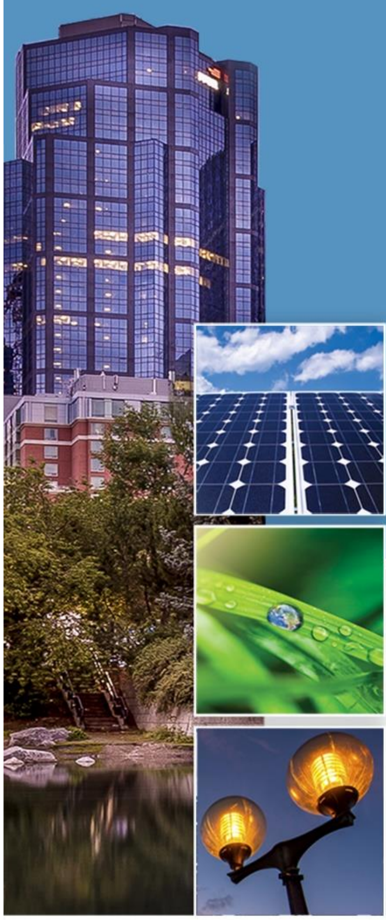
NEET Detailed Energy Audit Requirements

This document describes the requirements for the completion of NEET Detailed Energy Audits.

It includes the methodology and requirements for the quantification of potential energy savings and greenhouse gas emissions reductions.

June 2017



MCCAC
Municipal Climate Change Action Centre

Contents

1.0 Introduction

1.1 Purpose

This document has been developed to assist with the preparation of the Detailed Energy Audit report required for participation in the NEET program. Please note that the provisions in this document must be met in order for the audit to be eligible for funding through the NEET program.

The purpose of performing a detailed energy audit with quantified greenhouse gas emissions reductions and energy savings is to provide both the program participant and the MCCAC accurate estimates of the cost, energy savings, and greenhouse gas reductions for the energy efficiency opportunities in a facility.

Detailed quantification tracking of energy performance before and after energy efficiency retrofits has many benefits:

- Accurately assess energy savings for energy efficiency opportunities
- Help participants maintain and improve building performance and operations
- Data can be used by grant administrators to improve energy efficiency programs
- Identification of other energy savings opportunities

This document describes the greenhouse gas and energy savings measurement, quantification, and reporting requirements necessary for all energy efficiency measures identified in the audit as part of a NEET project.

1.2 Key Definitions

Energy conservation measure (ECM): any work that is intended to reduce the energy consumption or increase the energy efficiency of a facility through equipment retrofit or installation of new energy management systems or controls. Routine equipment maintenance is not an eligible ECM recommendation. While there is a distinction between energy efficiency and energy conservation, these terms can be used interchangeably for the purposes of this document.

No-cost/low-cost measures: energy conservation measures that can be implemented without significant capital cost investment (less than $1,000 per measure). Examples include: adjustment to set points, weatherization, programmable thermostats, etc.

Capital investment measures: energy conservation measures that involve the retrofit, reconfiguration, or replacement of existing energy using equipment that requires significant capital investment ($1,000 or greater per measure). Examples include: lighting upgrades, replacement of HVAC equipment with high efficiency models, upgrades to building envelope insulation, etc.

Renewable energy measures: energy conservation measures that involve on-site energy generation or energy transfer from a renewable source to offset existing energy consumption. Cogeneration may be included where significant greenhouse gas emissions reductions can be demonstrated. Examples include: solar PV, ground source heat pumps, solar hot water, etc.

Measurement boundary: a conceptual boundary drawn around equipment or systems to define all elements and factors that influence the energy use for a given energy efficiency measure.

Baseline: the ‘baseline’ case describes the energy use characteristics of the facility in its current state. It should be a fair representation of normal operating conditions and must span at least one year to capture a full operating cycle.

