



# LOCAL LAW 87 ANNUAL REPORT

FISCAL YEAR 2016

Prepared December 2016

# Local Law 87 Annual Report

## Fiscal Year 2016

December 2016

## **DCAS Energy Management – Local Law 87 Annual Report**

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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 and One City: Built to Last*.

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, 2016, DEM has filed a total of 178 EERs with the Department of Buildings (DOB). Thirteen (13) EERs were filed in FY 2016, the period covered by this report; six (6) EERs were filed in Fiscal Year (FY) 2015; the remaining 159 EERs were filed in FY 2014 in an early compliance period. This report reviews the FY 2015 and 2016 EERs together, and summarizes the following: 1) the most common EER improvements recommended by the energy audits for these buildings; 2) the analysis of the accuracy of such energy audits in predicting costs of the recommended capital improvements; 3) the post-installation analysis of the accuracy with which such audits predicted the actual savings achieved by the capital improvements; and recommendations as to appropriate legislative or 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, 2015 through June 30, 2016 (FY 2016).

### **Reasonable Energy Conservation Measures (ECMs)**

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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), as set forth in the definition of "simple payback" contained in LL 87. The City has done so through its energy efficiency capital improvement programs, where measures 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. Where reasonable measures do not meet capital eligibility requirements, the City seeks to fund those measures through its expense-funded program in coordination with retro-commissioning measure implementation. Henceforth, for the purpose of this report, these reasonable measures will be referred to as ECMs.

## Energy Efficiency Reports Submitted Pursuant to LL 87

The 178 EERs submitted to the Department of Buildings (DOB) to date represent buildings managed by 14 City agencies in all five boroughs.

| EERs Submitted by Boro | # of EERs  | % of Total |
|------------------------|------------|------------|
| Bronx                  | 33         | 19%        |
| Manhattan              | 46         | 26%        |
| Brooklyn               | 55         | 31%        |
| Queens                 | 35         | 20%        |
| Staten Island          | 9          | 5%         |
| <b>Total</b>           | <b>178</b> |            |

| EERs submitted by Fiscal Year and Agency            |            |                   |
|---|------------|-------------------|
|   | # of EERs  | Sq. Feet.         |
| <b>FY14 Total</b>                                   | <b>159</b> | <b>30,300,098</b> |
| Brooklyn Public Library                             | 2          | 412,917           |
| Department of Citywide Administrative Services      | 25         | 8,352,722         |
| Department of Homeless Services                     | 9          | 1,006,165         |
| Department of Correction                            | 7          | 2,935,530         |
| Department of Education                             | 80         | 12,323,383        |
| Department of Health and Mental Hygiene             | 1          | 260,308           |
| Department of Transportation                        | 2          | 211,200           |
| Department of Parks and Recreation                  | 7          | 457,729           |
| Department of Sanitation                            | 9          | 1,318,707         |
| New York Fire Department                            | 2          | 663,196           |
| Human Resources Administration                      | 2          | 145,441           |
| New York Police Department                          | 11         | 1,560,821         |
| New York Public Library                             | 1          | 600,000           |
| Taxi and Limousine Commission                       | 1          | 51,979            |
| <b>FY15</b>   | <b>6</b>   | <b>500,053</b>    |
| Department of Education                             | 6          | 500,053           |
| <b>FY16</b>   | <b>13</b>  | <b>2,838,137</b>  |
| Department of Citywide Administrative Services      | 4          | 1,801,300         |
| Department of Homeless Services                     | 2          | 272,380           |
| Department of Education                             | 7          | 764,457           |
| <b>Total EERs Submitted to DOB as of 06/30/2016</b> | <b>178</b> | <b>33,638,288</b> |

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

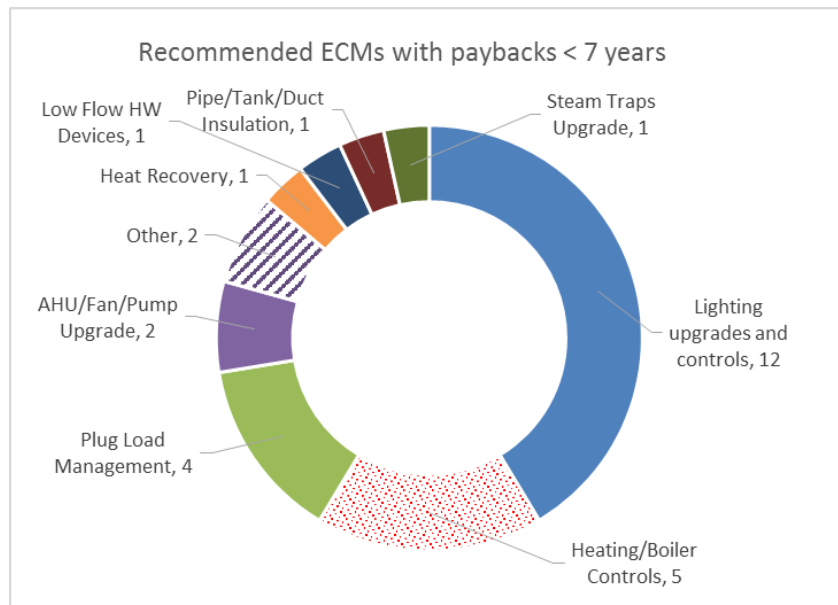
## Most Common EER Improvement Recommendations

There were 107 recommended ECMs in the 19 EERs filed with the DOB in FY 2015 and 2016. Over a quarter of the ECMs – 27% -- met the seven (7) year simple payback criteria for mandatory implementation for City buildings. The same proportion had paybacks of 20 years or more.

| ECMS by payback period       | # of ECMs | % of ECMs |
|------------------------------|-----------|-----------|
| Paybacks of 7 years or less  | 29        | 27%       |
| Paybacks from 7 to 10 years  | 19        | 18%       |
| Paybacks from 10 to 20 years | 30        | 28%       |
| Paybacks of 20 years or more | 29        | 27%       |
| Total                        | 107       | 100%      |

The most common improvements to base building systems recommended in these EERs irrespective of payback are for lighting upgrades and controls, and heating/boiler controls. Other measures recommended with less frequency cover other aspects of heating systems upgrades, electrical equipment upgrades, building controls, and building envelop improvements.

For recommended improvements with paybacks of seven years or less, the ECMs, and their frequencies, are as follows:



## Cost Predictions

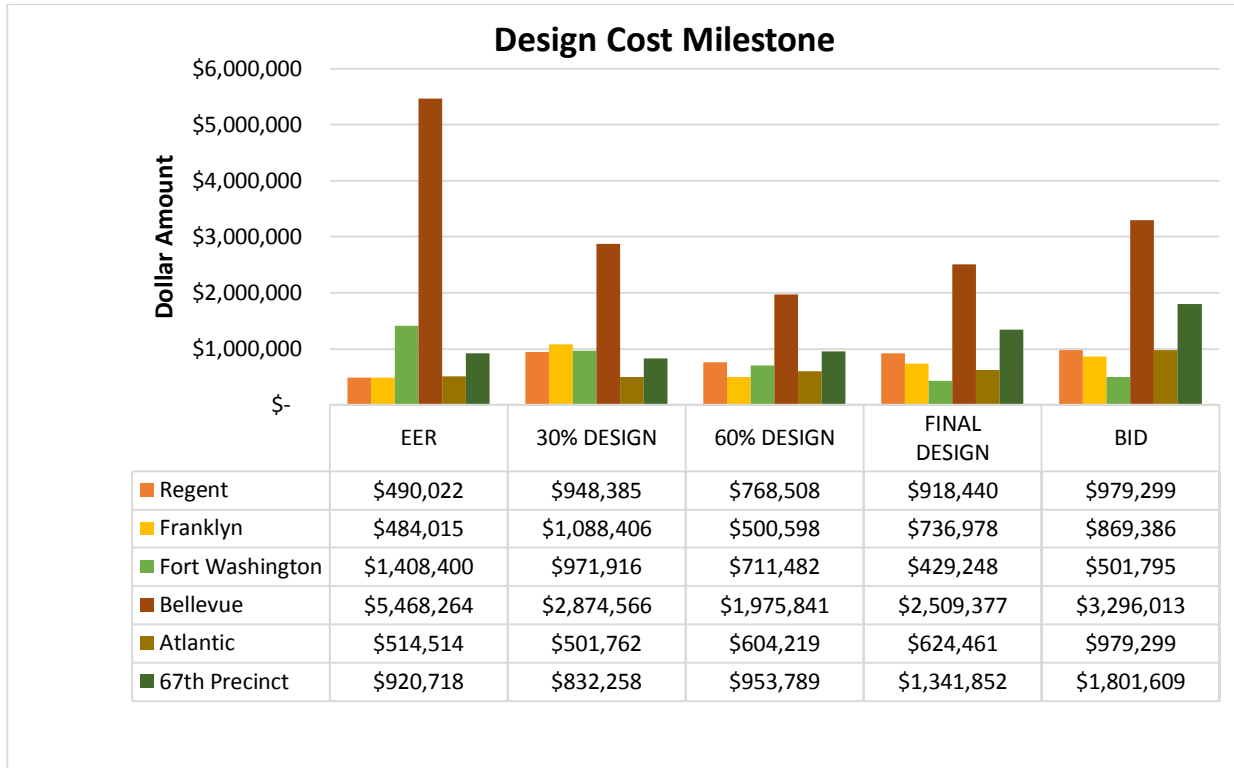
Local Law 87 requires DCAS to include in the annual report an analysis of the accuracy of energy audits in predicting costs of the recommended capital improvements. Substantial lead time is required for capital planning, funding, and project implementation following an energy audit. It is expected that over the next two years there will be a sufficient post-implementation period for a broad range of projects growing out of EERs, with enough capital improvements to more accurately assess the accuracy of the reports in predicting costs and savings.

