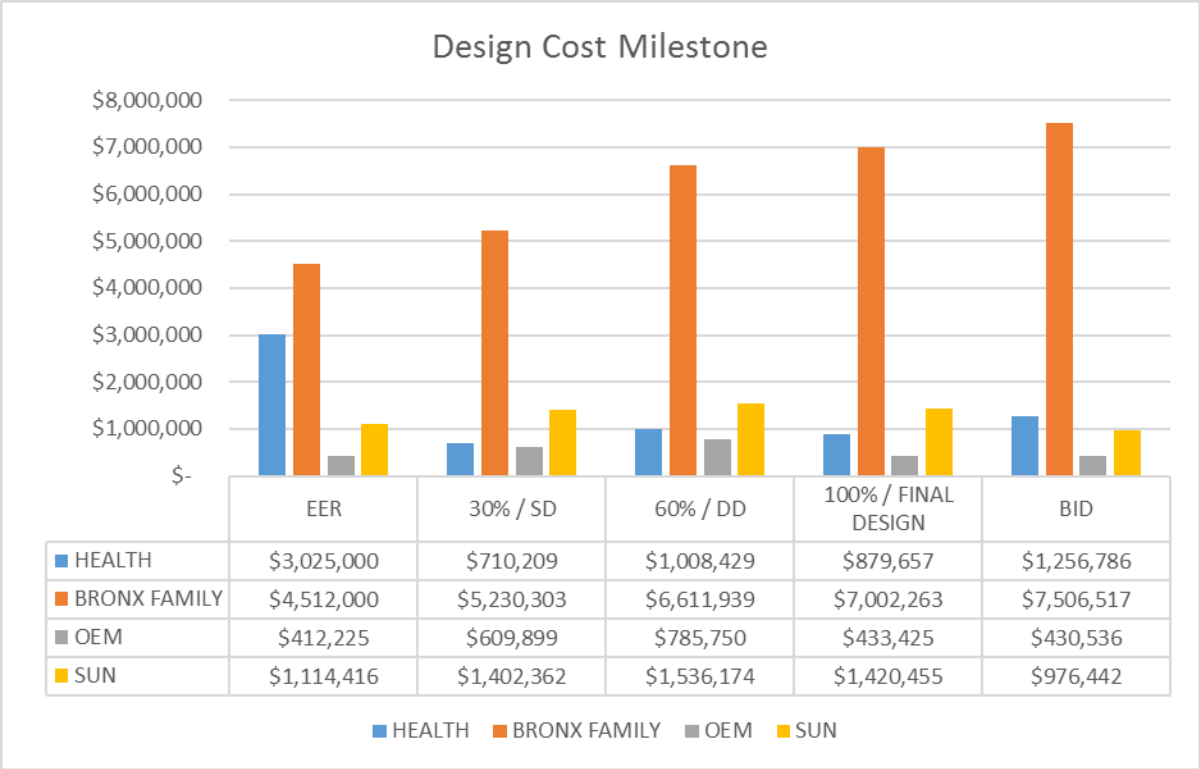
Table 5: Measures Implemented with Paybacks of Seven Years or Less

Recommended ECM Descriptions	*Estimated Implementation Cost*	*Actual Implementation Cost*	*Within AACE Acceptable Cost Estimate Range (-50% to +100%)*
Install Photocells on Exterior Lights	$4,187	$13,495	No
High Efficiency Plumbing Fixtures	$2,179	$5,600	No
Insulate Condensate Return Tank	$2,011	$7,304	No
Install Programmable Thermostat	$1,459	$3,058	No
Perimeter Heating Zone Control Valves	$44,306	$30,193	Yes
Boiler Controls Upgrade	$3,605	$3,823	Yes
Install VFDs on Dual Temperature Pumps	$17,647	$23,669	Yes
Wireless Pneumatic Thermostats	$85,262	$141,858	Yes
Exhaust Fan VFD Control	$15,849	$3,448	No
Add Economizer Controls on Boilers	$47,058	$31,820	Yes
Install Boiler Energy Management System	$30,000	$36,389	Yes
Lighting Upgrade Gym, Exit Signs, & Exterior Lamps	$29,611	$46,067	Yes
Insulate Boiler Condensate Recovery Tank (Stand-alone)	$7,611	$11,257	Yes
Insulate Piping	$1,119	$1,000	Yes
Install Boiler Controller	$40,194	$18,237	Yes
Install Thermostatic Valves on Classroom Radiators	$28,651	$64,731	No
Install Vacancy Sensor Classrooms & Support Areas	$19,910	$51,570	No
Install Boiler Fuel Economizers	$23,377	$14,037	Yes
Install Economizers on Boilers	$23,100	$33,743	Yes
Upgrade to LED Exit Signs	$9,750	$24,268	No

Second, DEM has tracked design-stage cost estimates and bid costs, as shown in **Figure 3** and **Table 6** below, for four capital projects that resulted from EERs and are now under construction. In total, across the four projects, final actual bid costs were 12% greater than the costs projected in the EERs. However,

there was greater variation on a project-by-project basis, consistent with the experience reported above for individual ECM cost projections. For the Health Department facility, a scope reduction made to the initial EER list of recommendations resulted in a bid cost that was approximately half of the initial EER projection. For the Bronx Family Courthouse, underestimates in EER costs made a similarly-sized difference, but in the opposite direction. While these ranges are not out of line with industry norms, they point to the need for DEM to have some implementation flexibility, if changes in savings estimates do not keep pace with changes in cost estimates.

Figure 3: Design Cost Milestone



	EER	30% / SD	60% / DD	100% / FINAL DESIGN	BID
HEALTH	$3,025,000	$710,209	$1,008,429	$879,657	$1,256,786
BRONX FAMILY	$4,512,000	$5,230,303	$6,611,939	$7,002,263	$7,506,517
OEM	$412,225	$609,899	$785,750	$433,425	$430,536
SUN	$1,114,416	$1,402,362	$1,536,174	$1,420,455	$976,442

Table 6: Cost Estimates Comparison

Project	*EER / Class 5*	*BID (Real Cost)*	*% BID Over or Under EER Projection*
Health	$3,025,000	$1,256,786	-58%
Bronx Family	$4,512,000	$7,506,517	66%
OEM	$412,000	$430,536	-4%
SUN	$1,114,416	$976,442	-12%
Total	**$9,063,041**	**$10,170,281**	**12%**

General Findings: EER Accuracy in Predicting Costs

In the early years of LL 87 compliance, it was common to find ECM cost estimates that were based on material and labor costs alone and did not include the following types of costs: design fees, construction management fees, overhead and profit, and environmental remediation costs, such as asbestos and PCBs. These omitted costs contributed to understatement of predicted costs.