Post-retrofit: the ‘post-retrofit’ case, synonymous with the ‘energy efficient’ case, describes the facility energy use characteristics after all energy efficiency measures identified as part of the NEET audit have been implemented.

2.0 Detailed Energy Assessment Report

2.1 General Requirements

The requirements for the detailed energy audit are as follows:

- The audit must be completed to a level of rigour comparable to ASHRAE Level II audit guidelines and sufficient to provide the data necessary to perform all required quantification calculations detailed in this document.
- The audit and quantification must be completed by a qualified professional with a legal right to work in Canada. A qualified professional will be a Professional Engineer (P. Eng), Certified Energy Manager (CEM), or a Certified Energy Auditor (CEA). This individual is bound by legal responsibility and the professional code of conduct of their respective associations.

2.2 Requirements for Detailed Energy Audits

An ASHRAE Level II audit will, at various levels of depth, explore all possible measures applicable to a particular facility. This analysis is completed with the intention of narrowing down a set of recommended measures that will be presented to the client in the Detailed Energy Audit report.

For a guide on the requirements of an ASHRAE Level II audit, please refer to the document “Procedures for Commercial Building Energy Audits” (ASHRAE 2011). This document can be purchased and downloaded from the ASHRAE website.

2.3 Greenhouse Gas and Energy Saving Quantification Requirements

The NEET Detailed Energy Audits must quantify and report the greenhouse gas emissions reductions and energy savings from all measures for a participating facility. The detailed quantification methodologies for this analysis are provided below.

Quantification requirements include:

- a quantified description of the facility operation and energy use in its current state (baseline);
- a comprehensive list of all energy efficiency measures;
- estimated energy savings and greenhouse gas emissions reductions from each measure and a total for all proposed measures;

- cost-effectiveness assessments for each measure; and
- reported assumptions, references, and details on the measurement and quantification process used for all measures.

3.0 Quantification and Emissions Reduction Methodology

3.1 Energy Use Measurement

The MCCAC energy savings measurement and quantification process is based on the Alberta Quantification Protocol for Energy Efficiency in Commercial and Institutional Buildings and the International Performance Measurement & Verification Protocol (2010).[1] As outlined in these protocols, energy measurement and verification can follow one of four typical approaches, summarized below.

Table 3.1: Summary of IPMVP Measurement and Verification Options

Approach	Description
A. Retrofit Isolation: Key Parameter Measurement	Engineering calculations of energy savings are completed for each measure through a combination of field measurements and estimates for key performance parameters. Measurement frequencies are short-term and range from samples to continuous measurements. Non-measured values are estimated based on historical data, manufacturer's specifications and engineering judgement
B. Retrofit Isolation: All Parameter Measurement	Same process as Approach A, but with no estimation. All values calculated from field measurements.
C. Whole Facility	Savings are calculated using the measured energy use at the whole facility or sub-facility level. Continuous measure of facility energy use over a baseline year are compared to continuous measurements for at least one year post-retrofit. Adjustments are required to account for factors such as weather and occupancy.
D. Calibrated Simulation	Savings are calculated through simulation of energy use across the whole facility or sub-facility. Simulation is calibrated with hourly or monthly data.

The quantification requirements for the NEET Detailed Energy Audit are to follow a **modified Approach A** in order to effectively balance the resources and cost of the audit assessment while maintaining an appropriate level of rigour.

The recommended approach and minimum requirements are described below. However, if the qualified energy professional deems that another method will be lower cost and of equal or greater accuracy, Approach B, C, or D can be employed in place of the described approach. In such cases, the energy consultant must provide a measurement and

[1] These documents are publically available and may be referenced.

verification plan appropriate to the selected methodology to MCCAC for approval, prior to completion of the Detailed Energy Audit report.

