BUILDING *performance* LAB
CUNY INSTITUTE FOR URBAN SYSTEMS
CITY UNIVERSITY OF NEW YORK

Dr. Robert E. Paaswell, Executive Director, CIUS
Michael Bobker, Executive Director, Building Performance Lab

101 West 31st St. 7th Fl., New York, NY 10001
cunybpl.org

MEMO

TO: Ellen Zielinski, Steve Lochner, DCAS
FROM: Kathy Careddu
PREPARED BY: Joan Gomez, Joe Silver
REVIEWED BY: Michael Bobker, CEM
RE: Intellidyne Final Savings Report
DATE: November 24, 2015

OVERVIEW

Intellidyne installed a series of Light Commercial Hot Water (LCH), Commercial Hot Water (CHW), and Commercial Air Conditioning (CAC) controls across four sites in DCAS' portfolio. The controls optimize equipment cycles based on proprietary algorithms. The vendor reports of substantial savings are generally validated by our review, with exceptions noted below. Vendor reported savings are based on measurement of unit run-times, considered an effective proxy for actual energy measurement. Validation by whole-building energy usage was not possible as baseline energy data available did not provide valid baseline models at any of the sites.

Summary Table of Savings

(Values are savings as measured by unit run-time.)

Location	Type of Unit	Application	Savings (%) Intellidyne Value	Savings (%) BPL Value	BPL Notes
NYPD - 112th Precinct	Hot Water Boiler	Space Heating	12.04	12.04	Accepted
NYPD - 112th Precinct	DHW Boiler	Domestic HW	29.36	-25*	Savings Decrease
Brooklyn Recreation Ctr.	Boilers, 2	Heating DHW & Pool	17.91 / 23.04	17.91	Accepted
Brooklyn Recreation Ctr.	RTU 1	Heating / Cooling	8.32 / 11.39	8.32	Accepted
Brooklyn Recreation Ctr.	RTU 2	Heating / Cooling	11.11 / 18.86	11.11	Accepted
Brooklyn Recreation Ctr.	RTU 3	Heating / Cooling	12.07 / 19.98	12.07 / 19.98	Accepted
Brooklyn Recreation Ctr.	RTU 4	Heating / Cooling	13.48 / 9.99	13.48 / 9.99	Accepted
Brooklyn Recreation Ctr.	RTU 5	Heating / Cooling	10.34 / N/A[1]	10.34 / N/A[1]	Accepted
Brooklyn Recreation Ctr.	Boiler	Heating	16.92	16.92	Accepted
Brooklyn Recreation Ctr.	Carrier Air Conditioner	Cooling	N/A[2]	N/A[2]	Accepted
FDNY - Red Hook	Boiler	Heating	N/A[3]	N/A[3]	Accepted
FDNY - Bronx	RTU	Cooling	7.9	6.78**	Savings Decrease
FDNY - Bronx	Boiler	Heating	23.63	14.89***	Savigns Decrease

[1] Savings were indeterminate because the heater barely ran during the test period.
[2] Savings were indeterminate because the compressors did not run during the test period.
[3] Savings could not be calculated due to reported interferences at the site that inhibited use of the controls.
* Initial savings calculated by Intellidyne ignored what appear to be outliers in water usage, which overestimated savings. The number given here is re-calculation after removing the 6 outliers.
** Initial savings calculated by Intellidyne had errors in cooling degree day calculations, which led to overestimated savings. The number given here is a re-calculation after correcting said errors.
*** Initial savings calculated by Intellidyne had errors in heating degree day calculations, which led to overestimated savings. The number given here is re-calculation after correcting said errors.

In the case of space cooling or heating, data was normalized by cooling degree days (CDD) and heating degree days (HDD) respectively. For domestic hot water use, data was normalized by gallons of water flow, using digital flow meters. BPL found discrepancies in run time reductions in the domestic hot water normalization in the NYPD – 112th Precinct, as well as an error in HDD and CDD calculations for the FDNY Engine Company 50 (Bronx) building.