More recently, DEM has worked with its consultants to ensure that all relevant estimated costs are incorporated into the simple payback calculation in EERs. As a result, the accuracy of EER cost estimates on a project-level basis has improved. For example, the FY 2016 LL 87 Report included some projects for which the bid cost exceeded the EER projection by 90% to 100%, while for FY 2017, costs are closer to a +/- 60% range. Nonetheless, costs estimated in EERs still are likely to vary compared to actual installed costs because the cost estimates for ASHRAE Level II Energy Audits are not required to be bid-level construction cost estimates. Industry experience shows that cost predictions become tighter throughout the project lifecycle, as projects move from conception to final design to final construction.

Section 3. Savings Prediction Accuracy

Local Law 87 also requires an analysis of the accuracy of audits in predicting savings for capital upgrades. DEM has engaged the City University of New York (CUNY)'s Building Performance Lab to perform this work. For EERs filed in FY 2017, additional time is required to complete either whole-facility review or selected single-ECM verifications. This timeline reflects the fact that, as stated previously, there generally is a long lead time for planning, budgeting, and implementing capital projects resulting from EERs. In addition, following capital project completion, a year of operations is necessary to assess the accuracy with which the audit predicted the actual savings achieved.

Nonetheless, to provide insight into audits' accuracy in predicting savings for capital upgrades, CUNY BPL has performed savings analyses of capital upgrades for three projects that are able to provide sufficient data, with the results reported in the case studies in **Appendix B**. **Case Study #1** analyzes savings from energy efficiency upgrades at the Queens Family Court. This project resulted from an EER that recommended capital improvements capable of being implemented without the normal long lead time. The EER was completed in June 2014, and the recommended measures were implemented by June 2016, enabling one full year of building operations data post-intervention, with the final EER being filed in November 2017.[1] The savings analysis indicated weather-normalized electricity savings of 13% from the combination of implemented ECMs and RCMs. The EER predicted electricity savings of 6% from the recommended ECMs and 30% from the RCMs. For the RCM savings, the largest savings were expected to come from certain equipment rescheduling. The savings have not been fully achieved due to unrealistic assumptions about flexibility in building schedules and operations and cooling tower operational limits required to meet other mandates. DEM has incorporated the lessons learned from this situation into its current technical review process with consultants. In addition, the other two case studies in **Appendix B** discuss savings from lighting retrofit projects similar to some of the capital projects often recommended in LL 87 EERs. **Case Study #2** indicates statistically valid savings of 12% to 20% for conventional lighting projects in FDNY stations for which consistent billing data was available, and **Case Study #3** shows savings of almost 40% in an NYPD facility where older lighting was replaced with LEDs.

In addition, DEM has reviewed actual energy use for 16 out of the total 37 facilities for which EERs were filed in FY 2017 in order to perform a savings analysis on non-capital work. The building portfolio encompassed thirteen schools, two shelters, and one court house. DEM used standard measurement and verification (M&V) protocols described in **Appendix B**, including adjusting for weather. The analysis considered the impacts of retro-commissioning work (RCMs) done at those facilities, along with a few expense-related ECMs. As shown in **Table 7**, this work yielded energy savings equivalent to 2.4% of base use, resulting in 343 metric tons of avoided carbon emission equivalents (measured as CO_2e) and $290,000 in cost savings.

[1] Due to the timing of the filing, the EER will be included in next year's LL 87 Report.

Table 7: Energy Savings and Cost Analysis

	Savings Claimed (Normalized)								
	Electrical Usage	Gas Usage	#2 Fuel Oil Usage	#4 Fuel Oil Usage	Steam	Total Energy (kBTu)	Total Annual Savings	MT Tons of CO2e	Simple Payback
Energy Unit Usage Savings	7,927 kWh	(21,336) Therms	30,903 Gallons	9,722 Gallons	281 Mlb	163,677,855	$292,419	343	6.15
Total Normal-ized Energy Used (kBtu)	42,801,315	64,051,465	30,288,844	19,893,492	6,642,740				
kBtu Savings	27,057	(2,133,665)	4,307,880	1,415,651	292,955	3,909,878			
% Saved	0.06%	(3.33%)	14.22%	7.12%	4.41%	2.39%			

To improve the accuracy of cost savings projections, DEM has instructed its consultants to consider not only positive cost savings created by interventions, but also negative cost savings created by interventions to arrive at net cost savings projections. Since negative cost savings (e.g., higher energy usage that increases energy costs) can offset positive cost savings (e.g., lower energy usage that decreases energy costs), both types of cost savings need to be combined to produce net cost savings; if only positive cost savings are considered, net cost savings will be overstated, reducing the accuracy of cost savings predictions. For the 16-building portfolio analyzed by DEM, there were negative savings at some of the facilities and positive savings at others.

Negative savings (energy cost increases) can be attributed to the following interventions that were implemented for LL 87 compliance:

1. Repairing outside air intakes: These interventions increase outside airflow, and thereby increase heating/cooling load, but improve occupant comfort by providing fresh outdoor air.
2. Replacing blocked steam traps: These interventions increase heating load, but improve occupant comfort by providing balanced steam flow to radiators.
3. Replacing failed H&V unit control valves: These interventions reduce heating load, but increase run time of units, and improve occupant comfort.
4. Calibrating sensors: Depending on sensor type, these interventions increase heating/cooling load, but improving occupant comfort by supplying sufficient conditioned air.
5. Performing Test, Adjusting, Balancing (TAB) work: These interventions increase fan power draw and heating/cooling load, but improve occupant comfort by providing sufficient air/water flow.
6. Cleaning H&V units: These interventions increase heating load due to greater air flow, but improve building air quality.
7. Repairing exhaust fans: These interventions increase power draw and heating/cooling load, but improve building air quality and alleviate potential “sick building” syndrome by increasing the number of air changes per hour.