3.1.1 Baseline Measurement

The baseline energy use of all energy equipment or systems within the facility must be quantified. The baseline measurement and quantification is completed using a combination of measured data and estimated parameters as outlined below:

Provide an overview of the site and building: to provide context for the baseline, provide a description of the site and building, and an overview of energy systems within the building. This must include basic physical parameters such as location, building type, total building floor area, and relevant occupancy and operational information to illustrate how the building is used. Finally, an overview of all energy systems must be provided which lists the systems and includes a physical description including the age and specifications of equipment, and an energy use break-down by system.

Define the measurement boundary: a measurement boundary must be defined for each energy efficiency measure. Doing so allows the narrowing of the scope of variables and factors that must be measured or quantified for an ECM and helps identify key metering points. Only changes to energy systems and operating variables within the measurement boundary must be included in the baseline and post-retrofit calculations. The measurement boundary also helps identify possible energy flows that may interact with other ECMs.

Determine normal operating parameters: for each ECM, determine the operating conditions that are representative of a typical facility over a full year operating cycle. Factors will vary for each ECM but generally include: building/room occupancy patterns, operating hours, load changes and cycles, building activities, and environmental factors. Parameters should be based on measured or observed data when possible. Stipulations based on historical data or extrapolated patterns can be used when applicable.

Determine performance of existing equipment: for each ECM, determine the annual energy use for the baseline equipment and systems within the measurement boundary.

$\text{ECM Energy Use}_{\text{Baseline}}$ is defined as the annual energy consumption within the ECM boundary prior to ECM installation, calculated for each energy type

Key energy performance parameters should be based on measured data taken at the component or system level. A single spot measurement may be sufficient for conditions with little variation. Otherwise, measurements should be short-term and may be periodic or continuous. The length of measurement period and frequency should be determined by the energy professional based on the equipment type, anticipated variation, length of operating cycles, and influence on energy consumption.

In cases where measurements are not possible or practical, stipulated data may be used to determine performance parameters or other influencing factors. Stipulations may be based on historical data, databases, engineering references, or manufacturer data.

If multiple versions of the same equipment are included within the measurement boundary, a statistically valid sample may be used in place of measuring all units.

Measured and stipulated energy performance of all equipment types and energy uses should be aggregated to the metering level and compared with metered data to validate assumptions.

Calculate baseline energy use of the facility: using the equipment performance data and operating parameters, calculate the total annual energy use of the baseline equipment and systems for all ECMs in the facility.

Facility baseline energy use is calculated for each energy type as:

$$\textit{Equation 1: } \textit{Facility Energy Use}_{Baseline} = \sum \textit{ECM Energy Use}_{Baseline}$$

In addition, include total annual facility energy use, based on historical utility data to be used as reference data for validation and context.

Calculate adjusted baseline energy use: the baseline is intended to be used for an equivalent comparison of a facility's energy use before and after ECM implementation. Variables that affect energy use but are unrelated to the proposed efficiency measures must be normalized to a reference condition which is held constant across the baseline and post-retrofit scenarios. Adjustments are typically made for weather-dependent measures and, in special cases, for changes to operating parameters.

All baseline energy use values for ECMs individually and for the facility as a whole should be reported as 'adjusted' energy use in the final report with adjustment calculations and assumptions provided in the appendix.

For weather dependent variables, normalize the baseline energy use to long-term average weather using a valid mathematical technique.[2] Temperature (e.g. heating degree days) must be considered. Humidity, wind, and other weather variables are to be considered as deemed relevant by the energy professional. Seasonal weather should be normalized to a period no less than 5 years and should be based on the nearest available meteorological data. Weather conditions during measurement periods must be reported for weather sensitive ECMs. Below is an example of baseline weather adjustment:

$$\textit{Equation 2: } \textit{Energy Use}_{Adjusted\ Baseline} = \textit{Facility Energy Use}_{Baseline} \times \frac{HDD_R}{HDD_B}$$

Where:

HDD_B *is heating degree days during the baseline period*

HDD_R *is heating degree days averaged for the reference period*

If it is anticipated that operating parameters affecting any ECM will be substantially different in the post-retrofit period for reasons unrelated to the proposed energy efficiency measures, the baseline should be adjusted to reflect these conditions. Changes in

[2] For guidance on weather data and assessing the validity of mathematical methods refer to section 8.9 and Appendix B of the International Performance Measurement and Verification Protocol: Concepts and Options for Determining Energy and Water Savings, Volume 1 (2010) prepared by Efficiency Valuation Organization.

conditions that result from ECMs such as controls or occupancy sensors should not be included in baseline adjustments.