Until then, DEM has analyzed predictive cost and savings information for two sets of information that it has. First, there were nine ECMs that were feasible and reasonable to implement along with the implementation of RCMs, in seven buildings. For these measures, projected costs were underestimated by almost 20% on an aggregate basis for selected ECMs. As shown in the table that follows, cost estimates varied widely for particular measures and for the same measure at different locations, but were within a reasonable range in total in the construction environment. Variations in cost estimates 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. For example, the \$1,265 cost recommendation of first ECM below was for upgrading a total of eight exit lights identified in the audit; the actual quantity of fixtures that needed replacement was forty-one. The large cost increase was a result of both the larger number of units installed and a higher cost per unit (per-unit went from \$158 to \$306). The variation in particular ECM cost projections supports DCAS's recommendations (see Recommendation section) for flexibility in identifying EMCs for implementation.

| Recommended ECM                                | Projected Implementation Cost | Actual Implementation Cost | % Actual Implementation Cost is Over (Under) Projected |
|--|-------------------------------|----------------------------|--|
| Upgrade Remaining non-LED Exit Lighting to LED | \$ 1,265                      | \$ 12,536                  | 891%   |
| Insulate Feed Water Tank                       | \$ 2,062                      | \$ 5,090                   | 147%   |
| Install Boiler Fuel Economizers                | \$ 17,109                     | \$ 1,804                   | -89%   |
| Occupancy sensors in classrooms                | \$ 55,136                     | \$ 64,620                  | 17%  |
| Occupancy sensors in classrooms                | \$ 30,258                     | \$ 30,773                  | 2%   |
| Replace or repair Steam Traps                  | \$ 21,011                     | \$ 27,127                  | 29%  |
| Install LED Exit Signs                         | \$ 13,358                     | \$ 17,547                  | 31%  |
| Install LED Exit Signs                         | \$ 20,873                     | \$ 15,580                  | -25%   |
| Install LED Exit Signs                         | \$ 12,903                     | \$ 27,701                  | 115%   |
| <i>Total</i>                                   | \$ 173,975                    | \$ 202,778                 | 17%  |

Second, DEM has tracked design-stage cost estimates and bid costs for capital projects now under construction for projects that resulted from EERs, as shown in the bar chart and table below. While the total final bid costs for these particular six construction projects were close to – in fact, 9% below – the total costs projected in the EERs, that is not the case on a project-by-project basis. For individual projects, EER cost projections vary widely from actual bid costs (consistent with the experience reported above for individual ECM cost projections). Four of the projects had bid costs ranging from 80% to double the initial projection. These ranges are not out of line with industry norms but also point to the

need for some flexibility in implementation, if changes in savings estimates do not keep pace with changes in cost estimates.



### COST ESTIMATES COMPARISON

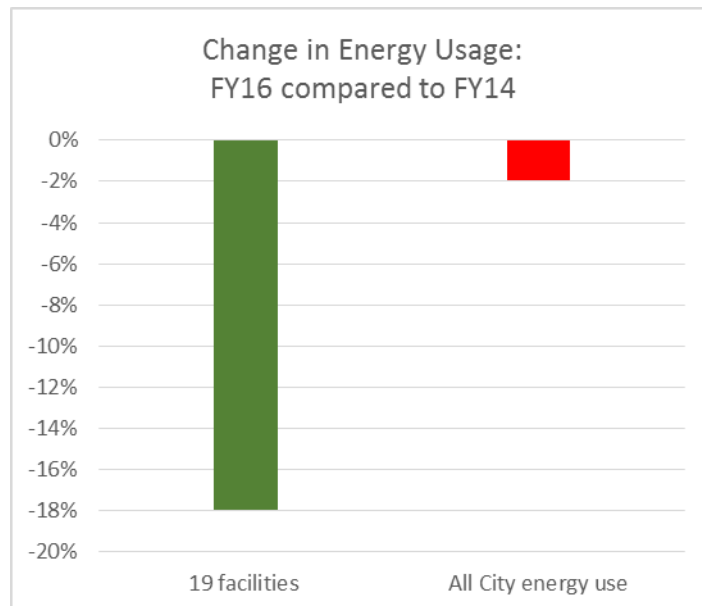
| Project                   | EER / Class 5      | BID                | % BID over or Under EER Projection |
|---------------------------|--------------------|--------------------|------------------------------------|
| Regent                    | \$490,022          | \$979,299          | 100%                               |
| Franklyn                  | \$484,015          | \$869,386          | 80%                                |
| Fort Washington           | \$1,408,400        | \$501,795          | -64%                               |
| Bellevue                  | \$5,468,264        | \$3,296,013        | -40%                               |
| Atlantic                  | \$514,514          | \$979,299          | 90%                                |
| 67 <sup>th</sup> Precinct | \$920,718          | \$1,801,609        | 96%                                |
| <b>TOTAL</b>              | <b>\$9,285,933</b> | <b>\$8,427,401</b> | <b>-9.2%</b>                       |

## Savings Predictions

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Local Law 87 also requires an analysis of the accuracy of audits in predicting savings. With respect to assessing savings estimates, more time will be needed to complete either whole-facility upgrades or selected single-ECM verifications. This is because, as stated above, the long lead time for planning, budgeting for, and implementing capital work has resulted in projects based on completed EERs that are still under construction. After implementation, a year of operation is necessary in order to assess the accuracy with which the audit predicts the actual savings achieved.

However, DEM has reviewed the actual energy used in the 19 facilities for which EERs were filed in FY15 and FY16. Retro-commissioning (RCM) work as done at those facilities, along with the implementation of a few low-cost ECMs. The chart below shows that as a whole, those facilities used 18% less energy in FY16 compared to FY14; the citywide drop over that same period was 2%. This is a dramatic difference, and likely points to the impact of savings from all of the work done, including the recommended RCMs, which are operational or maintenance measures implemented in the short term.



Further, DEM engaged the City University of New York (CUNY)'s Building Performance Lab to assess savings at the whole building level for select retrofit projects that are similar to some of the capital work recommended in LL87 EERs that will be the subject of future years' reports. That analysis can be found in Appendix B.

### **General Findings -- Accuracy of EERs in predicting costs:**

Estimated costs by ECM reflected in EERs are not congruent with construction industry standard practices used for bids and therefore do not accurately predict the actual cost of ECM implementation. In the early years of LL87 compliance, it was common to find ECM cost estimates based on material and labor costs alone. Another factor that contributes to EERs understating the actual costs associated with capital measures is the omission from EERs of costs associated with:



- Design and/or construction management fees
- Overhead and profit
- Environmental remediation costs (e.g., asbestos/PCBs)
- Field conditions
- Scope changes

To resolve this issue, 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 cost estimates in recent reports has improved. However, costs reported in the EER are still likely to vary compared to actual installed cost because cost estimates for ASHRAE Level II Energy Audit are not required to be bid-level construction cost estimates.