Positive savings (energy cost decreases) can be attributed to the following:

1. Calibrating sensors: Depending on sensor type, these interventions reduce heating/cooling load, while improving occupant comfort, by supplying accurate conditioned air temperatures.
2. Restoring control sequences: These interventions reduce power draw and heating/cooling load by operating equipment as designed.
3. Replacing failed terminal thermostats and control valves: These interventions reduce heating/cooling load, while improving occupant comfort.
4. Tuning boilers/DHW: These interventions improve boiler efficiency at the time of tuning. Since boiler efficiency decreases with time, we need to tune the boiler every year to achieve consistent efficiency.
5. Replacing blowing steam traps: These interventions reduce steam lost to the atmosphere.
6. Replacing vacuum/condensate pumps: These interventions reduce steam lost to the atmosphere, while also improving overall system efficiency.
7. Performing outside air balancing (reduce outside airflow): These interventions reduce heating/cooling load, while improving occupant comfort.
8. Repairing lighting controls: These interventions reduce power draw.
9. Eliminating water/steam leaks: These interventions reduce standby loss.
10. Insulating pipes: These interventions reduce standby loss.
11. Install weather-stripping/door sweeps: These interventions reduce infiltration/exfiltration at entrances.

General Findings: EER Accuracy in Predicting Savings

In sum, the M&V analyses conducted by CUNY's Building Performance Lab, as summarized in **Appendix B**, demonstrate an overall reduced energy usage where energy retrofit projects were completed, indicating that retrofits do yield reduced energy consumption and lower energy costs. Likewise, the M&V analysis performed by DEM for the 16-building portfolio, as summarized in **Table 7**, shows energy savings after implementation of retro-commissioning measures and low-cost ECMs recommended in energy audits. Thus, energy audits are an adequate tool for identifying measures that will yield energy savings. However, a more definitive evaluation of EER accuracy in predicting savings requires a greater number of projects that have reached one full year of operations post-completion of implemented capital measures, particularly projects that involve whole-building retrofits or measures for which partial energy load monitoring is feasible.

Recommended LL 87 of 2009 Legislative or Administrative Actions

The authors of this legislation had the foresight to anticipate that recommendations for legislative or administrative changes to LL 87 might be necessary, as real-world execution is not always consistent with the law's well-intentioned requirements. Since the passage of LL 87, DEM has gained significant practical experience with the benefits and challenges of LL 87 compliance. Based on this experience and the City's carbon reduction commitments re-affirmed under Executive Order 26, DEM is already implementing ECMs with longer paybacks than LL 87 requires. DEM does recommend extending the time limits for implementation of ECMs relative to the filing of the related EER, given the lead time required in the City's capital budget processes. These changes will help meet the City's 80 x 50 carbon reduction goals sooner and more efficiently.

APPENDIX A: EERs Submitted to DOB Pursuant to Local Law 87

ITEM	Facility Name	Address	Agency	BIN	BBL	Sq Ft	DOB Submission Date
1	SI 3 District Garage; RBS	Muldoon Ave, entrance to Fresh Kills	DSNY	5000000	5026850100	59,798	12/23/13
2	R008	100 Lindenwood Rd	DOE	5066295	5052210001	60,000	12/31/13
3	Brooklyn Central Court	120 Schermerhorn St	DCAS	3000534	3001690017	264,000	12/31/13
4	Queens Borough Hall	120-55 Queens Blvd	DCAS	4052812	4022740002	261,000	12/31/13
5	122nd Police Precinct	2320 Hylan Blvd	NYPD	5107580	5039060001	51,439	12/31/13
6	Murray Bergtraum High School	411 Pearl St	DOE	1001388	1001130100	305,000	12/31/13
7	St. Mary's Recreational Center	450 St Anns Ave	DPR	2003692	2025570001	56,125	12/31/13
8	26th Repair Shop	640 West 26th St	DSNY	1012267	1006700050	205,000	12/31/13
9	Police Headquarters	1 Police Plz	NYPD	1079143	1001190001	751,908	12/31/13
10	100 Gold St.	100 Gold St	DCAS	1001289	1000940025	594,000	12/31/13
11	Woodside Inspection Facility	24-55 Brooklyn-Queens Expwy	TLC	4022499	4010160045	51,979	12/31/13
12	Public Health Lab	455 1st Ave	DOHMH	1020610	1009320017	260,308	12/31/13
13	Humanities & Social Sciences Library	476 5th Ave	NYPL	1034194	1012570001	600,000	12/31/13
14	158th St. Fleet Svc's Shop	675 West 158th St	DOT	1087614	1021340218	94,200	12/31/13
15	Manhattan Criminal Court	100 Centre St	DCAS	1079000	1001670001	795,700	12/31/13
16	Brooklyn Public Library	10 Grand Army Plz	BPL	3029665	301183002	350,000	12/31/13
17	East Harlem Multi Service Center	413 East 120th St	HRA	1054888	1018080008	93,441	12/31/13
18	Roy Wilkins Recreation Center	Baisley Blvd & Merrick Blvd	DPR	4268835	4124060180	60,000	12/31/13
19	X129	2055 Mapes Ave	DOE	2012957	2031090001	148,475	12/31/13
20	Brooklyn Heights Branch	280 Cadman Plz West	BPL	3001939	3002390016	62,917	12/31/13
21	X174	456 White Plains Rd	DOE	2020580	2034780018	202,880	12/31/13
22	Co-op City (X153, 178, 180, 181 & 455)	650-850 Baychester Ave	DOE	2097470	2051410150	1,190,650	12/31/13
23	Mario Merola Bldg /County Court	851 Grand Concourse	DCAS	2002869	2024680001	555,859	12/31/13
24	5-Boro Complex	1 Randalls Island	DPR	1085920	1018190203	59,664	12/31/13
25	Queens Criminal Court	125-01 Queens Blvd	DCAS	4206522	4096530001	648,000	12/31/13
26	Bushwick Multi Service Center	1420 Bushwick Ave	HRA	3080067	3034440022	52,000	12/31/13
27	Q020	142-30 Barclay Ave	DOE	4114657	4050470001	156,175	12/31/13
28	M721	250 West Houston St	DOE	1009757	1005810054	133,325	12/31/13
29	M199	270 West 70th St	DOE	1030351	1011580040	105,700	12/31/13
30	X054	2703 Webster Ave	DOE	2113630	2032780014	98,980	12/31/13
31	Brooklyn Supreme Court	292-360 Adams St	DCAS	3000257	3001390020	823,584	12/31/13
32	K302	350 Lindwood St	DOE	3088357	3039690001	209,275	12/31/13
33	K126	424 Leonard St	DOE	3067788	3027120001	160,925	12/31/13
34	Q125	46-02 47TH Ave	DOE	4052874	4022840006	164,683	12/31/13