Document calculations, assumptions, and stipulated data: all calculations and relevant data must be clearly documented. For stipulated parameters, include all assumptions, supporting information and data sources. A third party should be able to verify calculations and understand the rational for assumptions. This can be included in an appendix.

3.1.2 Post-Retrofit Estimation

The post-retrofit energy use of all energy equipment or systems within the scope of proposed ECMs must be quantified. As these calculations are performed in advance of ECM implementation, measured operational data is unavailable. Therefore, these estimates should be completed with the best available information as outlined below:

Determine performance of new equipment: for each ECM, determine the annual energy use for all equipment or systems within the given measurement boundary.

$ECM\ Energy\ Use_{Post-retrofit}$ is defined as the annual energy consumption within the ECM boundary after ECM installation, calculated for each energy type (with the effects of significant ECM interactions accounted for as described below)

Performance parameters should be based on the best available data including manufacturer specifications, measured performance of similar equipment, databases and other engineering references.

ECMs that improve energy efficiency by altering use or loading cycles, for example occupancy sensors and variable frequency drives, will require the development and use of a new load profile. This should be factored into the annual energy use calculations for these measures to ensure that the full benefit of the ECM is considered.

Analyze ECM interactions: some energy efficiency measures, once implemented, can have an effect on other measures by altering the energy flow through the system or by changing the load conditions.

For all no-cost/low-cost and capital investment measures, interactions with other ECMs must be identified and a rudimentary estimation of the interaction should be performed to evaluate the significance. Any significant interaction, estimated to affect the energy use of another ECM by over 15 percent or has a greater than 5 percent effect on the total baseline energy use, must be quantified and accounted for using detailed engineering calculations. All other interactions can be identified and noted as negligible. All relevant supporting information and calculations relating to ECM interactions must be summarized in the appendix.

Calculate post-retrofit energy use of the facility: using the performance data for new equipment, calculate the total annual post-retrofit energy use of all ECMs in the facility. Calculations should be completed using the same core facility operating parameters and weather conditions as defined in the adjusted baseline. Exceptions include operating parameters that are directly and intentionally affected by the implementation of ECMs, such as control systems and occupancy sensors.

Facility post-retrofit energy use is calculated for each energy type as:

$$\text{Equation 3: } Facility\ Energy\ Use_{Post-retrofit} = \sum ECM\ Energy\ Use_{Post-retrofit}$$

Document calculations, assumptions, and stipulated data: clearly document all calculations and relevant data. For stipulated parameters, include all assumptions, supporting information and data sources. A third party should be able to verify calculations and understand the rationale for assumptions. Include this information in the appendix.

Identify significant uncertainty: with the above approach, a degree of uncertainty is anticipated in the post-retrofit calculations. In some cases, uncertainty may be high due to limited data or the nature of assumptions. Uncertainty levels should be estimated and must be noted in the report for all ECMs where uncertainty in annual energy use is greater than 50 percent. If there are post-retrofit measurements that could be taken upon completion to reduce uncertainty, recommendations should be made in the report. The MCCAC will review these recommendations with the participant and determine if any actions are necessary to enhance quantification calculations.

3.1.3 Energy Savings

Energy savings must be calculated for each measure and for the total of all proposed measures. These calculations assume that all proposed measures will be implemented and that any significant interaction effects are accounted for in the energy performance of each measure.

Note: all energy savings calculations must be performed using adjusted baseline energy use values.

