Template/Example

Measurement and Verification Plan

For Client/Project

(Option A Small Project)

# Document Control

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Revision No. | Date | Author | Reviewed | Approved |
| 0 | 1 April 2019 | Jack Smith | Jane Smith | John Smith |
|  |  |  |  |  |

Contents

[Document Control 1](#_Toc22203507)

[1. Facility and Project Overview 4](#_Toc22203508)

[Stakeholders and Project Team 4](#_Toc22203509)

[Description of the Site/Facility 4](#_Toc22203510)

[Project Description 4](#_Toc22203511)

[M&V Requirements and Key Outcomes 4](#_Toc22203512)

[2. ECM Intent 4](#_Toc22203513)

[ECM Description: 4](#_Toc22203514)

[Savings achieved by: 4](#_Toc22203515)

[Affected Equipment: 4](#_Toc22203516)

[Expected Savings: 4](#_Toc22203517)

[3. IPMVP Option and Measurement Boundary 5](#_Toc22203518)

[M&V Option: 5](#_Toc22203519)

[Measurement Boundary: 5](#_Toc22203520)

[Interactive Effects: 5](#_Toc22203521)

[4. Baseline Definition 5](#_Toc22203522)

[Period: 5](#_Toc22203523)

[Key Parameter: 5](#_Toc22203524)

[Estimated Parameters: 5](#_Toc22203525)

[Other parameters to consider: 5](#_Toc22203526)

[Equipment Inventory 5](#_Toc22203527)

[Static Factors: 5](#_Toc22203528)

[5. Reporting Period 5](#_Toc22203529)

[Period: 5](#_Toc22203530)

[Frequency: 5](#_Toc22203531)

[Measurements: 5](#_Toc22203532)

[6. Basis for Adjustment 6](#_Toc22203533)

[Conditions 6](#_Toc22203534)

[Routine Adjustments 6](#_Toc22203535)

[Non-routine Adjustments 6](#_Toc22203536)

[7. Calculation Methodology and Analysis Procedure 7](#_Toc22203537)

[Data Analysis Procedures: 7](#_Toc22203538)

[Savings Calculation Methodology: 7](#_Toc22203539)

[Assumptions: 7](#_Toc22203540)

[8. Energy Prices 7](#_Toc22203541)

[Electricity: 7](#_Toc22203542)

[9. Meter Specifications 8](#_Toc22203543)

[Clamp on Power Meter: 8](#_Toc22203544)

[Meter Reading and Witnessing protocol 8](#_Toc22203545)

[Lost measurements record plan 8](#_Toc22203546)

[10. Monitoring Responsibilities 8](#_Toc22203547)

[Operational Verification: 8](#_Toc22203548)

[Collecting Energy Data: 8](#_Toc22203549)

[Collecting Independent Variable Data: 8](#_Toc22203550)

[Collecting Static Factors: 8](#_Toc22203551)

[Analysing collected data: 8](#_Toc22203552)

[Reporting Savings: 8](#_Toc22203553)

[11. Expected Accuracy 8](#_Toc22203554)

[12. M&V Budget 9](#_Toc22203555)

[13. Report Format 10](#_Toc22203556)

[14. Quality Assurance 11](#_Toc22203557)

[Data gathering quality 11](#_Toc22203558)

[Data errors 11](#_Toc22203559)

[Missing data 11](#_Toc22203560)

[Verified Savings 11](#_Toc22203561)

[Operation Performance 11](#_Toc22203562)