ITEM	Facility Name	Address	Agency	BIN	BBL	Sq Ft	DOB Submission Date
35	K067	51 Saint Edwards St	DOE	3332507	3020390002	138,125	12/31/13
36	K013	557 Pennsylvania Ave	DOE	3085070	3038230001	64,925	12/31/13
37	Q120	58-01 136th St	DOE	4139491	4063730001	111,725	12/31/13
38	M217	645 Main St	DOE	1084848	1013730001	115,085	12/31/13
39	K135	686 Linden Blvd	DOE	3102005	3046730001	72,280	12/31/13
40	R080	715 Ocean Ter	DOE	5113169	5006830001	299,200	12/31/13
41	K009	80 Underhill Ave	DOE	3028204	3011450026	139,375	12/31/13
42	Q092	99-01 34 Avenue	DOE	4042496	4017140018	98,130	12/31/13
43	K318	101 Walton Street	DOE	3061328	3022460001	181,375	12/31/13
44	X125	1111 Pugsley Avenue	DOE	2025717	2037900040	175,325	12/31/13
45	X078	1400 Needham Avenue	DOE	2060191	2047190001	109,280	12/31/13
46	Q219	144-39 Gravett Road	DOE	4448708	4065070001	115,450	12/31/13
47	Q021	147-36 26th Avenue	DOE	4108665	4048030001	125,260	12/31/13
48	X127	1560 Purdy Avenue	DOE	2041247	2039480055	153,725	12/31/13
49	K307	209 York Street	DOE	3000158	3000560007	111,744	12/31/13
50	Q600	37-02 47th Avenue	DOE	4003259	4002280020	195,785	12/31/13
51	X111	3740 Baychester Avenue	DOE	2065992	2049160001	105,775	12/31/13
52	X142	3750 Baychester Avenue	DOE	2066190	2049350001	164,751	12/31/13
53	X068	4011 Monticello Avenue	DOE	2067852	2049860081	94,860	12/31/13
54	K131	4305 Fort Hamilton Parkway	DOE	3136085	3056030001	103,354	12/31/13
55	M540	443 West 135 Street	DOE	1059409	1019570078	163,000	12/31/13
56	M115	586 West 117th Street	DOE	1063228	1021330040	124,900	12/31/13
57	K801	65 Court Street	DOE	3002557	3002660020	342,200	12/31/13
58	K033	70 Thompkins Avenue	DOE	3048517	3017430018	175,300	12/31/13
59	M075	735 West End Avenue	DOE	1034190	1012530065	110,575	12/31/13
60	Q238	88-15 182nd Street	DOE	4212425	4099190006	240,055	12/31/13
61	X131	885 Bolton Avenue	DOE	2103869	2036440001	184,975	12/31/13
62	X039	965 Longwood Avenue	DOE	2005616	2027100001	102,100	12/31/13
63	K181	1023 New York Avenue	DOE	3327776	3049040010	153,725	12/31/13
64	K225	1075 Ocean View Avenue	DOE	3245498	3087120056	102,000	12/31/13
65	M022	111 Columbia Street	DOE	1004070	1003350001	151,000	12/31/13
66	K383	1300 Greene Avenue	DOE	3075413	3032980001	211,375	12/31/13
67	X104	1449 Shakespeare Avenue	DOE	2088263	2028730027	124,900	12/31/13
68	M025	145 Stanton Street	DOE	1004323	1003540080	160,000	12/31/13
69	K115	1500 East 92 Street	DOE	3232559	3082560001	123,000	12/31/13
70	X112	1925 Schieffelin Ave	DOE	2065991	2049050500	85,325	12/31/13
71	X057	2111 Crotona Avenue	DOE	2012359	2030810026	91,280	12/31/13
72	M600	225 West 24th Street	DOE	1014174	1007740019	363,130	12/31/13

ITEM	Facility Name	Address	Agency	BIN	BBL	Sq Ft	DOB Submission Date
73	M084	32 West 92 Street	DOE	1081042	1012050006	104,525	12/31/13
74	K218	370 Fountain Avenue	DOE	3095977	3042780001	181,325	12/31/13
75	M099	410 East 100th Street	DOE	1052998	1016930001	115,000	12/31/13
76	K220	4812 9th Avenue	DOE	3012824	3007780023	109,000	12/31/13
77	M043	509 West 129th Street	DOE	1059723	1019840033	135,000	12/31/13
78	K010	511 7th Avenue	DOE	3016509	3008690001	77,000	12/31/13
79	K138	760 Prospect Place	DOE	3330794	3012330026	164,525	12/31/13
80	R044	80 Maple Parkway	DOE	5027641	5012180001	116,500	12/31/13
81	K081	990 Dekalb Avenue	DOE	3043248	3016020019	130,925	12/31/13
82	Cioffe Borough Repair Shop	106-01 Ave D	DSNY	3252759	3038710001	75,000	12/31/13
83	Bronx Housing Court	1118 Grand Concourse	DCAS	2101266	2024620039	99,000	12/31/13
84	Manhattan House of Detention	125 White St	DOC	1079000	1001670001	514,000	12/31/13
85	Mark A. Constantino Judicial Ctr	130 Stuyvesant	DCAS	5000085	5000080070	150,300	12/31/13
86	Brooklyn W11G	1824 Shore Parkway	DSNY	3378180	3069430002	75,000	12/31/13
87	Bronx Bergen Building	1932 Arthur Ave	DCAS	2009911	2029470018	90,000	12/31/13
88	Bronx Concourse Plaza	198 East 161 Street	DCAS	2099027	2024430094	231,190	12/31/13
89	NYPD Command (BNND)	245 Glenmore Ave	NYPD	3083636	3036980032	60,000	12/31/13
90	84th Precinct & Engine Co 207	301 Gold St	NYPD	3000252	3001340006	50,000	12/31/13
91	Chelsea Recreational Center	430 West 25th Street	DPR	1012811	1007220057	83,940	12/31/13
92	Queens West 2,3,4,6 District Garage; CRS	52-35 58th Street	DSNY	4462505	4023610268	550,000	12/31/13
93	Central Repair Shop (CRS)	53-15 58th St	NYPD	4054276	4023610150	75,400	12/31/13
94	Brownsville Rec. Ctr	598 Christopher Ave	DPR	3085992	3038680002	72,000	12/31/13
95	George R. Vierno Center (GRVC)	Riker's Island	DOC	2096863	2026050040	458,000	12/31/13
96	Otis Bantun Correctional Center (OBCC)	Riker's Island	DOC		2999999999	344,632	12/31/13
97	Staten Island Borough Hall	10 Richmond Ter	DCAS	5000063	5000070001	81,538	12/31/13
98	Manhattan Civil Court	111 Centre St	DCAS	1001833	1001690010	467,000	12/31/13
99	Franklin Women's Shelter	1122 Franklin Ave	DHS	2004260	2026130001	97,000	12/31/13
100	Health Building	125 Worth St	DCAS	1001831	1001680032	406,109	12/31/13
101	Atlantic Avenue Men's Shelter	1322 Bedford Ave	DHS	3029748	3011990015	164,320	12/31/13
102	Excelsior Building	137 Centre St	DCAS	1002358	1001970017	59,000	12/31/13
103	Office of Emergency Mgmt. Hdqtrs	165 Cadman Plz East	DCAS	3000172	4000850006	66,245	12/31/13
104	Bronx Family & Criminal Court	215 East 161st St	DCAS	2002704	2024540001	490,000	12/31/13
105	Fort Washington Armory-Shelter	216 Ft Washington Ave	DHS	1063381	1021380079	88,519	12/31/13
106	Long Island City Courthouse	25-10 Court Sq	DCAS	4000698	4000830001	59,300	12/31/13
107	Regent Hotel Shelter	2720 Broadway	DHS	1056586	1018760020	102,275	12/31/13
108	Sun Building	280 Broadway	DCAS	1079215	1001531002	242,062	12/31/13
109	NYPD Precinct 67th	2820 Snyder Ave	NYPD	3117400	3051110024	53,976	12/31/13
110	PATH Office	346 Powers Ave	DHS	2091301	2025720006	72,000	12/31/13