Annual energy savings:
Annual energy savings for each ECM are calculated for all fuel types as follows:

$$\text{Equation 4: } ECM\ Energy\ Savings = ECM\ Energy\ Use_{Baseline} - ECM\ Energy\ Use_{Post-retrofit}$$

Annual facility energy savings (total of all proposed ECMs) are calculated for all fuel types as follows:

$$\text{Equation 5: } Facility\ Energy\ Savings = Facility\ Energy\ Use_{Adjusted\ Baseline} - Facility\ Energy\ Use_{Post-retrofit}$$

Facility lifetime energy savings:
To determine the full effect of the proposed ECMs, energy savings resulting from measures proposed in the NEET Detailed Energy Audit must also be quantified over the life of the measures. This is calculated by considering the annual energy savings from individual measures and their corresponding operational life. The expected operational life of all equipment included for the proposed ECMs should be determined using the best available information such as, manufacturer specifications, databases, research, and other engineering references. All equipment life values used in calculations and their source must be included in the report.

Lifetime energy savings for each proposed ECM are calculated as follows:

$$\text{Equation 6: } ECM\ Energy\ Savings_{Lifetime} = \sum ECM\ Energy\ Savings_{Energy\ type} \times Equipment\ life$$

Where:

Equipment life is the operational life of the equipment installed for each ECM in years

Total Lifetime emissions reductions for all proposed ECMs are calculated as:

$$\textit{Equation 7:}\ Facility\ Energy\ Savings_{Lifetime} = \sum ECM\ Energy\ Savings_{Lifetime}$$

Eligible energy savings:

As specified in the Quantification Protocol for Energy Efficiency in Commercial and Institutional Buildings (2010), a multiplier factor must be applied to energy savings to account for uncertainty. Accordingly, the eligible energy savings of an ECM are defined as:

$$\textit{Equation 8:}\ Eligible\ Energy\ Savings = Energy\ Savings \times M$$

Where:

M *is the eligibility multiplier, for all NEET audits use a value of* $M = 0.90$

This general equation must be applied to all energy savings calculations.

3.2 Greenhouse Gas Emissions

Greenhouse gas emission reductions must be quantified for all ECMs individually and as a total for all proposed measures. Greenhouse gas emission reductions must be calculated for all energy types affected by the proposed ECMs. Energy types typically include natural gas and grid electricity, but may include others depending on the facility.

3.2.1 Annual GHG Reductions

Annual emission reductions for each ECM are calculated as:

$$\textit{Equation 9:}\ ECM\ Emission\ Reduction_{Annual} = \sum ECM\ Eligible\ Energy\ Savings \times Emission\ Factor_{Energy\ type}$$

Where:

$Emission\ Factor_{Energy\ type}$ *is the emission factor for each type energy use, expressed in tonnes of* $CO_{2\ equivalent}$ *per unit energy. Emission factors are provided in Appendix A.*

Annual emission reductions for the facility as a whole are calculated as:

$$\textit{Equation 10:}\ Facility\ Emission\ Reduction_{Annual} = \sum ECM\ Emission\ Reduction_{Annual}$$

3.2.2 Lifetime GHG Reductions

To determine the full effect of the retrofit, emission reductions resulting from proposed ECMs must also be quantified over the life of the measures.

Lifetime emission reductions for each ECM individually and for the total of all proposed measures are calculated using the following general equation:

$$\textit{Equation 11:}\ Emission\ Reduction_{Lifetime} = Eligible\ Energy\ Savings_{Lifetime} \times Emission\ Factor_{Energy\ type}$$

3.3 Cost-effectiveness Tests

Cost-effectiveness tests are used to evaluate the economics of energy efficiency measures. Various calculations and metrics are used in the design phase to select appropriate efficiency measures and to evaluate the business case.

To ensure consistency across NEET audits, section 3.3.1 describes the requirements and methodologies for cost-effectiveness calculations that must be included in the Detailed Energy Audit report. For consistency, all payback calculations are to be completed for costs prior to the application of any rebates.

