QUANTIFICATION PROTOCOL FOR ENERGY EFFICIENCY IN COMMERCIAL AND INSTITUTIONAL BUILDINGS

Version: 1.0 **October 2010**

Specified Gas Emitters Regulation

Government of Alberta

Alberta

Disclaimer:

The information provided in this document is intended as guidance only and is subject to periodic revisions. This document is not a substitute for the law. Please consult the *Specified Gas Emitters Regulation* and applicable legislation for all purposes of interpreting and applying the law. In the event that there is a discrepancy between this document and the *Specified Gas Emitters Regulation* or other legislation, the *Specified Gas Emitters Regulation* and other legislation prevail.

All Quantification Protocols approved under the *Specified Gas Emitters Regulation* are subject to periodic review as deemed necessary by the Department, and will be re-examined at a minimum of every 5 years from the original publication date to ensure methodologies and science continue to reflect best-available knowledge and best practices. Any updates to protocols occurring as a result of the 5-year and/or other reviews that are not due to legal requirements will apply at the end of the first credit duration period for applicable project extensions and for all new projects coming forward.

Where a project condition differs from approved government methodologies, or the project developer is unclear on protocol interpretation relative to their specific project, the project developer must contact Alberta Environment to discuss an appropriate interpretation and receive approval for any methodology changes prior to undertaking the project.

Any comments, questions, or suggestions regarding the content of this document may be directed to:

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[1] Alberta Environment is developing guidance for third party verification.

1.0 Project and Methodology Scope and Definition

This document establishes approved methodology for quantifying greenhouse gas emission reductions from energy efficiency measures implemented in commercial and institutional buildings. This quantification protocol can be used by project developers to quantify greenhouse gas emission reductions resulting from the implementation of energy conservation measures resulting from changes in management practices and/or actual building improvements in new and retrofit projects. Emissions reductions are calculated as the difference in energy use in the project condition compared to the baseline. New builds are required to establish a baseline based on applicable building codes and a project condition that incorporates changes beyond these minimum standards. Retrofit projects are required to establish a baseline based on the greater of one full calendar year or one full operating cycle of data for actual building operations. Any changes in baseline conditions such as weather or building occupancy will require re-establishing the baseline to ensure all Offset Credits generated result from real reductions in greenhouse gas emissions.

This quantification protocol is written for those familiar with energy efficiency projects and implementation and monitoring of energy conservation measures. Familiarity with, and general understanding of, the terminology, processes, standards and operation associated with these measures is required. This protocol also requires a Certified Measurement and Verification Professional or a Certified Energy Manager with at least three years of experience in implementing and quantifying energy efficiency projects sign off on the offset project plan and project report. Projects that do not have appropriate sign-off will not be accepted in the Alberta Offset System.

1.1 Protocol Scope and Description

Methodology in this protocol applies to the quantification of direct and indirect greenhouse gas emission reductions resulting from the implementation of energy conservation measures in new commercial and institutional (CI) buildings or for the retrofit of existing buildings and specifically applies to energy conservation measures related to heating, ventilating, air conditioning and lighting systems. Other types of energy conservation measures , such as building envelope, tap water heating, elevators, occupant small electrical equipment, outdoor lighting, swimming pool pumping or heating, may qualify under this protocol. Project developers wishing to implement these types of projects should contact Alberta Environment to discuss the project prior to implementation to ensure the proposed activity meets program requirements and intent. Including select floors or areas of a building and not others is not permitted. A project must incorporate the entire building.

For the purposes of this protocol, eligible commercial and institutional buildings include but are not limited to:

- hotels, motels, and resorts;
- retail malls and stores;
- office buildings;
- arenas;

- hospitals and clinics;
- schools, universities, and campus residences;
- community centres, libraries, and fire/ambulance service buildings.

Protocol Approach

Alberta Environment has adapted calculation methodologies for energy conservation from the methods published by the Efficiency Valuation Organization in its International Performance Measurement and Verification Protocol (IPMVP)[2]. IPMVP is a recognized international standard for measuring, monitoring, and verifying energy conservation. It provides guidance adhering to widely accepted fundamental principles of measurement and verification, and project reporting. Other sources of accepted good practice guidance referred to in this protocol are listed further below in this protocol.