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111	Bellevue Men's Shelter	400 East 30th Street	DHS	1087298	1009620097	277,076	12/31/13
112	Manhattan Supreme Court	60 Centre St	DCAS	1085748	1001600021	322,300	12/31/13
113	Manhattan Family Court	60 Lafayette St	DCAS	1001842	1001710031	491,000	12/31/13
114	Louis J. Lefkowitz Building	80 Centre St	DCAS	1001830	1001660027	472,500	12/31/13
115	Queens Supreme Court	88-11 Sutphin Blvd	DCAS	4207071	4096910001	308,200	12/31/13
116	Queens Civil Court	89-17 Sutphin Blvd	DCAS	4448759	4096800001	320,535	12/31/13
117	Vernon C. Bain Center (VCBC)	1 Halleck St	DOC	1079143	1001190001	310,000	12/31/13
118	Eric M. Taylor Center (EMTC)	10-10Hazen St	DOC	2116651	2026050040	484,407	12/31/13
119	Queens 7/11 District Garage Annex	120-15 31st Ave	DSNY	4802407	4043460075	101,930	12/31/13
120	NYPD Precinct 73rd	1470 East New York Ave	NYPD	3080735	3034970002	50,020	12/31/13
121	George Motchan Det. Ctr (GMDC)	15-15 Hazen St	DOC	2097042	2026050040	533,491	12/31/13
122	Rose M. Singer (RMSC)	19-19 Hazen St	DOC	2109477	2026050040	291,000	12/31/13
123	Brooklyn North 1, 4 District Garage	157-175 Varick St	DSNY	3070545	3029620005	79,305	12/31/13
124	Bronx 12 District Garage	1643 East 233rd St	DSNY	2090261	2049740028	117,344	12/31/13
125	Ranaqua Shops and Garage	1900 Birchall Ave	DPR	2101004	2043330001	70,000	12/31/13
126	Asphalt Green Rec. Ctr	1750 York Ave	DPR	1085696	1015870001	56,000	12/31/13
127	Borden Avenue Shelter	21-10 Borden Ave	DHS	4000526	4000680002	55,000	12/31/13
128	Police Academy/13th Precinct	230 East 21st St	NYPD	1019613	1009010006	296,405	12/31/13
129	Manhattan Appellate Court	27 Madison Ave	DCAS	1016743	1008550001	54,300	12/31/13
130	NYPD Precinct 81st	30 Ralph Ave	NYPD	3044596	3016330039	58,745	12/31/13
131	NYPD Precinct 48th	450 Cross Bronx Expwy	NYPD	2009509	2029070010	59,328	12/31/13
132	Maspeth Central Shops	58-50 57th Rd	DOT	4805470	4026750015	117,000	12/31/13
133	Briarwood Residence	80-20 134th St	DHS	4314908	4096620020	50,000	12/31/13
134	NYPD Precinct 72nd	830 4th Ave	NYPD	3009843	3006680029	53,600	12/31/13
135	Manhattan 3 District Garage	South St Pier 36	DSNY	1805208	1002410013	55,330	12/31/13
136	Fort Totten	Various - See FDNY sheet	FDNY	9999999	4059170001	421,996	12/31/13
137	Fire Academy - Randalls	Various - See FDNY sheet	FDNY	1085640	1018190015	241,200	12/31/13
138	M054	103 W 107th St	DOE	1055990	1018620011	137,000	12/31/13
139	K251	1037 E 54 St	DOE	3214729	3077580001	91,280	12/31/13
140	K279	1070 East 104 St	DOE	3326733	3082300001	124,925	12/31/13
141	K276	1070 East 83rd	DOE	3225637	3080340001	282,180	12/31/13
142	K191	1600 Park Place	DOE	3036635	3013750012	92,480	12/31/13
143	K321	180 7th Ave	DOE	3337516	3009710028	109,444	12/31/13
144	M019	185 1st Ave	DOE	1006478	1004530034	84,125	12/31/13
145	Q225	190 Beach 110th St	DOE	4303853	4161810001	84,100	12/31/13
146	M661	240 2nd Ave	DOE	1020416	1009210064	55,260	12/31/13
147	X135	2441 Wallace Ave	DOE	2051313	2044320001	163,300	12/31/13
148	K650	257 N 6th St	DOE	3062135	3023300011	224,525	12/31/13