3.3.1 Simple Payback

Simple payback is used to quantify the cost-effectiveness of an energy efficiency retrofit from a participant perspective.

Simple payback calculations are required for all individual ECMs and for the total of all proposed ECMs and are calculated using the equations below:

Equation 12: $\text{Simple Payback (years)} = \frac{\text{Initial Capital Cost}}{\text{Annual Cost Savings}}$

Where:

Annual cost savings are calculated using the measure or total energy savings defined in the sections above

For the purpose of the simple payback assessment, calculations should assume a constant energy price applied to the energy savings based on current rates. Initial capital cost values and energy prices should be included in the report appendix.

3.3.2 Net Present Value (NPV) Life-cycle Cost

Full life-cycle cost accounting is a cash flow analysis technique that is well suited to capture the full benefits of an energy efficiency retrofit from a participant perspective. This approach enables comparison between the baseline and post-retrofit scenarios in a way that accounts for equipment life, replacement costs, and the value of currently installed equipment.

NPV life-cycle cost calculations comparing the baseline to the post-retrofit cases are required for all capital investment measures and all renewable energy measures. NPV calculations are not required for no-cost/low-cost measures.

Full life-cycle cost accounting can become relatively onerous depending on the scope and detail of the analysis. In order to ensure calculations are performed consistently and efficiently, a pre-determined scope definition and required calculation assumptions are included in the methodology below.

Cash flow analysis should be expressed in net present value using the equation below:

Equation 13: $NPV = C_0 + \sum_{t=1}^{n} \frac{C_T}{(1+d)^t}$

Where:

C_o *is the initial investment cost in cashflow year zero (expressed as negative for a cost)*

C_T *is the sum of cash flow in year t (expressed in current dollars)*

d *is the discount rate (does not include inflation)*

n *is the number of cashflow periods (based on ECM equipment life)*

t *is the current time period (year)*

Note: Equation 13 and the methodology outlined below can be applied to the calculation of NPV for individual ECMs.

Required assumptions and approaches:

- The number of cash flow periods should be based on the equipment life of each ECM. The baseline and post-retrofit NPV for each measure should be calculated over the same time period.
- Baseline equipment replacement is consistent: assume for the baseline that existing equipment will be replaced by equipment types matching what is currently installed or what would be required by current codes (if applicable).
- 5% discount rate: while different discount rates can be used in NPV calculations, a set discount rate is required to ensure comparability across ECMs.
- Initial energy prices should be defined by the energy consultant based on rates that reflect costs currently experienced by the NEET participant.
- Energy prices increase 1% per year: energy prices can have a significant influence on the economics of ECMs over the life of the equipment. While price escalation can be assumed, it is difficult to predict future prices with any degree of accuracy. To ensure calculation consistency, assume energy prices start at current rates and increase by 1% each year, over the life of the measure. This growth rate is deliberately set to be conservative. Note: no other inflation calculations are required for energy prices as NPV calculations express prices in present day values.
- The scope of cash flow items should include: purchase cost, installation cost, replacement cost and energy cost savings for the baseline equipment and the post-retrofit equipment. These terms are defined below. Other items such as maintenance and disposal costs are considered out of scope.
- For baseline equipment with a remaining life expectancy, the value of replacement should be deferred until the cash flow period that is consistent with the equipment's expected end of life.

Purchase cost: the up-front capital cost required for the ECM equipment and associated materials. This does not include labour and installation. This should be included in the C_O term of the cash flow analysis (see Equation 13).

Installation cost: the estimated cost of labour for installation of the ECM and associated materials. These costs may vary due to factors including the building type, location, and ECM installation location. This should be included in the C_O term of the cash flow analysis.