Simple and advanced calculation methodologies are provided based on the availability of supporting documentation and the level of conservatism applied to claimed emissions reductions. Calculations applied in the simple approach assume less data availability and are inherently more conservative than advanced calculations. This flexibility allows project developers to maximize the greenhouse gas emission reductions quantified based on availability of data and project budget.

The following reference materials were consulted during the development of this protocol:

1. ISO 14064-2:2006 Specification With Guidance at the Project Level for Quantification, Monitoring and Reporting of Greenhouse Gas Emission Reductions or Removal Enhancements
2. International Performance Measurement and Verification Protocol, Volume I, II and III (IPMVP)
3. ASHRAE Guideline 14-2002 Measurement Of Energy And Demand Savings
4. Model Energy Efficiency Program Impact Evaluation Guide under the US National Action Plan for Energy Efficiency, November 2007
5. GE-AES Greenhouse Gas Services (GHGS) Draft Energy Efficiency Methodology
6. Various energy efficiency related Approved Methodologies, Small Scale CDM Methodologies, and New Methodologies from UNFCCC CDM Executive Board's website as of January 2008.
7. The Alberta Protocol Development Process (Carbon Offsets Solutions website)
8. Environment Canada's Draft Guide to Quantification Methodologies and Protocols (March 2006)
9. Canada's Offset System for Greenhouse Gases- Guide for Protocol Developers-August 2008 (Draft)
10. Alberta Environment's Approved Quantification Protocol for Energy Efficiency Projects (September 2007, Version 1)
11. Alberta Environment's Draft Quantification Protocol for Commercial and Institutional Green Building Projects (January 2008)

[2] Copies of the IPMVP protocol can be obtained at www.evo-world.org

12. Alberta Environment's Offset Credit Project Guidance Document-February 2008
13. Alberta Environment's Offset Credit Verification Guidance Document-September 2007
14. ANSI/ASHRAE Standard 90.1 - Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings. (1999 & 2007 versions)

Project developers are encouraged to review these documents prior to under taking an energy conservation project.

1.2 Protocol Applicability

Project developers must be able to demonstrate the offset project meets the requirements of the Alberta Offset System, the *Specified Gas Emitters Regulation*, this quantification protocol, and related guidance documents. In particular, the project developer must provide sufficient evidence to demonstrate that:

1. The energy conservation measures employed in the new build or retrofit project have consistent methodology and assumptions, including but not limited to sources, sinks, and measurement between the baseline and project condition;
2. The quantification of reductions achieved by the project is based on actual measurement and monitoring[3], and are consistent with the requirements of this protocol; and
3. The project must meet the eligibility criteria stated in section 7 of the *Specified Gas Emitters Regulation.*

1.3 Protocol Flexibility

Alberta Environment recognizes there is variability in availability of data and project implementation. The following flexibility options have been developed to support implementation of energy conservation projects in commercial and institutional buildings:

1. Four (4) quantification options[4] are available based on the nature of the project being undertaken:
    a. Option A – *Retrofit Isolation: Key Parameter Measurement*; Savings are determined by measurements of the key parameters which affect the energy use of the energy conservation measure-affected systems
    b. Option B – *Retrofit Isolation: All Parameter Measurement*; Savings are determined by measuring the energy use of the energy conservation measure-affected systems
    c. Option C – *Whole Facility:* Energy use for the entire facility is measured and any savings are calculated accordingly
    d. Option D – *Calibrated Simulation:* Energy use and savings are determined using an accurate and calibrated simulation of the facility

[3] Some exceptions for direct measurement and monitoring are allowed and are explained in section 4.1 of this protocol.
[4] These options are described in more details further in the document

2. Projects can be compiled using a simple or advanced quantification approach:
   a. Simple Approach - prescribes conservative monitoring methods, computations and assumptions.
   b. Advanced Approach - requires a higher level of monitoring (and associated cost), and therefore, has less conservative assumptions, which may allow eligible projects to deliver greater offset credits to the market relative to the simple approach.