ITEM	Facility Name	Address	Agency	BIN	BBL	Sq Ft	DOB Submission Date
149	X101	2750 Lafayette Ave	DOE	2080231	2055470001	182,525	12/31/13
150	X121	2750 Throop Ave	DOE	2054253	2045260001	111,700	12/31/13
151	K329	2929 West 30th St	DOE	3189517	3070510001	122,225	12/31/13
152	R052	450 Buel Ave	DOE	5053746	5037050001	85,699	12/31/13
153	M028	475 West 155th St	DOE	1076739	1021070026	122,525	12/31/13
154	K287	50 Navy St	DOE	3000203	3001110001	98,725	12/31/13
155	Q011	54-25 Skillman Ave	DOE	4028447	4012390001	101,260	12/31/13
156	R031	55 Layton Ave	DOE	5001150	5000490182	92,600	12/31/13
157	Q205	75-25 Bell Blvd	DOE	4164007	4077530001	120,648	12/31/13
158	Q191	85-15 258 St	DOE	4180083	4088010014	82,620	12/31/13
159	University Ave	1041 University Ave, Bronx	DHS	2003496	2025270014	99,975	12/31/13
160	K185	8601 Ridge Blvd	DOE	3153416	3060430001	64,880	12/23/14
161	K269	1957 Nostrand Avenue	DOE	3113780	3049940023	97,300	12/30/14
162	K022	442 St. Marks Avenue	DOE	3028281	3011480050	105,925	12/30/14
163	K902	62 Park Place	DOE	3259250	3009410050	92,480	12/30/14
164	Q089	85-28 Britton Avenue	DOE	4037370	4015140001	82,288	12/30/14
165	K849 and K839	4001 18th Avenue	DOE	3127692	3054160048	57,180	06/30/15
166	K152	725 East 23rd Street	DOE	3205780	3075510026	197,100	12/11/15
167	Webster Avenue SRO	1075 Webster Ave	DHS	2102353	2024250020	174,600	12/11/15
168	X015	2195 Andrews Avenue	DOE	2096013	2032240009	162,125	12/23/15
169	K309	794 Monroe Street	DOE	3045047	3016430036	106,860	12/23/15
170	Manhattan Municipal Building	1 Centre St	DCAS	1001394	1001210001	1,070,800	12/23/15
171	Manhattan Surrogate's Court	31 Chambers St	DCAS	1001670	1001530024	212,500	12/23/15
172	Q131 within (Q131,Q911)	170-45 84th Ave	DOE	4211112	4098750001	73,232	12/23/15
173	Q081	559 Cypress Ave	DOE	4082076	4034370001	69,000	12/23/15
174	Q154	75-02 162nd St	DOE	4148003	4068340001	91,260	12/23/15
175	Barbara Kleinman Residence	269 Skillman Ave	DHS	3338306	3028850001	97,780	01/06/16
176	Brooklyn Borough Hall	209 Joralemon St	DCAS	3000256	3001390001	50,000	04/18/16
177	Brooklyn Municipal Building	210 Joralemon St	DCAS	3002558	3002660030	468,000	04/20/16
178	M841	466 West End Avenue	DOE	1032754	1012300001	64,880	06/08/16
179	Seneca Houses Residence	1215 Seneca Ave, Bronx	DHS	2006338	2027610043	64,315	07/27/16
180	Transportation Repair Shop	48-67 34th Street, LIC	FDNY	4003451	4002540001	92,800	07/27/16
181	X089 and X919	980 Mace Avenue	DOE	2051571	2044440016	117,680	11/17/16
182	K660	145 Pennsylvania Avenue	DOE	3083660	3037040001	180,175	11/18/16
183	X102	1827 Archer Street	DOE	2028640	2039210030	163,325	11/18/16
184	K202 within (K202,K958)	982 Hegeman Ave	DOE	3098664	3044770001	135,975	11/18/16
185	K324	800 Gates Ave	DOE	3044657	3016360001	205,375	12/06/16
186	X071 and X948	3040 Roberts Avenue	DOE	2046140	2041710001	135,125	12/16/16

ITEM	Facility Name	Address	Agency	BIN	BBL	Sq Ft	DOB Submission Date
187	X182	601 Newman Avenue	DOE	2021923	2035640001	102,175	12/16/16
188	Tweed Courthouse	52 Chambers St	DCAS	1079146	1001220001	170,131	12/16/16
189	K190	590 Sheffield Avenue	DOE	3085491	3038380018	93,660	12/23/16
190	X047	1794 East 172nd Street	DOE	2025622	2037860016	100,925	12/27/16
191	X046 and X846	279 East 196th Street	DOE	2094729	2032950001	103,300	12/27/16
192	X120	890 Cauldwell Ave	DOE	2004496	2026310048	138,175	12/27/16
193	X058	459 East 176th Street	DOE	2009540	2029090032	74,480	02/15/17
194	K224	755 Wortman Avenue	DOE	3346166	3045300001	126,100	03/27/17
195	K092	601 Parkside Ave	DOE	3115866	3050490055	134,500	04/26/17
196	R043	100 Essex Drive	DOE	5149609	5024500320	194,208	06/23/17
197	X008 and X808	3010 Briggs Avenue	DOE	2094734	2032990060	92,480	06/23/17
198	M042	71 Hester St	DOE	1003998	1003090001	74,080	06/23/17
199	Q012	42-00 72nd St	DOE	4031853	4013490028	116,105	06/28/17
200	R045	58 Lawrence Ave	DOE	5007417	5002760007	87,680	06/28/17
201	X073 and X873	1020 Anderson Avenue	DOE	2003051	2025040082	90,280	06/29/17
202	M081	212 West 120th Street	DOE	1058447	1019250019	110,480	06/29/17
203	M113	240 West 113th St	DOE	1055111	1018280015	105,100	06/29/17
204	K214 within (K214,K949)	2944 Pitkin Ave	DOE	3095254	3042430001	102,033	06/29/17
205	X306	40 West Tremont Avenue	DOE	2098721	2028620014	202,975	06/30/17
206	Manhattan Bowery Shelter	8 East 3rd Street, NYC	DHS	1006546	1004580011	55,000	06/30/17
207	Q040 and Q988	109-20 Union Hall Street	DOE	4263341	4121510001	126,525	06/30/17
208	X028 and X928	1861 Anthony Avenue	DOE	2007603	2028040031	94,980	06/30/17
209	Mount Eden Avenue SRO Res	50 Mt Eden Ave West	DHS	2090448	2028650049	68,185	06/30/17
210	X118 (0200016)	577 East 179th St	DOE	2011995	2030690001	115,375	06/30/17
211	M036	123 Morningside Dr	DOE	1055890	1018500002	85,280	06/30/17
212	K253 within (K253, K964)	601 Ocean View Ave	DOE	3244470	3086660610	83,000	06/30/17
213	K254	1801 Ave Y	DOE	3203132	3074200026	73,200	06/30/17
214	345 Adams St, Brooklyn	345 Adams St	DCAS	3392969	3001407503	327,530	06/30/17
215	Abe Stark Ice Rink	Coney Island Boardwalk and West 19th St	DPR	3341513	3070730101	51,900	06/30/17