We recommend that these, and other minor errors (details below) are updated, before the savings report is released.

M&V EVALUATION

- Pre-Retrofit Analysis
  - *M&V Plan and Baseline Calculations*

    Intellidyne installed their building systems control technology in four buildings, and collected data from August 2014 through September 2015. In total, they installed 19 controllers/economizers across all the sites, in boilers, domestic hot water heaters (DHW), roof top units (RTU), and a commercial air conditioner (CAC). Whole building analysis was not possible for any building, as analysis of prior year energy consumption, performed by BPL, showed high degrees of uncertainty in the data. Therefore, Intellidyne's measurement and verification protocol followed IPMVP Option A: Retrofit Isolation. Baseline calculations were measured by turning off Intellidyne controls on alternating days. Savings were calculated by measuring run time (RT) on systems with Intellidyne controls, and comparing to baseline days when controls were turned off.[1]

    For all controls instances, except the one on a DHW heater, savings calculations were normalized using heating degree days (HDD) and cooling degree days (CDD) respectively. DHW measurements were normalized by daily DHW flow in gallons per day, per BPL recommendation.

- Installation Phase
  - *Technology Implementation*

    Intellidyne controls were installed and training conducted at four sites. However, one site, the FDNY Engine Company 202 in Red Hook, suffered interference which prevented accurate savings analysis. Intellidyne's control unit was continuously removed or set to standby. In future installations, BPL recommends further work be devoted to training on-site maintenance staff or tenants, where relevant.

  - *Data Collection and Presentation*

    Data was collected and presented in extensive excel documents. We found what appear to be two minor errors in these documents, unrelated to energy savings calculations, that should be updated in the final report.
    - Brownsville Recreation Center - DHW report says only 92 days were tested, but actually 168 days were tested, the whole winter season. Vendor must justify or correct.

[1] On-off measurement is suitable for systems with constant flow rate and/or power draw. All equipment in this pilot meet this criteria. Such measurement is not suitable for equipment that modulates or has variable speed control.

- All sites - Burner usage factor calculations need to be updated to accurately reflect the number of boilers for each site. It appears the default value was left at 3. Vendor must justify or correct.

- Post-Retrofit Analysis
  - *Energy Savings*

In order to determine the savings, the vendor compares the two consumption cases (IntelliCon "in" and "out" of circuit). From that information the vendor can deduce with a high degree of confidence what the consumption for the "in" circuit portion of the testing would have been without the additional control (i.e. – the "baseline" for M&V purposes).

BPL has found these vendor savings calculations, as a percentage of system run time, to be generally accurate. However, in the case of specific systems, we have found errors in computation that need to be updated in a final report (see below).

- NYPD – 112th Precinct: For this site, the vendor reports domestic hot water boiler savings of 29.36%. The run-time for the DHW boiler in this facility is normalized by the gallons used during the test period, 6/25/2014 to 10/15/2014[2]. The average domestic hot water consumption was 268 gallons per day, with a runtime of 2751 seconds. However, there are six days during this period when the amount used far exceeds the average usage without running longer than average (even on off days):

  - 7/8/2014 (on day) = 4105 gallons used with a RT = 2621 seconds
  - 8/30/2014 (off day) = 1083 gallons used with a RT = 1966 seconds
  - 9/2/2014 (on day) = 1209 gallons used with a RT = 2340 seconds
  - 9/6/2014 (on day) = 1714 gallons used with a RT = 1849 seconds
  - 9/17/2014 (off day) = 1112 gallons used with a RT = 2361 seconds
  - 9/18/2014 (on day) = 2780 gallons used with a RT = 2468 seconds

We suggest these anomalous readings to be caused by water meter / meter read errors that should be excluded, as they significantly skew the savings analysis results.