##

|  |
| --- |
| Facility and Project Overview |
| Stakeholders and Project Team | **Client:** Government Agency Regional Office**Client Rep:** Office Manager**Project Manager:** Lighting Contractor**M&V Specialist:** Jack Smith (independent) |
| Description of the Site/Facility | Location: 123 Smith Drive – Level 2Type: Tenancy of Commercial Building* Open plan space
* Regular Office hours
* Air Conditioning supplied from Central plant
 |
| Project Description | Replace existing T8 Florescent lighting fittings with LED Tubes throughout open plan office area.  |
| M&V Requirements and Key Outcomes | The proposal for the lighting upgrade from the lighting contractor included a guarantee that the energy cost savings from the LED upgrade would provide a simple payback period of less than four years. This was to be verified independently.  |

|  |
| --- |
| ECM Intent |
| ECM Description: | Replace existing T8 Florescent lighting fittings with LED Tube fittings throughout open plan office area. |
| Savings achieved by: | Reduced electricity consumption and demand costs. |
| Affected Equipment: | All existing T8 Lighting troffers  |
| Expected Savings: | Energy and Demand savings of ($3000) per annum. |

|  |
| --- |
| IPMVP Option and Measurement Boundary |
| M&V Option: | Since weekly office hours were very regular, the available budget for the project was small and the technical risk of not achieving the guaranteed savings was low, **Option A: Key Parameter Measurement** was selected. |
| Measurement Boundary: | 10 lighting circuits on the Tenancy distribution board. |
| Interactive Effects: | Since the air conditioning was supplied form the landlord controlled central plant, the tenant is does not benefit from any central plant operating cost reductions, the interactive effects of reduced cooling load and increased heating demand from the LED upgrade was ignored.  |

|  |
| --- |
| Baseline Definition |
| Period: | Prior to the replacement of the lighting, a one off period of 30 minutes during normal office hours when all lighting circuits were turning on. |
| Key Parameter: | The power draw of each lighting was to be measured by a registered electrician at the Tenancy Switch Board. |
| Estimated Parameters: | The lighting operating hours are estimated to be a consistent 60 hours per week. |
| Other parameters to consider: | * Lighting levels readings were taken, prior to the LED upgrade, in a number of locations throughout the office areas to ensure there was degradation of lighting levels as a result of the upgrade.
* The interactive effects on the air conditioning system energy consumption are ignored.
 |
| Equipment Inventory  | All T8 Lighting Fittings in open plan office area. |
| Static Factors: | Any failed T8 tubes were to be noted immediately prior to the baseline measurement period and accordingly appropriate adjustments would be made to the baseline.  |

|  |
| --- |
| Reporting Period |
| Period: | Immediately after the replacement of the lighting, a one off period of 30 minutes during normal office hours when all lighting circuits were turning on. |
| Frequency: | Once. |
| Measurements: | Electrical power draw of each lighting circuit measured at the tenancy switch board. |

|  |
| --- |
| Basis for Adjustment |
| Conditions | There are no condition changes that impact on the verified energy saving and as such the verified results are independent of the prevailing conditions during the baseline and reporting periods. |
| Routine Adjustments | No adjustments required. |
| Non-routine Adjustments | Should any lamps be found to be failed during the baseline measurement period, than the measure power reduction for the respective lighting circuit will be adjusted using the following calculations:Energy Savings Adjustment = no. failed lamps x 32 watts x annual office hoursDemand Savings Adjustment = no. failed lamps x 32 watts  |

|  |
| --- |
| Calculation Methodology and Analysis Procedure |
| Data Analysis Procedures: | The measure power draw of each lighting circuit is to be recorded for both the baseline and reporting periods. The annual operating hours of the office would be discussed and agreed with the office manager. |
| Savings Calculation Methodology: | The following table details how the Energy and Demand savings are calculated for each lighting circuit: |
| Assumptions: | The Office Manager assessment of annual office hours will be accurate.Office lighting levels will not be degraded by the LED upgrade.  |

|  |
| --- |
| Energy Prices |
| Electricity: | Blended rate of 13 cents per kWh to be used for the valuation of all energy savings.Fixed rate of $4/kW per month for Demand savings.  |

|  |
| --- |
| Meter Specifications |
| Clamp on Power Meter: | Fluke 345 Power Quality Clamp Meter |
| Meter Accuracy = ±1%  |
| Meter Reading and Witnessing protocol | The Independent M&V specialist will witness the power measurements undertaken by the registered electrician for the pre and post measurements. |
| Lost measurements record plan | Not applicable. |