APPENDIX B: Measurement and Verification (M&V) of Energy Reductions

DEM tasked the CUNY Building Performance Lab ("BPL") with analyzing several energy retrofit projects completed during FY 2017. BPL analyzed energy consumption data at the whole facility level for these projects. Where energy retrofit projects were completed and operational for at least one year, BPL found that the data demonstrated reduced energy usage.

M&V Methodology

Energy consumption data was provided to BPL in the form of a comma-delimited (CSV) file that contained utility billing data (by meter) for electric, gas and steam, as well as data from fuel oil delivery logs (as available). The data was reviewed for gaps and outliers, and then prepared for analysis. For each facility, a raw data file was created with electricity and fuel energy consumption data for 12 months prior to the project construction start date (pre-retrofit) and for 12 months after project completion (post-retrofit). Where a facility used multiple fuel energy types (i.e., natural gas and steam), consumption data for those meters was converted to BTUs and combined for analysis purposes. Electricity data was left in kilowatt-hour (kWh) units. A standard daily average outside air temperature ("OAT") data file also was used for analysis, with LaGuardia Airport as the selected weather station.

The energy usage reduction analysis was based on the monthly energy use data from the utility bills, per the Option C Whole Facility[2] measurement and verification (M&V) approach set forth in the International Performance Measurement and Verification Protocol (IPMVP). This approach also is consistent with the methodology put forth in ASHRAE Guideline 14-2014 – Measurement of Energy, Demand and Water Savings. The approach requires that an empirical energy model between energy use and its main influencing parameter, which in this case is weather (OAT), be developed to model baseline period energy use.

Under the M&V approach, the baseline period is defined as the 12 months immediately preceding implementation of the energy conservation measures in the building. The baseline model then is adjusted to post-retrofit conditions, using OAT from the post-installation period. The result, referred to as the adjusted baseline, is an estimate of what the baseline energy use would have been, had no measures been installed in the building. Energy usage reduction, essentially avoided energy usage, is the difference between the adjusted baseline usage and the measured energy usage for the post-retrofit period.

It is important to note two caveats related to this approach. First, there may not be perfect alignment between retrofit start and end dates and monthly energy consumption billing period start and end dates, due to the way in which utility meters are read and energy consumption is billed. Second, a precise comparison of audit-estimated energy usage reductions and actual energy usage reductions may not be possible when a combination of energy conservation measures (ECMs) are installed, as energy usage is measured at the building level and not by individual ECM.

[2] International Performance Measurement & Verification Protocol (IPMVP) – Core Concepts April 2016 EVO 10000 – 1:2016

Case Studies

Case Study #1: Queens Family Court
Project: Variable frequency drives, valves on air handlers, and various retro-commissioning measures
Retrofit Dates: 12/31/2014-1/1/2015

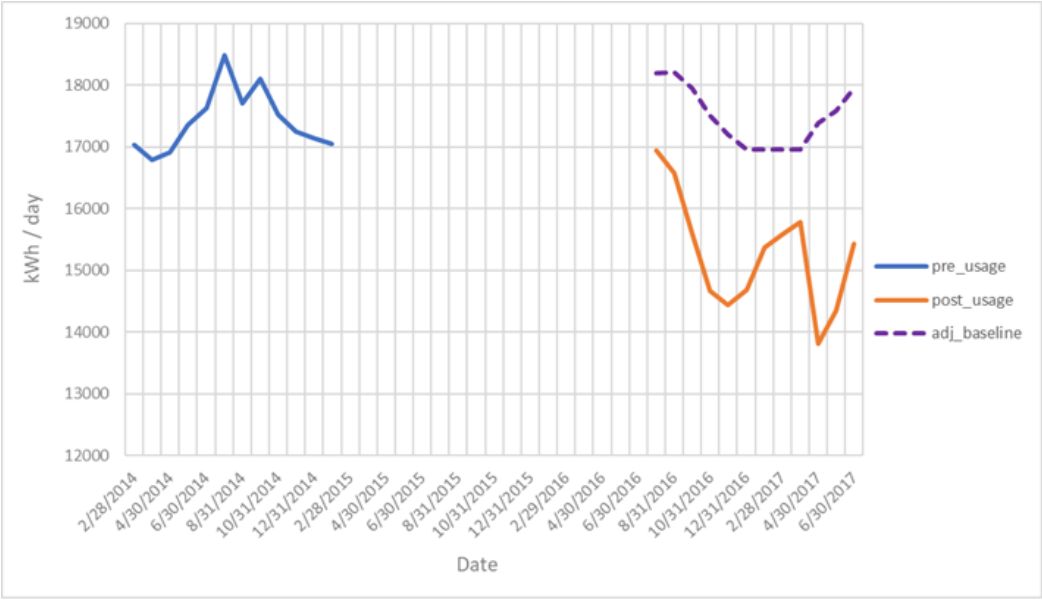
According to DEM, the measures implemented at this facility included variable frequency drives on the chilled water pumps; valves on the heated and chilled water coils on air handling units; and various retro-commissioning measures. These measures would be expected to produce both electricity and fuel oil and natural gas savings.

The electricity reduction model in **Figure A** shows pre-retrofit baseline usage (blue line), actual post-retrofit usage (orange line), and adjusted baseline usage (dotted purple line). The retrofit construction period is the gap in between the pre- and post-retrofit periods. According to this model, adjusted baseline electric usage during the post-retrofit period was estimated at 6,381,400 kWh, and actual electric usage was 5,572,960 kWh. As such, the electric reduction over the 12-month post-retrofit period (through January 2016) was: 808,438 kWh ± 3%, or 13% of adjusted baseline usage.