***General Findings -- Accuracy of EERs in predicting savings:***

The M&V analyses provided by CUNY's Building Performance Lab demonstrate reduced energy usage where energy retrofit projects were completed, indicating that retrofits do yield reduced energy consumption and lower energy costs. And DEM's own analyses show energy savings after implementation of operational measures recommended in energy audits. Thus, the energy audit is an adequate tool for identifying measures that will yield energy savings. However, the report's accuracy in predicting the amount of savings is difficult to determine. A precise comparison of audit estimates for energy reductions and actual energy reductions is not possible as energy usage is measured at the building level and not by individual ECMs. There are other variables that impact energy use at a building level including but not limited to its hours of occupancy, type of use, existing building equipment, and changes to plug loads, which makes it difficult to isolate the precise impact of an ECM. Despite these uncertainties, it is clear that building energy use decreased through the EER process.

## **Recommended LL 87 of 2009 Legislative or Administrative Actions**

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The drafters 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 well-intentioned requirements of the law. Since the passage of LL 87, DCAS has gained significant practical experience with the benefits and challenges of compliance with the law. Based on this experience, DCAS will be proposing changes that provide the ability to implement more ECMs, including those with longer paybacks than this law requires, and to not pursue ECMs where building conditions have changed. In order to do this efficiently, within a given building ECMs with longer paybacks would be bundled together with ECMs with shorter paybacks. Time limits for implementation of ECMS relative to the filing of the related EER may also need to be extended. 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     | EER DOB Filing Date |
|------|--|-----------------------------|--------|---------|------------|-----------|---------------------|
| 1    | St. Mary's Recreational Ctr              | 450 St Anns Ave             | DPR    | 2003692 | 2025570001 | 56,125    | 12/24/13            |
| 2    | Murray Bergtraum HS                      | 411 Pearl St                | DOE    | 1001388 | 1001130100 | 305,000   | 12/24/13            |
| 3    | PS 8                                     | 100 Lindenwood Rd           | DOE    | 5066295 | 5052210001 | 60,000    | 12/20/13            |
| 4    | 26th Repair Shop                         | 640 West 26th St            | DSNY   | 1012267 | 1006700050 | 205,000   | 12/27/13            |
| 5    | 122nd Police Precinct                    | 2320 Hylan Blvd             | NYPD   | 5107580 | 5039060001 | 51,439    | 12/27/13            |
| 6    | Brooklyn Central Court                   | 120 Schermerhorn St         | DCAS   | 3000534 | 3001690017 | 264,000   | 12/27/13            |
| 7    | Queens Borough Hall                      | 120-55 Queens Blvd          | DCAS   | 4052812 | 4022740002 | 261,000   | 12/27/13            |
| 8    | Manhattan Criminal Court                 | 100 Centre St               | DCAS   | 1079000 | 1001670001 | 795,700   | 12/27/13            |
| 9    | Police Headquarters                      | 1 Police Plz                | NYPD   | 1079143 | 1001190001 | 751,908   | 12/27/13            |
| 10   | Public Health Lab                        | 455 1st Ave                 | DOHMH  | 1020610 | 1009320017 | 260,308   | 12/27/13            |
| 11   | Humanities & Social Sc Lib               | 476 5th Ave                 | NYPL   | 1034194 | 1012570001 | 600,000   | 12/27/13            |
| 12   | 158th St. Fleet Svc's Shop               | 675 West 158th St           | DOT    | 1087614 | 1021340218 | 94,200    | 12/30/13            |
| 13   | 100 Gold St.                             | 100 Gold St                 | DCAS   | 1001289 | 1000940025 | 594,000   | 12/27/13            |
| 14   | Woodside Insp. Facility                  | 24-55 Brooklyn-Queens Expwy | TLC    | 4022499 | 4010160045 | 51,979    | 12/27/13            |
| 15   | Brooklyn Heights Branch                  | 280 Cadman Plz West         | BPL    | 3001939 | 3002390016 | 62,917    | 12/27/13            |
| 16   | Mario Merola /County Court               | 851 Grand Concourse         | DCAS   | 2002869 | 2024680001 | 555,859   | 12/27/13            |
| 17   | Co-op City (PS 153, 178, 180, 181 & 455) | 650-850 Baychester Ave      | DOE    | 2097470 | 2051410150 | 1,190,650 | 12/31/13            |
| 18   | X174                                     | 456 White Plains Rd         | DOE    | 2020580 | 2034780018 | 202,880   | 12/30/13            |
| 19   | X129                                     | 2055 Mapes Ave              | DOE    | 2012957 | 2031090001 | 148,475   | 12/31/13            |
| 20   | Brooklyn Supreme Court                   | 292-360 Adams St            | DCAS   | 3000257 | 3001390020 | 823,584   | 12/30/13            |
| 21   | Queens Criminal Court                    | 125-01 Queens Blvd          | DCAS   | 4206522 | 4096530001 | 648,000   | 12/30/13            |
| 22   | K009                                     | 80 Underhill Ave            | DOE    | 3028204 | 3011450026 | 139,375   | 12/26/13            |
| 23   | Q020                                     | 142-30 Barclay Ave          | DOE    | 4114657 | 4050470001 | 156,175   | 12/30/13            |
| 24   | Q120                                     | 58-01 136th St              | DOE    | 4139491 | 4063730001 | 111,725   | 12/30/13            |
| 25   | Q125                                     | 46-02 47th Ave              | DOE    | 4052874 | 4022840006 | 164,683   | 12/20/14            |
| 26   | K302                                     | 350 Linwood St              | DOE    | 3088357 | 3039690001 | 209,275   | 12/31/13            |
| 27   | M199                                     | 270 West 70th St            | DOE    | 1030351 | 1011580040 | 105,700   | 12/31/13            |
| 28   | K126                                     | 424 Leonard St              | DOE    | 3067788 | 3027120001 | 160,925   | 12/31/13            |
| 29   | X054                                     | 2703 Webster Ave            | DOE    | 2113630 | 2032780014 | 98,980    | 12/30/13            |
| 30   | Q092                                     | 99-01 34 Ave                | DOE    | 4042496 | 4017140018 | 98,130    | 12/24/13            |
| 31   | K135                                     | 686 Linden Blvd             | DOE    | 3102005 | 3046730001 | 72,280    | 12/24/13            |

| ITEM | Facility Name              | Address                    | Agency | BIN     | BBL        | Sq Ft   | EER DOB Filing Date |
|------|----------------------------|----------------------------|--------|---------|------------|---------|---------------------|
| 32   | K067                       | 51 Saint Edwards St        | DOE    | 3332507 | 3020390002 | 138,125 | 12/30/13            |
| 33   | M721                       | 250 West Houston St        | DOE    | 1009757 | 1005810054 | 133,325 | 12/30/13            |
| 34   | R080                       | 715 Ocean Terrace          | DOE    | 5113169 | 5006830001 | 299,200 | 12/30/13            |
| 35   | K013                       | 557 Pennsylvania Ave       | DOE    | 3085070 | 3038230001 | 64,925  | 12/30/13            |
| 36   | M217                       | 645 Main St                | DOE    | 1084848 | 1013730001 | 115,085 | 12/24/13            |
| 37   | Bushwick Multi Service Ctr | 1420 Bushwick Ave          | HRA    | 3080067 | 3034440022 | 52,000  | 12/26/13            |
| 38   | 5-Boro Complex             | 1 Randalls Island          | DPR    | 1085920 | 1018190203 | 59,664  | 12/30/13            |
| 39   | M075                       | 735 West End Avenue        | DOE    | 1034190 | 1012530065 | 110,575 | 12/24/13            |
| 40   | X068                       | 4011 Monticello Avenue     | DOE    | 2067852 | 2049860081 | 94,860  | 12/30/13            |
| 41   | X078                       | 1400 Needham Avenue        | DOE    | 2060191 | 2047190001 | 109,280 | 12/30/13            |
| 42   | X111                       | 3740 Baychester Avenue     | DOE    | 2065992 | 2049160001 | 105,775 | 12/30/13            |
| 43   | X112                       | 1925 Schieffelin Ave       | DOE    | 2065991 | 2049050500 | 85,325  | 12/24/13            |
| 44   | X125                       | 1111 Pugsley Avenue        | DOE    | 2025717 | 2037900040 | 175,325 | 12/31/13            |
| 45   | X127                       | 1560 Purdy Avenue          | DOE    | 2041247 | 2039480055 | 153,725 | 12/24/13            |
| 46   | X131                       | 885 Bolton Avenue          | DOE    | 2103869 | 2036440001 | 184,975 | 12/27/13            |
| 47   | X142                       | 3750 Baychester Avenue     | DOE    | 2066190 | 2049350001 | 164,751 | 12/31/13            |
| 48   | K131                       | 4305 Fort Hamilton Parkway | DOE    | 3136085 | 3056030001 | 103,354 | 12/30/13            |
| 49   | K307                       | 209 York Street            | DOE    | 3000158 | 3000560007 | 111,744 | 12/24/13            |
| 50   | K318                       | 101 Walton Street          | DOE    | 3061328 | 3022460001 | 181,375 | 12/30/13            |
| 51   | Q021                       | 147-36 26th Avenue         | DOE    | 4108665 | 4048030001 | 125,260 | 12/24/13            |
| 52   | Q219                       | 144-39 Gravett Road        | DOE    | 4448708 | 4065070001 | 115,450 | 12/30/13            |
| 53   | Q238                       | 88-15 182nd Street         | DOE    | 4212425 | 4099190006 | 240,055 | 12/20/13            |
| 54   | K801                       | 65 Court Street            | DOE    | 3002557 | 3002660020 | 342,200 | 12/20/13            |
| 55   | M115                       | 586 West 117th Street      | DOE    | 1063228 | 1021330040 | 124,900 | 12/30/13            |
| 56   | K218                       | 370 Fountain Avenue        | DOE    | 3095977 | 3042780001 | 181,325 | 12/23/13            |
| 57   | K115                       | 1500 East 92 Street        | DOE    | 3232559 | 3082560001 | 123,000 | 12/24/13            |
| 58   | K181                       | 1023 New York Avenue       | DOE    | 3327776 | 3049040010 | 153,725 | 12/30/13            |
| 59   | M043                       | 509 West 129th Street      | DOE    | 1059723 | 1019840033 | 135,000 | 12/24/13            |
| 60   | M540 A Philip Randolph HS  | 443 West 135 Street        | DOE    | 1059409 | 1019570078 | 163,000 | 12/30/13            |
| 61   | K010                       | 511 7th Avenue             | DOE    | 3016509 | 3008690001 | 77,000  | 12/24/13            |
| 62   | K033                       | 70 Thompkins Avenue        | DOE    | 3048517 | 3017430018 | 175,300 | 12/31/13            |
| 63   | K081                       | 990 Dekalb Avenue          | DOE    | 3043248 | 3016020019 | 130,925 | 12/26/13            |
| 64   | K220                       | 4812 9th Avenue            | DOE    | 3012824 | 3007780023 | 109,000 | 12/24/13            |