Replacement cost - baseline: to compare the baseline NPV with the post retrofit NPV, currently installed equipment will likely require replacement one or more times over the cash flow analysis period (*n*). As stated above, the baseline should assume that equipment replacements will match what is currently installed or what would currently be required if the minimum standards have since changed. The replacement costs should be considered in the C_T term in the replacement year of the cash flow analysis (see Equation 13). This value should include the cost of purchase and installation for the replacement.

Energy cost savings: the cost savings associated with the energy saved in the post-retrofit scenario. The annual cost savings is defined as annual the energy savings, as calculated above, multiplied by the energy price in a given year. This should be considered in the C_T term in all years of the post-retrofit cash flow analysis (see Equation 13).

4.0 Summary of Required Detailed Energy Audit Report Contents

This report provides the requirements and methodology for completing the required Detailed Energy Audit report. **Please note: All NEET detailed energy audit reports must be presented in the following format.**

The outline below provides the core sections and subsections along with the format of key tables. Additional information, figures, and tables can be included as required by the contents described in this document as a whole, or as seen fit by the energy consultant.

Note: the report must also include all data and calculations as described in the sections above that may not be summarized in this table.

Table 4.0: Outline of Required Detailed Energy Audit Report Contents

Section	Report Content
Executive summary	Brief description of report and analysis Summary tables • Energy Savings and GHG Reductions Summary Table • Financial Analysis Summary Table
Background	Quantification team: • Team members and qualifications • Contact information • Date of report and site visit(s) Description of audit approach: • Scope and methodology • Limitations
Facility characteristics	Description of the site and buildings: • Physical description including: building type, building configuration, envelope characteristics, building floor area and layout, window area • Building operation/occupancy information, including number of occupants, occupancy schedule, and primary building activities Utility analysis: • For each energy type, annual and monthly energy use information for the past 3 years (as available) including: annual energy consumption, monthly trends and/or energy use profiles

<table>
<tr><td></td><td>Utility costs or relevant billing information
Annual energy use breakdowns by energy type and by end use
Other relevant figures/data</td></tr>
<tr><td>Energy systems analysis</td><td>For each of the following systems:
Building envelope
Lighting systems
Mechanical systems / HVAC
Plug loads and other electrical systems
Include the following information:
Description of the energy system
Equipment information: equipment type, model, age, condition, useful life, etc.
Images or other relevant information
System energy use (unless clearly provided in utility analysis)</td></tr>
<tr><td>Energy conservation measures</td><td>Summary of Energy Conservation measures:
Energy Savings and GHG Reductions Summary Table
Financial Analysis Summary Table
Please organize ECM sections in the following order:
No-cost/low-cost measures
Capital investment measures
Renewable energy measures
Additional energy saving considerations (if any)
For each individual ECM include:

Measure boundary:
A description of the scope of all equipment and measurement points in the boundary
List all potential energy flow interactions
Measure baseline:
Description of existing equipment, technology, specifications, and age
Description of normal operating parameters for energy systems within boundary
ECM description:
Description of ECM/retrofit: technology, specifications, efficiency, service lifetime, cost
Description of any changes to operation parameters or load profiles due to ECM
Energy and GHG Performance:
Baseline adjusted annual energy use (kWh or GJ)
ECM annual energy use, adjusted for interactions (kWh or GJ)
ECM annual energy savings (kWh or GJ)
ECM eligible annual energy savings (kWh or GJ)</td></tr>
</table>

	• ECM annual and lifetime GHG emission reduction (tonne CO_2e) • ECM analysis Summary Table below Financial analysis • Estimated capital cost of measure including equipment and installation • Other cost considerations • ECM simple payback (years) [all measures] • Baseline NPV cost ($) [capital & renewable measures] • ECM NPV cost ($) [capital & renewable measures] • ECM Analysis Summary Table below
Appendix	All supporting materials as required in the described methodology, including: • Measurement processes, data sets, calculations, measure interaction estimates, measure uncertainty estimates, reference sources, assumptions, etc. Appendix notes: • Information presented in appendix should clearly link to final values presented in the report. • Appendix values/calculations may use other units as required but should be converted to final units (GJ and kWh) as early as possible in calculations.