These flexibility options allow the project developer to balance the level of detail in monitoring requirements with the degree of conservativeness in various calculations to ensure that greenhouse gas emission reductions quantified under each approach are comparable from the standpoint of quality and verifiability. Justification for the option and approach selected must be provided in the Offset Project Plan.

1.4 Glossary of New Terms

Adjusted-Baseline Energy	The energy use of the baseline period, adjusted to a different set of operating conditions.
Baseline Adjustments	The non-routine adjustments arising during the project period from changes in any energy governing characteristic of the facility within the measurement boundary, except the named independent variables used for routine adjustments.
Baseline Energy	The energy use occurring during the baseline period without adjustments.
Baseline Period	The period of time chosen to represent operation of the facility or system before implementation of an Energy Conservation Measure. This period will be the greater of one year or the time required to reflect one full operating cycle of a system or facility with variable operations.
Confidence Level	The probability that any measured value will fall within a stated range of precision.
Constant	A term used to describe a physical parameter which does not change during a period of interest. Minor variations may be observed in the parameter while still describing it as constant. The magnitude of variations that are deemed to be 'minor' must be reported in the monitoring and verification Plan.
Cycle	The period of time between the start of successive similar operating modes of a facility or piece of equipment whose energy use varies in response to operating procedures or independent variables. For example the cycle of most buildings is 12 months, since their energy use responds to outdoor weather which varies on an annual basis. Another example is the weekly cycle of an industrial process which operates differently on Sundays than during the rest of the week.
ekWh (Equivalent kilowatt hours)	A non-electric energy use (e.g. fuel) is converted to the equivalent electrical energy quantity in kWh, using standard conversion factors.
Energy Conservation Measure (ECM)*	An activity or set of activities designed to increase the energy efficiency of a facility, system or piece of equipment. Energy Conservation Measures may also conserve energy without changing efficiency. Several Energy Conservation Measures may be carried out in a facility at one time, each with a different thrust. An Energy Conservation Measure may involve one or more of: physical changes to facility equipment, revisions to operating and maintenance procedures, software changes, or new

	means of training or managing users of the space or operations and maintenance staff. An Energy Conservation Measure may be applied as a retrofit to an existing system or facility, or as a modification to a design before construction of a new system or facility.
Estimate	A process of determining a parameter used in a savings calculation through methods other than measuring it in the baseline and project periods. These methods may range from arbitrary assumptions to engineering estimates derived from manufacturer's rating of equipment performance. Equipment performance tests that are not made in the place where they are used during the project period are estimates, for purposes of adherence with IPMVP.
Consistency	The Project and the Baseline should provide the same function and quality of products or services. This type of comparison requires a common metric or unit of measurement (such as the mass of beef produced, land area cropped, energy use/per unit of product or area) for comparison between the Project and Baseline activity (refer to the Project Guidance Document for the Alberta Offset System for more information.
Certified Energy Manager (CEM)	Designation administered by the Association of Energy Engineers.
Independent Variable	A parameter that is expected to change regularly and have a measurable impact on the energy use of a system or facility.
Monitoring and Verification Plan	Monitoring and Verification Plan – Plan that focuses on the determination of energy conservation measures following IPMVP guidance.
Measurement Boundary	A notional boundary drawn around equipment and/or systems to segregate those which are relevant to savings determination from those which are not.
Named Sites	Sites within a project which are listed within the project documents. They do not need to be near each other.
Non-Routine Adjustments	The individually engineered calculations to account for changes in static factors within the measurement boundary since the baseline period. When non-routine adjustments are applied to the baseline energy they are sometimes called just "baseline adjustments" (IPMVP Volume I, 2007). For this quantification protocol non-routine adjustments also account for changes in the "surplus" characteristics of the project.
Project Period	The project period is equivalent to the reporting period as defined by IPMVP and below.