| ITEM | Facility Name                    | Address                     | Agency | BIN     | BBL        | Sq Ft   | EER DOB Filing Date |
|------|----------------------------------|-----------------------------|--------|---------|------------|---------|---------------------|
| 65   | East Harlem Multi Srvce Ctr      | 413 East 120th St           | HRA    | 1054888 | 1018080008 | 93,441  | 12/24/13            |
| 66   | Roy Wilkins Recreation Ctr       | Baisley Blvd & Merrick Blvd | DPR    | 4268835 | 4124060180 | 60,000  | 12/24/13            |
| 67   | M099                             | 410 East 100th Street       | DOE    | 1052998 | 1016930001 | 115,000 | 12/30/13            |
| 68   | M022                             | 111 Columbia Street         | DOE    | 1004070 | 1003350001 | 151,000 | 12/31/13            |
| 69   | X057                             | 2111 Crotona Ave            | DOE    | 2012359 | 2030810026 | 91,280  | 12/24/13            |
| 70   | X104                             | 1449 Shakespeare Ave        | DOE    | 2088263 | 2028730027 | 124,900 | 12/30/13            |
| 71   | K138                             | 760 Prospect Place          | DOE    | 3330794 | 3012330026 | 164,525 | 12/31/13            |
| 72   | K383                             | 1300 Greene Avenue          | DOE    | 3075413 | 3032980001 | 211,375 | 12/31/13            |
| 73   | K225                             | 1075 Ocean View Avenue      | DOE    | 3245498 | 3087120056 | 102,000 | 12/24/13            |
| 74   | R044                             | 80 Maple Parkway            | DOE    | 5027641 | 5012180001 | 116,500 | 12/30/13            |
| 75   | M025                             | 145 Stanton Street          | DOE    | 1004323 | 1003540080 | 160,000 | 12/24/13            |
| 76   | M084                             | 32 West 92 Street           | DOE    | 1081042 | 1012050006 | 104,525 | 12/31/13            |
| 77   | X039                             | 965 Longwood Avenue         | DOE    | 2005616 | 2027100001 | 102,100 | 12/24/13            |
| 78   | Q600                             | 37-02 47th Avenue           | DOE    | 4003259 | 4002280020 | 195,785 | 12/31/13            |
| 79   | M600                             | 225 West 24th Street        | DOE    | 1014174 | 1007740019 | 363,130 | 12/31/13            |
| 80   | Brooklyn Public Library          | 10 Grand Army Plz           | BPL    | 3029665 | 301183002  | 350,000 | 2/10/14             |
| 81   | Bronx Housing Court              | 1118 Grand Concourse        | DCAS   | 2101266 | 2024620039 | 99,000  | 12/23/13            |
| 82   | Bronx Concourse Plaza            | 198 East 161 Street         | DCAS   | 2099027 | 2024430094 | 231,190 | 12/27/13            |
| 83   | Bronx Bergen Building            | 1932 Arthur Ave             | DCAS   | 2009911 | 2029470018 | 90,000  | 12/23/13            |
| 84   | Mark A. Constantino Judicial Ctr | 130 Stuyvesant              | DCAS   | 5000085 | 5000080070 | 150,300 | 12/23/13            |
| 85   | Manhattan Supreme Court          | 60 Centre St                | DCAS   | 1085748 | 1001600021 | 322,300 | 12/27/13            |
| 86   | Sun Building                     | 280 Broadway                | DCAS   | 1079215 | 1001531002 | 242,062 | 12/27/13            |
| 87   | Long Island City Courthouse      | 25-10 Court Sq              | DCAS   | 4000698 | 4000830001 | 59,300  | 12/23/13            |
| 88   | Queens Civil Court               | 89-17 Sutphin Blvd          | DCAS   | 4448759 | 4096800001 | 320,535 | 12/24/13            |
| 89   | Louis J. Lefkowitz Building      | 80 Centre St                | DCAS   | 1001830 | 1001660027 | 472,500 | 12/27/13            |
| 90   | Manhattan Civil Court            | 111 Centre St               | DCAS   | 1001833 | 1001690010 | 467,000 | 12/24/13            |
| 91   | Excelsior Building               | 137 Centre St               | DCAS   | 1002358 | 1001970017 | 59,000  | 12/24/13            |
| 92   | Health Building                  | 125 Worth St                | DCAS   | 1001831 | 1001680032 | 406,109 | 12/24/13            |
| 93   | Bronx Family & Criminal Court    | 215 East 161st St           | DCAS   | 2002704 | 2024540001 | 490,000 | 12/24/13            |
| 94   | Staten Island Borough Hall       | 10 Richmond Ter             | DCAS   | 5000063 | 5000070001 | 81,538  | 12/24/13            |
| 95   | Queens Supreme Court             | 88-11 Sutphin Blvd          | DCAS   | 4207071 | 4096910001 | 308,200 | 12/24/13            |
| 96   | Manhattan Family Court           | 60 Lafayette St             | DCAS   | 1001842 | 1001710031 | 491,000 | 12/24/13            |

