Teme Building – 3 Port Valve

Measurement & Verification Plan

June 2018

Contents

1. ECM Intent

1.1 The energy conservation measure (ECM) involves installation of a 3 port diverting valve in the heating pipe work. The purpose of the energy conservation project is to enable temperature controls reducing the flow temperature as the building heats up. Heating temperature controls are managed through a Buderus interface allowing compensator slope controllability from within the plant room.

1.2 Operational verification of the ECM will be obtained through commissioning of equipment as part of the 3 port valve installation.

2. Selected IPMVP Option and Measurement Boundary

2.1 Measurement and Verification of ECM will use Option C from IPMVP (IPMVP Volume I EVO 10000-1:2012) to determine avoided energy. Total gas consumption for Teme building will be used as the measurement to determine savings. Building level gas consumption will be used to determine avoided energy obtained from the buildings main gas sub meter. Option C has been selected as the installation will have an impact on gas consumption for the whole of the building. The building has a sub-metered gas meter which captures building wide gas consumption

3. Baseline: Period, Energy and Conditions

3.1 The baseline period will be twelve months preceding the start of the ECM installation, between the periods 1st June 2016 to 31st May 2017.

3.2 For the purpose of accurate baselining, three weeks consumption data for the festive holiday period have been removed from the baseline data as this period has very low occupancy which has a negative effect on the correlation of data with prevailing weather conditions, due to the reduced heating and hot water demand during these times. Consumption and savings during this period will be monitored and reported for on a like for like basis.

3.3 The baseline gas consumption data will be collated from the DynamatPlus aM&T system which hosts and archives the buildings gas sub-metered data. Gas consumption data will be collated into weekly units. There will be no routine adjustments made to the gas consumption data obtained from DynamatPlus.

3.4 Baseline data will coincide with Heating Degree Days (HDD) acting as the independent variable.

3.5 Static factors include occupancy type (student residential), occupancy periods (tenancy length) and operating conditions (all other non-heating related equipment to remain the same). The buildings size, type and envelope are considered unchanged and static factor in the method.

4. Reporting Period

4.1 The reporting period for the ECM shall be 3 years from the date of practical completion of installation.

5. Basis for Adjustment

5.1 All energy measurements will undergo routine adjustments based on weather related data (i.e. heating degree days at 15.5°C base temperature). Weather-based components are determined using actual climate data obtained from www.degreedays.net. HDD data will be obtained for weather station 'IWORCEST54: St. Johns, Worcester, Worcester, GB (2.24W,52.18N) (8mi/13km)'. There will be no routine adjustments made to the climate data.

5.2 Savings will be reported as avoided energy use as per equation 1b of IPMVP Volume I EVO 10000-1:2012 where:

Avoided Energy Use (or Savings) = Adjusted-Baseline Energy – Reporting-Period Energy (±Non-Routine Adjustments of baseline energy to reporting-period conditions)

6. Analysis Procedure

6.1 All baseline period energy will be adjusted using the following model:

Y = 137.32 + (24.47 x HDD)

Where:

Y = Adjusted baseline energy (in kWh)

137.32 = one fixed coefficient unrelated to the *independent variables* (i.e. the non-heating related baseload in kWh)

24.47 = heating degree day derived coefficient (i.e. weekly kWh increase in consumption for each additional heating degree day for that period)

HDD = number of heating degree days in a given week (at base temperature of 15.5°C)

All coefficients have been determined using multiple regression of the baseline energy data with a baseline heating degree day temperature of 15.5°C (selected for high R^2 value following linear regression analysis). Summary output of analyses given below in Table 1.

Table 1. Summary output of regression analyses of data included in Appendix A.

Regression Statistics	
Multiple R	0.884
R Square	0.782
Adjusted R Square	0.778
Standard Error	327.902
Observations	54.000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	20075785	20075785	186.7177	7.66E-19
Residual	52	5591012	107519.5		
Total	53	25666797			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*
Intercept	137.321	68.926	1.992	0.052	-0.988	275.631	-0.988
HDD@15.5C	24.471	1.791	13.664	0.000	20.878	28.065	20.878

6.2 The coefficient of determination, R^2, (shown as "R Square" above) is relatively high at 0.782, indicating that 78% of the variation in the 54 energy data points are explained by the model using HDD as an independent variable. The R Square result indicates a strong relationship between the variables and justifies using the model to estimate adjustments as defined in Equation 1b. The estimated coefficient of 24.471 kWh per HDD has a standard error of 1.791 and a t-statistic of 13.664. Results illustrate a 95% confidence for adjusted consumption range is 20.878 kWh to 28.065 kWh per additional HDD.

Table B.1 from the Appendix B of IPMVP Volume I EVO 10000-1:2012 indicates an appropriate critical t value is 1.3 with an 80% confidence. The standard error of the estimate using the regression formula is 327.902. The average HDDs per week is 34.8 (not shown in output). To predict what gas consumption would have been under average heating conditions, these values are inserted into the regression model:

Predicted consumption = 137.321 + (24.471 x 34.8)

= per 988 kWh average heating degree day week

Using t-value of 1.3, for 54 data points and an 80% confidence level, the range of possible predictions is:

Range of predictions = 988 ± (1.3 x 327.9) = 563 kWh to 1,415 kWh

The absolute precision is approximately ±426.9 kWh (= 1.3 x 327.9) and the relative precision is ±43% (= 426.2 / 988).

7. Energy Prices

7.1 The energy price used to value the savings will be the current tariff for that given period so as to represent the most accurate financial savings achieved. The energy price used in the savings calculation will be updated with any change of contract or tariff during the period. The current tariff cost for natural gas is £0.01911 per kWh.

8. Meter Specifications

8.1 Teme Building gas sub-meter will be used for M&V purposes for this ECM. The building gas sub-meter registers every 30 minutes and is access from the intuitions aM&T system DynmatPlus aM&T.

8.2 In the event of a loss of data, consumption will be calculated based on previous performance against target for given degree days.

9. Monitoring Responsibilities

9.1 It will be the responsibility of UW Energy Officer to collate and report on all energy data, independent variables and static factors within the measurement boundary during reporting period.

10. Expected Accuracy

10.1 The meter data is considered accurate for the M&T purpose. The gas sub meter was calibrated as part of the aM&T installation and commissioning process. aM&T meters are checked for accuracy as part of the maintenance contract delivered by the service provider. Due to the level of accuracy of the data no uncertainty adjustments shall be made to the measurement of savings in the planned savings report.

11. Budget

11.1 No monetary budget has been assigned directly to the M&V of this ECM as data is currently readily available from the buildings gas sub meter. Limited time resources will be required from the Estates team in order to analyse and prepare the data for the required reporting outlined in section 12 below.

12. Report Format

12.1 An annual summary report will be prepared for 3 subsequent years.

13. Quality Assurance

13.1 The identified risks and mitigating actions in this M&V process are as follows:

- Meter failure – The proposed strategy involves the use of one main sub meter and there is a low risk of measurement failure. In the event of a complete meter failure, savings will be estimated based on previous average performance of savings up to the date of meter failure.
- Unexpected changes to the building, its operation, or to its use – It is not expected that there will be any changes made to the core usage of the building at any time, however, any

major changes to occupancy will be included in the routine adjustments of savings calculations.