|  |
| --- |
| Monitoring Responsibilities |
| Operational Verification: | Lighting Contractor |
| Collecting Energy Data: | Lighting Contractor |
| Collecting Independent Variable Data: | Not Applicable |
| Collecting Static Factors: | Lighting Contractor |
| Analysing collected data: | Jack Smith (M&V Specialist) |
| Reporting Savings: | Jack Smith (M&V Specialist) |

|  |
| --- |
| Expected Accuracy |
| Required level of Accuracy and Precision | Results to be reported with 90% probability (confidence) and ±10% precision |
| Metering equipment measurement standard error calculation | $$SE\_{metering}=\frac{meter relative precision∙measured value}{t}$$Where t = t-statistic for infinite sample sizes Power Meter Accuracy = ±1%.At the required 90% confidence level the Standard Error of measurement by this meter will be calculated as:$$SE\_{metering} =\frac{0.01∙kWh}{1.645}=0.006 kWh\_{}$$Where 1.645 is the t-value @ 90% confidence  |
| Sampling Error Calculation | The power draw on all lighting circuits are being measured and therefore no sampling related uncertainty applies. |
| Modelling Uncertainty Calculation | The modelling standard error will be calculated once the baseline model has been developed. |
| Savings Assessment Uncertainty Calculation | Savings Assessment Uncertainty Formula:$$SE\_{daily savings}=\sqrt{(SE\_{baseline})^{2}+(SE\_{Reporting })^{2}}$$Where:$$SE\_{baseline}=\sqrt{(SE\_{sampling})^{2}+ (SE\_{Measurement})^{2}+(SE\_{Modelling})^{2}}$$$$SE\_{reporting}=\sqrt{(SE\_{sampling})^{2}+ (SE\_{Measurement})^{2}+(SE\_{Modelling})^{2}}$$To calculate the confidence interval for the estimated savings ($\hat{x}$):* $\hat{x}-t∙SE\left(\hat{x}\right)\leq x\leq \hat{x}+t.SE(\hat{x})$

where:* Absolute Precision $\left(\hat{x}\right)=t∙SE(\hat{x})$
* Relative Precision $\left(\hat{x}\right)=\frac{t∙SE(\hat{x})}{(\hat{x})}$

and: t is the t-value for (n-1) degrees of freedom  |

|  |
| --- |
| M&V Budget |
| M&V Plan | $300 excl GST (2 hours @ $150 per hour) |
| Measurements | $200 excl GST (2 hours for electrician) |
| Report | $300 excl GST (2 hours @ $150 per hour)  |
| Total Budget | $800 excl GST |

|  |
| --- |
| Report Format |
|  | The report will include at a minimum the following information:* Project background
* ECM description
* M&V Option chosen for the ECM or project
* Reporting period start and end dates
* M&V activities conducted during the reporting period, including:
* Start and end time for the measurement period
* Energy use data
* Data for independent and static variables
* Description of inspection activities conducted
* Verified saving calculations and methodology
* Provide detailed description of data analysis and methodology
* Provide an updated list of assumptions and source of data used in the calculations
* Provide details of any baseline or saving adjustments including both routine and non-routine adjustments to account for changes
* Provide details of utility costs used to calculate the reported savings
* Clear presentation of verified energy, cost savings and comparison to the proposed savings.
 |

|  |
| --- |
| Quality Assurance |
| Data gathering quality | CMVP will be analysing and verifying. |
| Data errors | Low risk with:* accurate power meter
* Office Manager has been in her role for a number of years
 |
| Missing data | * Baseline power measurements witnessed by M&V specialist.
* No other data loss risks.
 |
| Verified Savings | CMVP over sight |
| Operation Performance | Lighting contractor is accountable for replacement lighting system performance. |