| ITEM | Facility Name                       | Address                              | Agency | BIN     | BBL        | Sq Ft     | EER DOB Filing Date |
|------|-------------------------------------|--------------------------------------|--------|---------|------------|-----------|---------------------|
| 97   | Off. of Emergency Mgmt. HQ          | 165 Cadman Plz East                  | DCAS   | 3000172 | 4000850006 | 66,245    | 12/27/13            |
| 98   | Manhattan Appellate Court           | 27 Madison Ave                       | DCAS   | 1016743 | 1008550001 | 54,300    | 12/24/13            |
| 99   | Bellevue Men's Shelter              | 400 East 30th Street                 | DHS    | 1087298 | 1009620097 | 277,076   | 12/27/13            |
| 100  | Regent Hotel Shelter                | 2720 Broadway                        | DHS    | 1056586 | 1018760020 | 102,275   | 12/27/13            |
| 101  | Franklin Women's Shelter            | 1122 Franklin Ave                    | DHS    | 2004260 | 2026130001 | 97,000    | 12/27/13            |
| 102  | Atlantic Ave Men's Shelter          | 1322 Bedford Ave                     | DHS    | 3029748 | 3011990015 | 164,320   | 12/27/13            |
| 103  | PATH Office                         | 346 Powers Ave                       | DHS    | 2091301 | 2025720006 | 72,000    | 12/30/13            |
| 104  | Ft Washington Arm.-Shelter          | 216 Ft Washington Ave                | DHS    | 1063381 | 1021380079 | 88,519    | 12/24/13            |
| 105  | Borden Avenue Shelter               | 21-10 Borden Ave                     | DHS    | 4000526 | 4000680002 | 55,000    | 12/24/13            |
| 106  | Briarwood Residence                 | 80-20 134th St                       | DHS    | 4314908 | 4096620020 | 50,000    | 12/24/13            |
| 107  | Manhattan House of Detention        | 125 White St                         | DOC    | 1079000 | 1001670001 | 1,079,000 | 12/24/13            |
| 108  | George R. Vierno Ctr (GRVC)         | 9-9 Hazen St                         | DOC    | 2096863 | 4026050040 | 458,000   | 12/23/13            |
| 109  | Otis Bantun Correctional Ctr (OBCC) | Riker's Island                       | DOC    | 9999999 | 2999999999 | 344,632   | 12/23/13            |
| 110  | Rose M. Singer (RMSC)               | 19-19 Hazen St                       | DOC    | 9999999 | 2999999999 | 291,000   | 12/24/13            |
| 111  | George Motchan Det Ctr (GMDC)       | 15-15 Hazen St                       | DOC    | 2097042 | 4026050040 | 533,491   | 12/24/13            |
| 112  | Eric M. Taylor Center (EMTC)        | 10-10 Hazen St                       | DOC    | 9999999 | 4026050040 | 484,407   | 12/24/13            |
| 113  | Vernon C. Bain Center (VCBC)        | 1 Halleck St                         | DOC    | 2101256 | 2027800073 | 310,000   | 12/27/13            |
| 114  | Maspeth Central Shops               | 58-50 57th Rd                        | DOT    | 4805470 | 4026750015 | 117,000   | 12/27/13            |
| 115  | Chelsea Recreational Center         | 430 West 25th Street                 | DPR    | 1012811 | 1007220057 | 83,940    | 12/24/13            |
| 116  | Brownsville Rec. Ctr                | 598 Christopher Ave                  | DPR    | 3085992 | 3038680002 | 72,000    | 12/23/13            |
| 117  | Asphalt Green Rec. Ctr              | 1750 AquaCenter York Ave             | DPR    | 1085696 | 1015870001 | 56,000    | 12/23/13            |
| 118  | Ranaqua Shops and Garage            | 1900 Birchall Ave                    | DPR    | 2101004 | 2043330001 | 70,000    | 12/23/13            |
| 119  | Queens West 2,3,4,6 DG; CRS         | 52-35 58th Street                    | DSNY   | 4462505 | 4023610268 | 550,000   | 12/27/13            |
| 120  | Cioffe Borough Repair Shop          | 106-01 Ave D                         | DSNY   | 3252759 | 3038710001 | 75,000    | 12/23/13            |
| 121  | SI 3 District Garage; RBS           | Muldoon Ave, entrance to Fresh Kills | DSNY   | 5000000 | 5026850100 | 59,798    | 12/23/13            |
| 122  | Brooklyn W11G                       | 1824 Shore Parkway                   | DSNY   | 3378180 | 3069430002 | 75,000    | 12/23/13            |
| 123  | Brooklyn North 1, 4 DG              | 157-175 Varick St                    | DSNY   | 3070545 | 3029620005 | 79,305    | 12/27/13            |
| 124  | Manhattan 3 DG                      | South St Pier 36                     | DSNY   | 1805208 | 1002410013 | 55,330    | 12/27/13            |
| 125  | Queens 7/11 DG Annex                | 120-15 31st Ave                      | DSNY   | 4802407 | 4043460075 | 101,930   | 12/23/13            |
| 126  | Bronx 12 DG                         | 1643 East 233rd St                   | DSNY   | 2090261 | 2049740028 | 117,344   | 12/23/13            |
| 127  | Fort Totten                         | Various - See FDNY sheet             | FDNY   | 9999999 | 4059170001 | 421,996   | 12/24/13            |
| 128  | Fire Academy - Randalls             | Various - See FDNY sheet             | FDNY   | 1085640 | 1018190015 | 241,200   | 12/27/13            |

| ITEM | Facility Name              | Address                | Agency | BIN     | BBL        | Sq Ft   | EER DOB Filing Date |
|------|----------------------------|------------------------|--------|---------|------------|---------|---------------------|
| 129  | NYPD Command (BNN Div)     | 245 Glenmore Ave       | NYPD   | 3083636 | 3036980032 | 60,000  | 12/23/13            |
| 130  | Central Repair Shop (CRS)  | 53-15 58th St          | NYPD   | 4054276 | 4023610150 | 75,400  | 12/27/13            |
| 131  | 84th Precinct & Eng Co 207 | 301 Gold St            | NYPD   | 3000252 | 3001340006 | 50,000  | 12/23/13            |
| 132  | NYPD Precinct 67th         | 2820 Snyder Ave        | NYPD   | 3117400 | 3051110024 | 53,976  | 12/23/13            |
| 133  | NYPD Precinct 72nd         | 830 4th Ave            | NYPD   | 3009843 | 3006680029 | 53,600  | 12/24/13            |
| 134  | NYPD Precinct 81st         | 30 Ralph Ave           | NYPD   | 3044596 | 3016330039 | 58,745  | 12/27/13            |
| 135  | Police Acad/13th Precinct  | 230 East 21st St       | NYPD   | 1019613 | 1009010006 | 296,405 | 12/27/13            |
| 136  | NYPD Precinct 48th         | 450 Cross Bronx Expwy  | NYPD   | 2009509 | 2029070010 | 59,328  | 12/27/13            |
| 137  | NYPD Precinct 73rd         | 1470 East New York Ave | NYPD   | 3080735 | 3034970002 | 50,020  | 12/24/13            |
| 138  | K191                       | 1600 Park Place        | DOE    | 3036635 | 3013750012 | 92,480  | 12/31/13            |
| 139  | K251                       | 1037 E 54 St           | DOE    | 3214729 | 3077580001 | 91,280  | 12/31/13            |
| 140  | K276                       | 1070 East 83rd         | DOE    | 3225637 | 3080340001 | 282,180 | 12/31/13            |
| 141  | K279                       | 1070 East 104 St       | DOE    | 3326733 | 3082300001 | 124,925 | 12/31/13            |
| 142  | K287                       | 50 Navy St             | DOE    | 3000203 | 3001110001 | 98,725  | 12/24/13            |
| 143  | K321                       | 180 7th Ave            | DOE    | 3337516 | 3009710028 | 109,444 | 12/31/13            |
| 144  | K329                       | 2929 West 30th St      | DOE    | 3189517 | 3070510001 | 122,225 | 12/31/13            |
| 145  | K650                       | 257 N 6th St           | DOE    | 3062135 | 3023300011 | 224,525 | 12/24/13            |
| 146  | M019                       | 185 1st Ave            | DOE    | 1006478 | 1004530034 | 84,125  | 12/31/13            |
| 147  | M028                       | 475 West 155th St      | DOE    | 1076739 | 1021070026 | 122,525 | 12/24/13            |
| 148  | M054                       | 103 W 107th St         | DOE    | 1055990 | 1018620011 | 137,000 | 12/31/13            |
| 149  | Q011                       | 54-25 Skillman Ave     | DOE    | 4028447 | 4012390001 | 101,260 | 12/31/13            |
| 150  | Q191                       | 85-15 258 St           | DOE    | 4180083 | 4088010014 | 82,620  | 12/31/13            |
| 151  | Q205                       | 75-25 Bell Blvd        | DOE    | 4164007 | 4077530001 | 120,648 | 12/31/13            |
| 152  | Q225                       | 190 Beach 110th St     | DOE    | 4303853 | 4161810001 | 84,100  | 12/31/13            |
| 153  | R031                       | 55 Layton Ave          | DOE    | 5001150 | 5000490182 | 92,600  | 12/31/13            |
| 154  | R052                       | 450 Buel Ave           | DOE    | 5053746 | 5037050001 | 85,699  | 12/31/13            |
| 155  | X101                       | 2750 Lafayette Ave     | DOE    | 2080231 | 2055470001 | 182,525 | 12/31/13            |
| 156  | X121                       | 2750 Throop Ave        | DOE    | 2054253 | 2045260001 | 111,700 | 12/24/13            |
| 157  | X135                       | 2441 Wallace Ave       | DOE    | 2051313 | 2044320001 | 163,300 | 12/31/13            |
| 158  | M661                       | 240 2nd Ave            | DOE    | 1020416 | 1009210064 | 55,260  | 12/24/13            |
| 159  | University Ave Res         | 1041 University Ave    | DHS    | 2003496 | 2025270014 | 99,975  | 12/27/13            |
| 160  | K022                       | 442 St. Marks Avenue   | DOE    | 3028281 | 3011480050 | 105,925 | 12/30/14            |