Table Format Outlines:

Please note: for buildings that use energy sources beyond natural gas and electricity, additional columns must be added when using the table templates below.

Energy Savings and GHG Reductions Summary Table

ECM	Description	Annual electricity savings[1]	Annual natural gas savings[1]	Annual GHG reductions	Measure life	Lifetime GHG reductions
#		kWh	GJ	tCO_2e	years	tCO_2e
1	Low cost measure…					
2						
3	Capital measure…					
4						
5	Renewable energy measure…					
6						
…						
ECM Totals						

[1] eligible energy savings

Financial Analysis Summary Table

ECM	Description	Total Cost	Annual energy savings[2]	Simple payback	Baseline NPV cost[3]	Measure NPV cost[3]
#		$	$	years	$	$
1	Low cost measure…					
2						
3	Capital measure…					
4						
5	Renewable energy measure…					
6						
…						
ECM Totals						

[2] all energy types

[3] for capital and renewable measures only

ECM Analysis Summary Table

Description	Units	Electricity	Natural gas	Total
ECM energy use – baseline[4]	kWh, GJ, GJ			
ECM energy use – post retrofit[5]	kWh, GJ, GJ			
Annual energy savings	kWh, GJ, GJ			
Eligible annual energy savings	kWh, GJ, GJ			
Annual GHG reductions	tCO_2e			
Annual energy cost savings	$			
Description	Units	Total		
Measure life	years			
Lifetime GHG reductions	tonnes			
ECM unit cost (include when applicable)	$			
Number of units (include when applicable)	#			
ECM total cost	$			

Simple payback	years	
Baseline NPV cost[6]	$	
Measure NPV cost[6]	$	

[4] Baseline adjusted annual energy use

[5] ECM annual energy use adjusted for any interactions (assume all no-cost/low-cost and capital ECMs implemented)

[6] for capital and renewable measures only

Appendix A: Emissions Factors

Greenhouse gas emissions shall be expressed in metric tonnes of CO_2 equivalent and must be calculated for all energy types affected by proposed ECMs. Emissions factors must be appropriately selected to reflect the operation as well as all relevant emission types.

Below are the most common emissions factors. For other emissions factors, please refer to the Carbon Offset Emission Factors Handbook (ESRD, Climate Change, 2015, No. 1).

Factor	Value	Description
Renewable electricity generation	0.64 tCO_2e/MWh	Distributed renewable displacement at point of use (includes line loss). Applicable to ECMs displacing grid electricity with distributed renewable generation at point of use.
Reduction in grid electricity usage	0.64 tCO_2e/MWh	Reduction in grid electricity usage (includes line loss). Applicable to energy efficiency ECMs resulting in decreased grid electricity usage.
Combustion of natural gas	1929 gCO_2e/m^3 (equivalent to 0.05 tCO_2e/GJ)	For residential, commercial and institutional buildings. Calculated from ESRD Handbook, Table 6 (2015, No. 1)
Combustion of propane	1540 gCO_2e/m^3	For other uses (institutional buildings). Calculated from ESRD Handbook, Table 6 (2015, No. 1)
Combustion of light fuel oil	2735 gCO_2e/L	For commercial / institutional buildings. Calculated from ESRD Handbook, Table 7 (2015, No. 1)
Combustion of diesel	2786 gCO_2e/L	Calculated from ESRD Handbook, Table 7 (2015, No. 1)
Combustion of motor gasoline	2295 gCO_2e/L	Calculated from ESRD Handbook, Table 7 (2015, No. 1)

Below are the most common global warming potential emissions factors. For other gas types, please refer to the Carbon Offset Emission Factors Handbook (ESRD, Climate Change, 2015, No. 1).

Gas type	Formula	100-year GWP
Carbon dioxide	CO_2	1
Methane	CH4	25
Nitrous oxide	N_2O	298