Precision	The amount by which a measured value is expected to deviate from the true value. Precision is expressed as a "±" tolerance. Any precision statement about a measured value should include a confidence statement. For example a meter's precision may be rated by the meter manufacturer as ±10% with a 95% confidence level.
Reporting Period	The period of time following implementation of an Energy Conservation Measure when savings reports adhere to IPMVP. For this protocol the reporting period is also the crediting period and the project period.
Routine Adjustments	The calculations made by a formula shown in the M&V Plan to account for changes in selected independent variables within the measurement boundary since the baseline period.
Energy Savings	The reduction in energy use resulting from implemented Energy Conservation Measures. Physical savings (are) expressed as avoided energy use. Savings are not the simple difference between baseline and project period utility bills or metered quantities.
Surplus	Surplus projects are defined as Energy Conservation Measures that were not required by then prevalent laws, regulations, building codes and acts.
Site Energy	The energy quantity measured at an end user's site, without consideration of upstream energy delivery system's energy use.
Static Factors	Those characteristics of a facility which affect energy use, within the chosen measurement boundary, but which are not used as the basis for any routine adjustments. These characteristics include fixed, environmental, operational and maintenance characteristics. They may be constant or varying.

2.0 Baseline Condition

Project developers are required to establish a project baseline. Offset Credits are generated by calculating emissions in the project condition relative to the baseline to yield a change (decrease) in greenhouse gas emissions and as such, baseline assumptions must be representative of actual conditions prior to implementing the greenhouse gas emissions reduction project. If changes in the baseline or project occur, such as changes in building codes, square footage, and occupancy or similar that affects the integrity of the baseline, the project developer should contact Alberta Environment, and may be required to restate the project baseline to maintain consistency with the project condition.

The baseline is the most appropriate and best estimate of greenhouse gas emissions that would have occurred in the absence of the project. In this protocol, Identification of the baseline scenario is presented for two distinct project types; retrofits to existing facilities and new buildings.

2.1 Baseline Scenario Identification for Existing Facilities

According to the IMPVP guidance, the baseline scenario for existing facilities is determined based on the historical data collected over the baseline period. IPMVP describes the baseline period as:

- "Representing all operating modes of the facility. This period should span a full operating cycle from maximum energy use to minimum. For example, building energy use is normally significantly affected by weather conditions, so a whole year's baseline data is needed to define a full operating cycle. Likewise the energy use of a …system (fan) may only be governed by a fixed occupancy pattern…, which varies on a weekly cycle. Energy Conservation Measure planning may require study of a longer time period than is chosen for the baseline period. Longer study periods assist the planner in understanding facility performance and determining what the normal cycle length actually is."
- "Fairly represent all operating conditions of a normal operating cycle. For example, though a year may be chosen as the baseline period, if data is missing during the selected year for one month, comparable data for the same month in a different year should be used to ensure the baseline record does not under represent operating conditions of the missing month."
- "Include only time periods for which all fixed and variable energy-governing facts are known about the facility. Extension of baseline periods backwards in time to include multiple cycles of operation requires equal knowledge of all energy-governing factors throughout the longer baseline period in order to properly derive routine and non-routine adjustments…after Energy Conservation Measure installation."
- "Coincide with the period immediately before commitment to undertake the retrofit. Periods further back in time would not reflect the conditions existing before retrofit and may therefore not provide a proper baseline for measuring the effect of just the Energy Conservation Measure."

This type of baseline scenario is referred to in this protocol as a historical benchmark.

The default baseline scenario approach selected for this protocol related to retrofit projects is the historical baseline approach using the greater of one year or one full operating cycle of data prior to project implementation.

When parts of the project involve changes in operating procedures or replacement of failed equipment, the baseline energy use shall reflect the lowest energy usage level contained in the then prevalent laws, regulations, building codes and acts.

2.2 Baseline for New Facilities

For energy efficiency projects added to the design and construction of a new system or facility, the baseline is the lowest energy usage level reflected by the then prevalent laws, regulations, building codes and acts. Local building codes may provide minimum requirements for the energy-efficient design of buildings which can be used as the baseline scenario[5]. ASHRAE Standard 90 and Canada's MNECB are examples of relevant building code referenced standards that can be used to determine the minimum requirement for building energy efficiency. The code or standard selected must be the version current at the time of building design. If the time of design is unclear (may be difficult to clearly identify), it will be deemed to be no more than three years before the commissioning of the building. The code/standard selected for the purpose of determining the baseline of new facilities must be identified and justified. Publication date and version number must also be clearly identified.