| ITEM | Facility Name                | Address              | Agency | BIN     | BBL        | Sq Ft     | EER DOB Filing Date |
|------|------------------------------|----------------------|--------|---------|------------|-----------|---------------------|
| 161  | K185                         | 8601 Ridge Blvd      | DOE    | 3153416 | 3060430001 | 64,880    | 12/23/14            |
| 162  | K269                         | 1957 Nostrand Avenue | DOE    | 3113780 | 3049940023 | 97,300    | 12/30/14            |
| 163  | K849 and K839                | 4001 18th Avenue     | DOE    | 3127692 | 3054160048 | 57,180    | 06/30/15            |
| 164  | K902                         | 62 Park Place        | DOE    | 3259250 | 3009410050 | 92,480    | 12/30/14            |
| 165  | Q089                         | 85-28 Britton Avenue | DOE    | 4037370 | 4015140001 | 82,288    | 12/30/14            |
| 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  | K309                         | 794 Monroe Street    | DOE    | 3045047 | 3016430036 | 106,860   | 12/23/15            |
| 169  | Manhattan Municipal Building | 1 Centre St          | DCAS   | 1001394 | 1001210001 | 1,070,800 | 12/23/15            |
| 170  | Manhattan Surrogate's Court  | 31 Chambers St       | DCAS   | 1001670 | 1001530024 | 212,500   | 12/23/15            |
| 171  | Q081                         | 559 Cypress Ave      | DOE    | 4082076 | 4034370001 | 69,000    | 12/23/15            |
| 172  | Q154                         | 75-02 162nd St       | DOE    | 4148003 | 4068340001 | 91,260    | 12/23/15            |
| 173  | Q131 within (Q131,Q911)      | 170-45 84th Ave      | DOE    | 4211112 | 4098750001 | 73,232    | 12/23/15            |
| 174  | X015                         | 2195 Andrews Avenue  | DOE    | 2096013 | 2032240009 | 162,125   | 12/23/15            |
| 175  | Brooklyn Borough Hall        | 209 Joralemon St     | DCAS   | 3000256 | 3001390001 | 50,000    | 04/18/16            |
| 176  | Brooklyn Municipal Building  | 210 Joralemon St     | DCAS   | 3002558 | 3002660030 | 468,000   | 04/20/16            |
| 177  | M841                         | 466 West End Avenue  | DOE    | 1032754 | 1012300001 | 64,880    | 06/08/16            |
| 178  | Barbara Kleinman Residence   | 269 Skillman Ave     | DHS    | 3338306 | 3028850001 | 97,780    | 01/06/16            |

## **APPENDIX B: Measurement and Verification of Energy Reductions**

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The Energy Data Lab (EDL) at the CUNY Building Performance Lab (BPL) was tasked by NYC DCAS Energy Management (DEM) with analyzing a number of energy retrofit projects completed during FY16. EDL analyzed energy consumption data at the whole facility level for these projects, and found that the data demonstrate reduced energy usage where energy retrofit projects were completed and operational for at least one year.

### **Methodology**

Energy consumption data was provided to CUNY Building Performance Lab (BPL) in the form of a .csv file that contained billing data by meter for electric, gas and steam; as well as a limited amount of data from fuel oil delivery logs. The data were reviewed for gaps and outliers, and prepared for analysis: a raw data file was created for each facility that included electricity and fuel energy consumption data for 12 months prior to the retrofit start data and 12 months post-retrofit completion. 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 data file was used for analysis, with LaGuardia airport as the selected weather station.

The energy usage reduction analysis follows the Efficiency Valuation Organization's International Performance Measurement and Verification Protocol (IPMVP) Option C Whole Facility<sup>1</sup> measurement and verification (M&V) approach based on the monthly energy use data from the utility bills, and is also consistent with the methodology put forth in ASHRAE Guideline 14-2014, Measurement of Energy, Demand and Water Savings. This M&V approach requires that an empirical energy model between energy use and its main influencing parameter, which in this case is weather (outdoor air temperature), be developed to model baseline period energy use.

The baseline period is defined as the 12 months immediately preceding implementation of the energy conservation measures in the building. This model is then adjusted to post-installation conditions, using weather data (outdoor air temperature) from the post-installation period. The result 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, are the difference between the adjusted baseline use and the measured energy use for the post-install period.

It should be noted, that there may be some overlap between retrofit start/end dates and monthly energy consumption billing period start/end dates, due to the way in which utility meters are read and energy consumption is billed.

### **Case Studies**

#### **Case Study #1: Central Harlem Health Center**

**Project: Lighting Upgrade**

**Retrofit Dates: 5/1/2014-9/1/2014**

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<sup>1</sup> International Performance Measurement & Verification Protocol (IPMVP) – Core Concepts April 2016 EVO 10000 – 1:2016



The electric model in Figure 1a shows pre-installation baseline usage (blue line), actual post-installation usage (red line) and adjusted baseline usage (dotted pink line); the retrofit construction period is the gap in between the pre- and post-retrofit periods. According to this model, adjusted baseline usage during this period was estimated at 319,640 kWh, and actual usage was 268,800 kWh. As such, the electric reduction over the 12-month post-installation period (through August 2015) was: 50,840 kWh ± 34.6%, or 15.9% of adjusted baseline usage.

The project at this facility was a lighting retrofit. The lighting upgrade would be estimated to affect electric usage, with little effect (if any) on natural gas usage. The energy usage reduction models confirm the reduced electricity usage, and seem to indicate that this reduction primarily affected the electric baseload; this can be seen in the way the entire adjusted baseline usage is lower, yet the actual summer electric peak is still about the same relative magnitude as they would have been had no retrofit occurred, according to the adjusted baseline model.

As such, the data support the evidence of an overall decrease in electricity consumption from the baseline to the post-installation period, although the statistical metrics associated with the model convey a moderately high degree of uncertainty around the fit of the model to the data provided. It should be noted that actual electricity consumption is higher than the adjusted baseline around March 2015; the cause of this change in typical usage pattern is unknown.

The natural gas model in Figure 1b shows no significant difference in usage from the pre-retrofit to post-retrofit periods, confirming that the lighting upgrade had no perceptible effect on the fuel energy consumption.