Four of the six days of high usage periods are days when the IntelliCon was on ("in-circuit"). If this were reversed, which is quite possible as these outlier days seem to be random and arbitrary, the system would have seen considerable negative savings (around -85%). When these dates are removed, savings still remain negative, at -25%. With these figures in mind, BPL recommends that these dates be considered outliers, and removed from the energy savings report. It is quite possible that leaks or system malfunction are to blame for the presence of negative savings in this unit. Therefore, DCAS should decide whether or not to report savings for this unit, due to these potential errors.

- FDNY – Engine Company 50 (Bronx): For this facility, the controller on the space heating boiler demonstrated 23.63% savings. This value is calculated using the total run-time for the boiler

[2] Test data is limited to this part of the demonstration period as high volume of leaks during earlier parts of the period make the data non-representative.

normalized by the amount of HDD during the test period. However, in the excel worksheet (OAT tab) it was found an inconsistency when calculating the HHDs. For the occupied hours, the cell containing the balance point that is used for the calculation, was included into a table format that is preventing excel from doing the right calculation. As a result, negative HDDs are being created and therefore when the final summation is performed the resulting value is lower than what it should have been. The same situation is observed for on and off days. When this calculation is corrected, savings yield a value around 15% for heating and 7% for cooling. BPL recommends this calculation to be corrected in the final savings report.

- FDNY – Engine Company 202 (Red Hook): Because of onsite interference, accurate savings calculations were not possible.

- Brownsville Recreation Center: This site showed substantial savings in all units except for two which did not run long enough for accurate savings calculations to be measured.

- Whole Building Energy Analysis: For all sites, we would have liked to see a whole building analysis completed, in order to compare run-time savings to actual energy savings. However, energy consumption data for all sites prior to the installations proved to be of poor quality and did not allow construction of validated baseline models.

FINAL RECOMMENDATIONS & CONCLUSIONS

Vendor should update their report to make the following adjustments:

- Reflect the BPL recommended changes to the NYPD – 112th Precinct and the FDNY Engine Company 50 (Bronx) sites.

- Correct usage factor calculations to properly reflect the number of boilers in each report and the domestic hot water report should be updated to reflect the corrected number of sample days as well as re-calculated savings.

- Use BPL's table in this memo or correct their table which has inconsistent placement of heating and cooling percentage savings.

Savings at the one DHW instance were not verified. This should be subject to further discussion with the vendor and possible further testing.

We note that all controlled equipment in the pilot were fixed-rate, on-off devices. Such equipment matches load requirements by on-off duty cycling. The control logic is more complex for modulating devices, motors with variable-speed drives, and modular staged equipment (boilers, refrigeration/ac compressors) and Intellidyne control logic for such equipment has not been tested by this demonstration.

Additionally, and outside the scope of Intellidyne control and this demonstration project, we observe that the presence of a high balance point for HDD calculations at NYPD 112th Precinct and a low balance point for CDD calculation at FDNY Engine Company 50, which may be representative

of building issues at those sites, such as high infiltration/ventilation and/or poor envelope insulation. The data shows that the former is heating the building when the OAT is in the mid-70s and the latter is still cooling the building when the OAT is in the mid 50's. Therefore, there may be additional energy savings opportunities that should be investigated.

Replicability

This technology is well suited for buildings with high heating and/or cooling consumption and fixed-rate (on/off) mechanical equipment; the pilot does not support deployment for domestic water heating (DHW) without further testing and analysis. Its simple installation requires no re-work to equipment or systems. It may be especially suitable for smaller facilities where extensive control up-grades are unlikely to be undertaken. It may be especially suitable for application where loads are reduced by other measures but mechanical equipment is not re-sized and replaced to match the reduced loads.

Replicability of the product/technology may be limited as follows:

- Buildings with robust Building Automation System (BAS) or other form of programmable control that may be capable of adjusting boiler or RTU cycling based on outdoor and indoor space air temperatures.
- Sites with modulating boilers and/or variable speed motor controls and/or units with multiple, staged compressors, where on-off cycling logic is less applicable and the operation of the proprietary control logic has not as yet been demonstrated.

Replication is also sensitive to manual override by onsite staff and maintenance. Therefore, significant effort should be made to educate or train said staff in order to prevent such interference.