In addition to electricity, this facility uses a combination of fuel oil and natural gas. However, because fuel oil is reported by delivery, not by actual consumption, as well as the number of estimated natural gas meter readings, the fuel models were unreliable and are not included here. As such, avoided energy calculations for the ECMs that impact natural gas or fuel oil consumption are not available.

Overall, the data supports evidence of an overall decrease in electricity consumption from the pre-retrofit baseline to the post-retrofit period. The statistical metrics associated with the model convey a moderate degree of uncertainty around the fit of the model to the data provided.

Figure A. Queens Family Court – Electricity Reduction Model



Case Study #2: FDNY Engine Company 230
Project: Lighting Upgrade
Retrofit Dates: 12/31/2014-1/1/2015

According to DEM, the project at this specific fire station facility was a lighting retrofit. The lighting upgrade would be expected to affect electric usage, with little effect (if any) on natural gas usage.

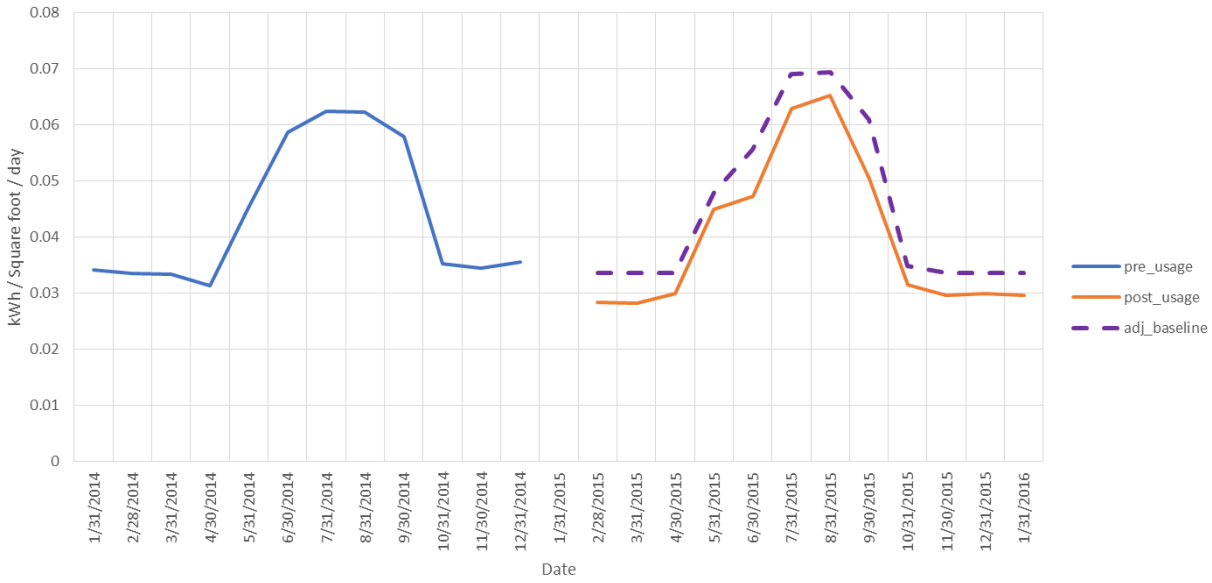
The electricity reduction model in **Figure B** shows pre-retrofit baseline usage (blue line), actual post-retrofit usage (orange line) and adjusted baseline usage (dotted purple line). The retrofit construction period is the gap in between the pre- and post-retrofit periods. According to this model, adjusted baseline usage during the post-retrofit period was estimated at 74,031 kWh, and actual usage was 65,638 kWh. As such, the electric reduction over the 12-month post-retrofit period (through January 2016) was: 8,393 kWh ± 9%, or 12% of adjusted baseline usage.

The energy usage reduction model confirms reduced electricity usage, and seems to indicate that the reduction primarily affected the electric baseload. This can be seen in **Figure B**, where the entire adjusted baseline usage is higher than the actual usage, while the actual summer electric peak is still about the same relative magnitude as it would have been had no retrofit occurred.

This individual facility was one of 28 fire stations included in a set of lighting upgrades for FDNY fire stations. Of the 28, only six had sufficient post-retrofit electricity data for modeling, with reasonable statistics and uncertainty less than 10% of savings. The savings for these six facilities ranged from 12% to 20% per facility, compared to their respective adjusted baseline usage. It should not be inferred that the overall project (all 28 facilities) had savings in this range

Overall, the data supports the evidence of an overall decrease in electricity consumption from the pre-retrofit baseline to the post-retrofit period. The statistical metrics associated with the model convey a relatively low degree of uncertainty around the fit of the model to the data provided.

Figure B. FDNY Engine Company 230 – Electricity Reduction Model



Case Study #3: NYPD Brooklyn Property Division Lighting Retrofit
Project: LED Lighting Retrofit
Retrofit Dates: 02/01/2016 – 06/01/2016

According to DEM, the project at this facility involved the replacement of lighting fixtures throughout the facility. The lighting upgrade would be expected to affect electric usage, with little effect (if any) on natural gas usage.

The electricity reduction model in **Figure C** shows pre-retrofit baseline usage (blue line), actual post-retrofit usage (orange line) and adjusted baseline usage (dotted purple line); the retrofit construction period is the gap in between the pre- and post-retrofit periods. According to this model, adjusted baseline usage during the post-retrofit period was estimated at 468,493 kWh, and actual usage was 284,730 kWh. As such, the electric reduction over the 12-month post-installation period (June 2016 through May 2016) was: 183,763 kWh ± 2%, or 39% of adjusted baseline usage.

The energy usage reduction model confirms the reduced electricity usage, and seems to indicate that this reduction primarily affected the electric baseload. This can be seen in **Figure C**, where the entire adjusted baseline usage is higher than the actual usage, while the actual summer electric peak is still about the same relative magnitude as it would have been had no retrofit occurred.

Overall, the data supports the evidence of a decrease in electricity consumption from the pre-retrofit baseline to the post-retrofit period, and the statistical metrics associated with the model convey a very low degree of uncertainty around the fit of the model to the data provided.

Figure C. NYPD Brooklyn Property Division – Electricity Reduction Model