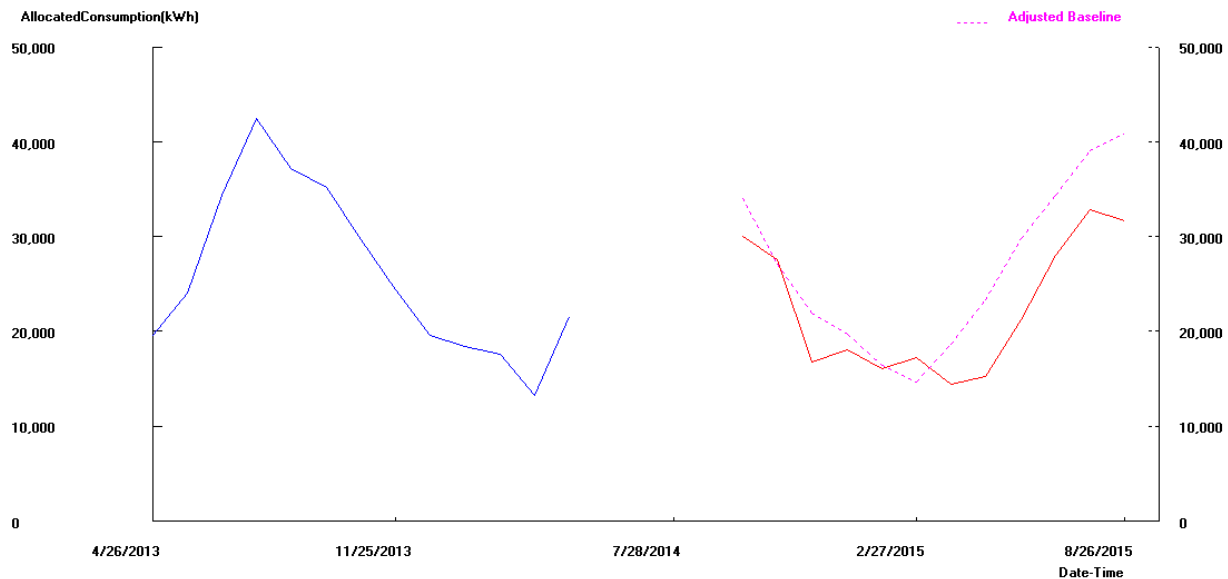


Figure 1a. Central Harlem Health Center – Electricity Reduction Model

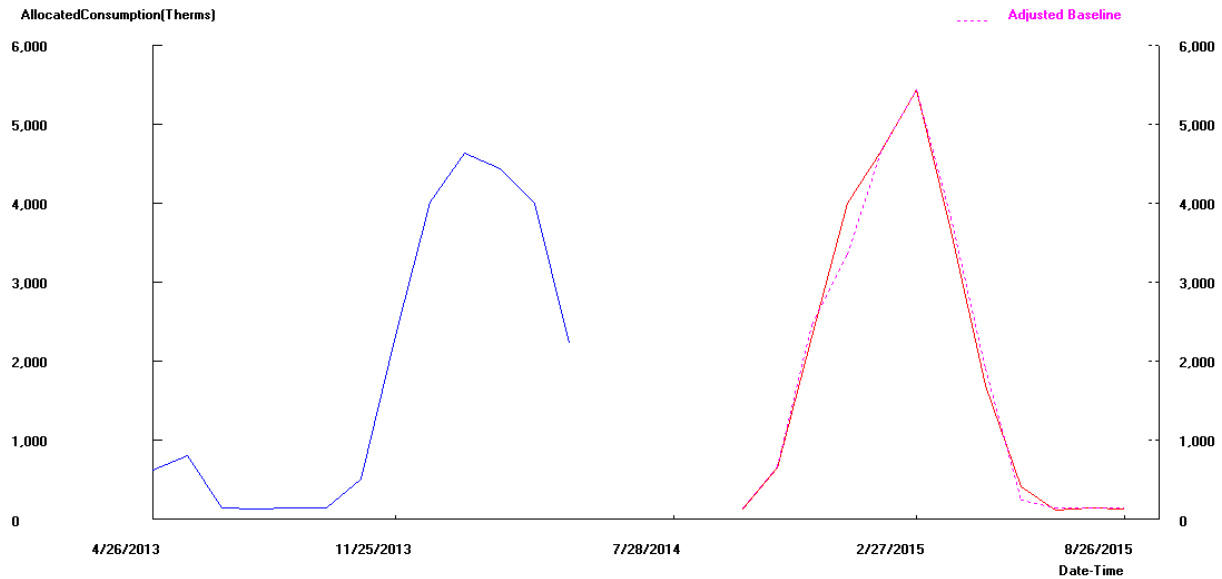


Figure 1b. Central Harlem Health Center – Natural Gas Reduction Model

## Case Study #2: Randall’s Island (Buildings 6 & 7)

### Project: High-Efficiency RTU Replacements

Retrofit Dates: 4/7/2015-7/1/2015

The electric model in Figure 2 shows pre-installation baseline usage (blue line), actual post-installation usage (red line) and adjusted baseline usage (dotted pink line); the retrofit construction period is the gap in between the pre- and post-retrofit periods. According to this model, adjusted baseline usage during this period was estimated at 449,220 kWh, and actual usage was 343,513 kWh. As such, the electric reduction over the 12-month post-installation period (through June 2016) was: 105,707 kWh ± 16.6%, or 23.5% of adjusted baseline usage. Note that the fuel energy was not modeled, as fuel oil is used at the facility and only delivery log data is available, which is not sufficient for a reliable model.

The project at this facility was replacement of current rooftop packaged units (RTUs) used for cooling with high-efficiency RTUs. This upgrade would be estimated to affect electric usage. The energy usage reduction models confirm the reduced electricity usage, and seem to indicate that this reduction yielded a slight overall reduction in electricity consumption, with a significant drop in summer peaks. It should be noted that there were a number of estimated electricity meter readings during the pre- and post-retrofit periods: March 2014, December 2015 and June 2016. Often, when readings are estimated for one month, we find actual readings for the following month that are higher than expected, to compensate for under-reporting during the estimated month. This would likely explain the unusual spikes in usage that are seen in the post-retrofit actual usage, which are higher than the adjusted baseline.

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

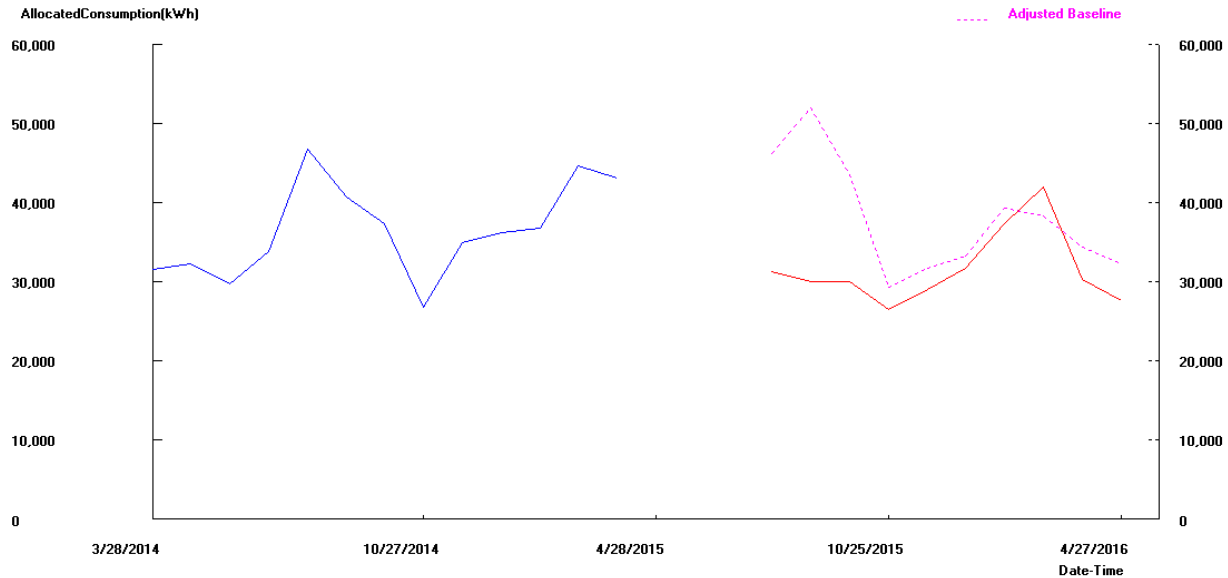


Figure 2. Randall's Island – Electricity Reduction Model

**Case Study #3: Asser Levy Pool**  
**Project: Lighting Retrofit**  
**Retrofit Dates: 5/4/2015-6/19/2015**

The electric model in Figure 3 shows pre-installation baseline usage (blue line), actual post-installation usage (red line) and adjusted baseline usage (dotted pink line); the retrofit construction period is the gap in between the pre- and post-retrofit periods. According to this model, adjusted baseline usage during this period was estimated at 374,595 kWh, and actual usage was 322,320 kWh. As such, the electric reduction over the 12-month post-installation period (through June 2016) was: 52,175 kWh ± 37.1%, or 13.9% of adjusted baseline usage.

The project at this facility was a lighting retrofit. The lighting upgrade would be estimated to affect electric usage, with little effect on fuel energy usage. The electricity usage reduction model confirms overall reduced electricity usage; however, the model shows some reduction in peak usage during summer 2015 and an uptick in usage again a year post-retrofit (summer 2016). There was an estimated electricity meter reading in October 2015 which might account for the drop in usage for that month; however, the overall usage pattern does not appear to be consistent with this type of retrofit. This could point to other physical or operational changes to at the facility (e.g., a change in operating hours for the pool) which might merit further investigation. The fuel energy was not modeled, as fuel oil is used at the facility and only delivery log data is available, which is not sufficient for a reliable model.

As such, the data support the evidence of an overall decrease in electricity consumption from the baseline to the post-installation period, although the statistical metrics associated with the model convey a moderately high degree of uncertainty around the fit of the model to the data provided. The higher degree of uncertainty might be caused by the unusual pattern in post-retrofit actual consumption.

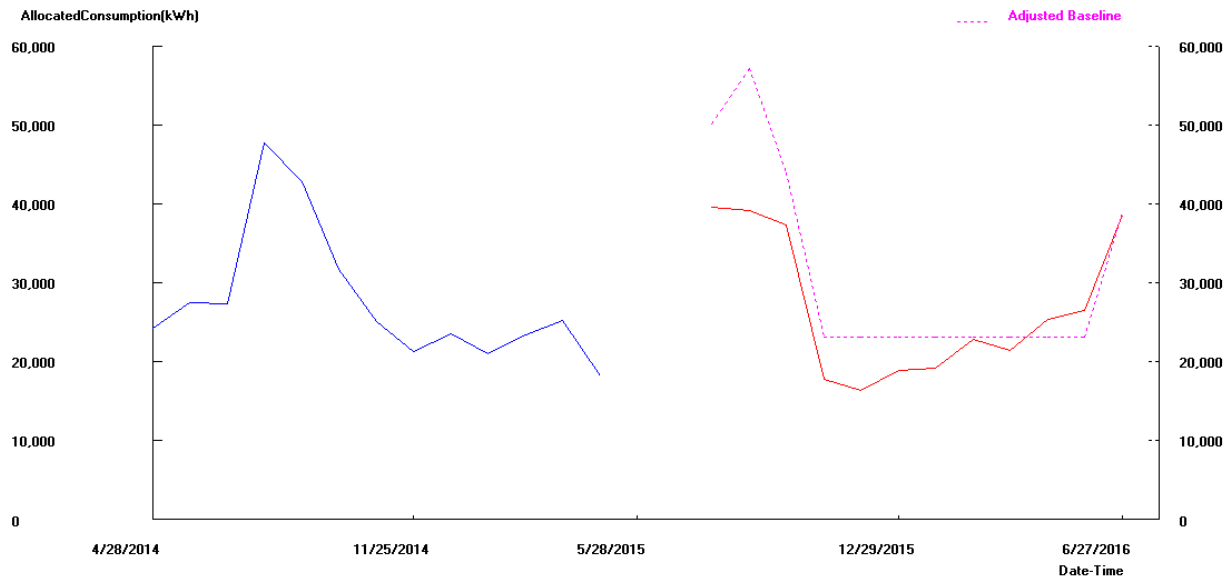


Figure 3. Asser Levy Recreation Center – Electricity Reduction Model

#### Case Study #4: Morrisania Health Center

**Project: Lighting upgrade**

**Retrofit Dates: 9/1/2014-3/1/2015**

The electricity model in Figure 4a shows pre-installation baseline usage (blue line), actual post-installation usage (red line) and adjusted baseline usage (dotted pink line); the retrofit construction period is the gap in between to pre- and post-retrofit periods. According to this model, adjusted baseline usage during this period was estimated at 925,078 kWh, and actual usage was 824,400 kWh. As such, the electric reduction over the 12-month post-installation period (through February 2016) was: 100,678 kWh ± 30.2%, or 10.9% of adjusted baseline savings.

The project at this facility was a lighting retrofit. The energy usage reduction models confirm the reduced electricity usage, and seem to indicate that this reduction primarily affected the electric baseload; this can be seen in the way the entire adjusted baseline usage is lower, yet the actual summer electric peak is still about the same relative magnitude as it would have been had no retrofit occurred, according to the adjusted baseline model.

As such, the data support the evidence of an overall decrease in electricity consumption from the baseline to the post-installation period, although the statistical metrics associated with the model convey a moderately high degree of uncertainty around the fit of the model to the data provided. It

should be noted that there were estimated electricity utility meter readings for the month of January 2016, which might account for the uncharacteristic usage pattern seen around that time.

The natural gas model in Figure 4b shows no significant difference in usage from the pre-retrofit to post-retrofit periods, confirming that the lighting upgrade had no perceptible effect on the fuel energy consumption.

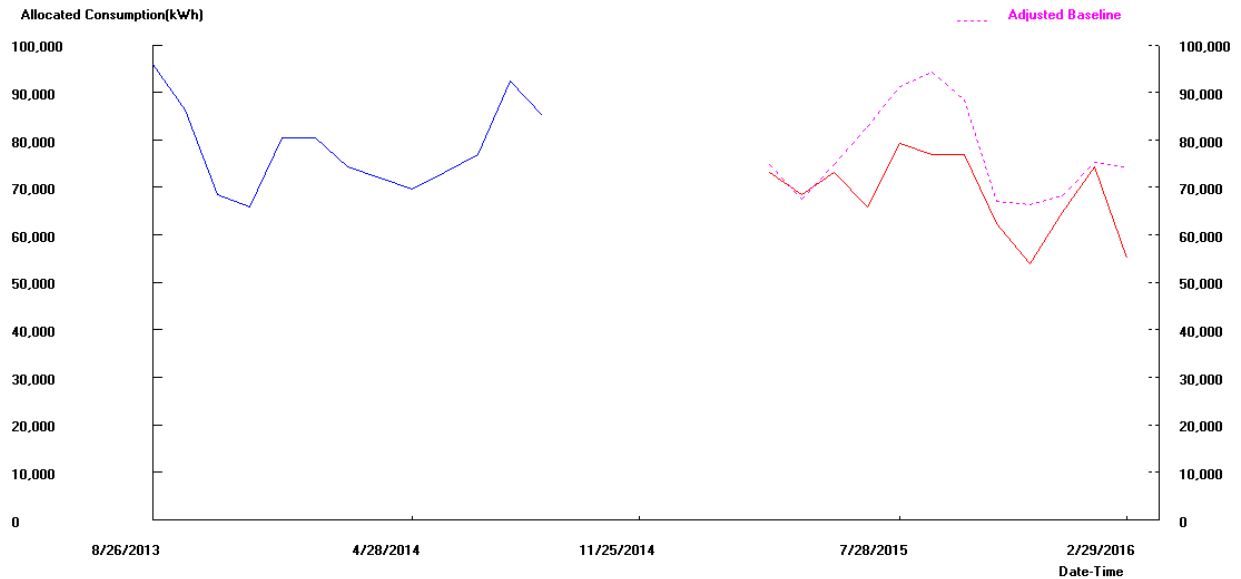


Figure 4a. Morrisania Health Center – Electricity Reduction Model

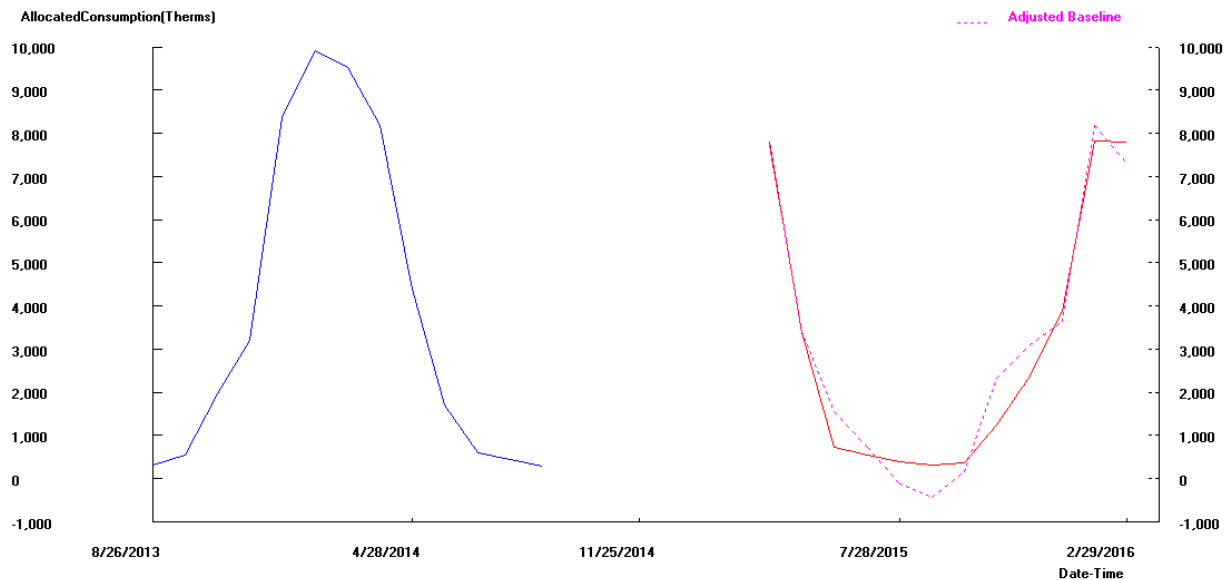


Figure 3b. Morrisania Health Center – Natural Gas Reduction Model