Historical data is not available for new builds; therefore project developers must establish the project baseline based on the lowest energy usage level contained in prevalent regulations. Good practice guidance or standards (including, but not limited to MNECB, ASHRAE) provide minimum requirements for the energy-efficient design of buildings and can be used to support a performance standard baseline. Justification for the selection of the appropriate edition of the standard or building code must be provided in the Offset Project Plan and should speak to the relevant version being used based on the project/building characteristics and year of design and/or commissioning.

Baseline Scenario Adjustments[6]

The baseline scenario identified for the projects eligible under this quantification protocol will require adjustments to ensure consistency with the project. Typical adjustment includes routine adjustments and non-routine adjustments as defined below.

Routine Adjustments of the Baseline

IPMVP provides the following guidance on performing routine baseline adjustments "for any energy-governing factors, expected to change routinely during the project period, such as weather. A variety of techniques can be used to perform the adjustments. Techniques may be as simple as a constant value (no adjustment) or as complex as a several multiple parameter non-

[5] Refer to IPMVP Volume III, Part 1 (2006) Chapter 2, and Volume I (2009), section 4.10 for additional information on baselines for new facilities

[6] Appendix A of IMPVP Volume 1 contains examples of routine and non-routine adjustments that may be useful for users of this protocol to review.

linear equations each correlating energy with one or more independent variables. Valid mathematical techniques must be used to derive the adjustment method.” Project developers should review the IPMVP protocol for examples of routine adjustments.

Non-Routine Adjustments of the Baseline

IPMVP provides the following guidance on performing non-routine adjustments “for those energy-governing factors which are not usually expected to change, such as: the facility size, the design and operation of installed equipment, or the type of occupants. These static factors must be monitored for change throughout the project period.”

Non-Surplus Adjustments of the Baseline

Non-routine adjustments are defined to include any necessary adjustments to the baseline arising from changes in the ‘surplus’ status of the project or parts thereof. During the project period, baseline data must be adjusted for any parts of the project which become non-surplus.

Surplus projects are defined as Energy Conservation Measures that were not required by then prevalent laws, regulations, building codes and acts. However, if any change occurs to such requirements after the project was installed, project eligibility (or surplus) may change. Therefore, any necessary non-surplus adjustment must be made to the baseline.

A common situation warranting a non-surplus baseline adjustment arises when a project replaces equipment with more efficient equipment, but ahead of its normal end of life date. Up to its normal end of life date, the savings would be surplus and therefore determined relative to the historical baseline. However after this date, the baseline becomes the efficiency standard prevailing at the time of the retrofit.

To enable non-surplus baseline adjustments, the project documentation must report the:

- original installation date and normal lifetime of all equipment that is replaced under the project. Normal lifetime data should come from referenced independent sources.
- energy standards inherent in any relevant building codes, acts and common products or practices used in the industry, as of the date of the retrofit.

Ongoing reporting of savings must make non-surplus adjustments beginning with the date of change in surplus status, such as the date of a relevant new regulation or the notional end of life dates of relevant sections of the retrofit. These adjustments must bring the baseline level to that of the standard that was in place at the time of project design. (If the project only installed equipment meeting those standards, the baseline equals the project energy use, and there are no further eligible savings.)

Project developer must provide calculation detail and justification for all routine and non-routine adjustments in the project report.

2.3 Identification of Sources and Sinks for the Baseline

Historical Benchmark and Performance Standard

All sources and sinks relevant to the baseline scenario selected must be identified. In addition to on-site sources and sinks, sources and sinks upstream and downstream of the facility must also be identified.

Common sources and sinks found in energy efficiency projects related to buildings include, but are not limited to:

- On Site fuel burning
- Materials manufacturing
- Transportation of equipment
- Electricity production (on-site or purchased from grid), fossil fuel production and delivery to the site
- Maintenance, operation, construction and decommission (energy consumed during these activities)

All sources and sinks have been arranged by their relation to the project site and the time at which greenhouse gas emissions occur, as seen in **FIGURE 2.2**.

FIGURE 2.1: Process Flow Diagram for Baseline Condition

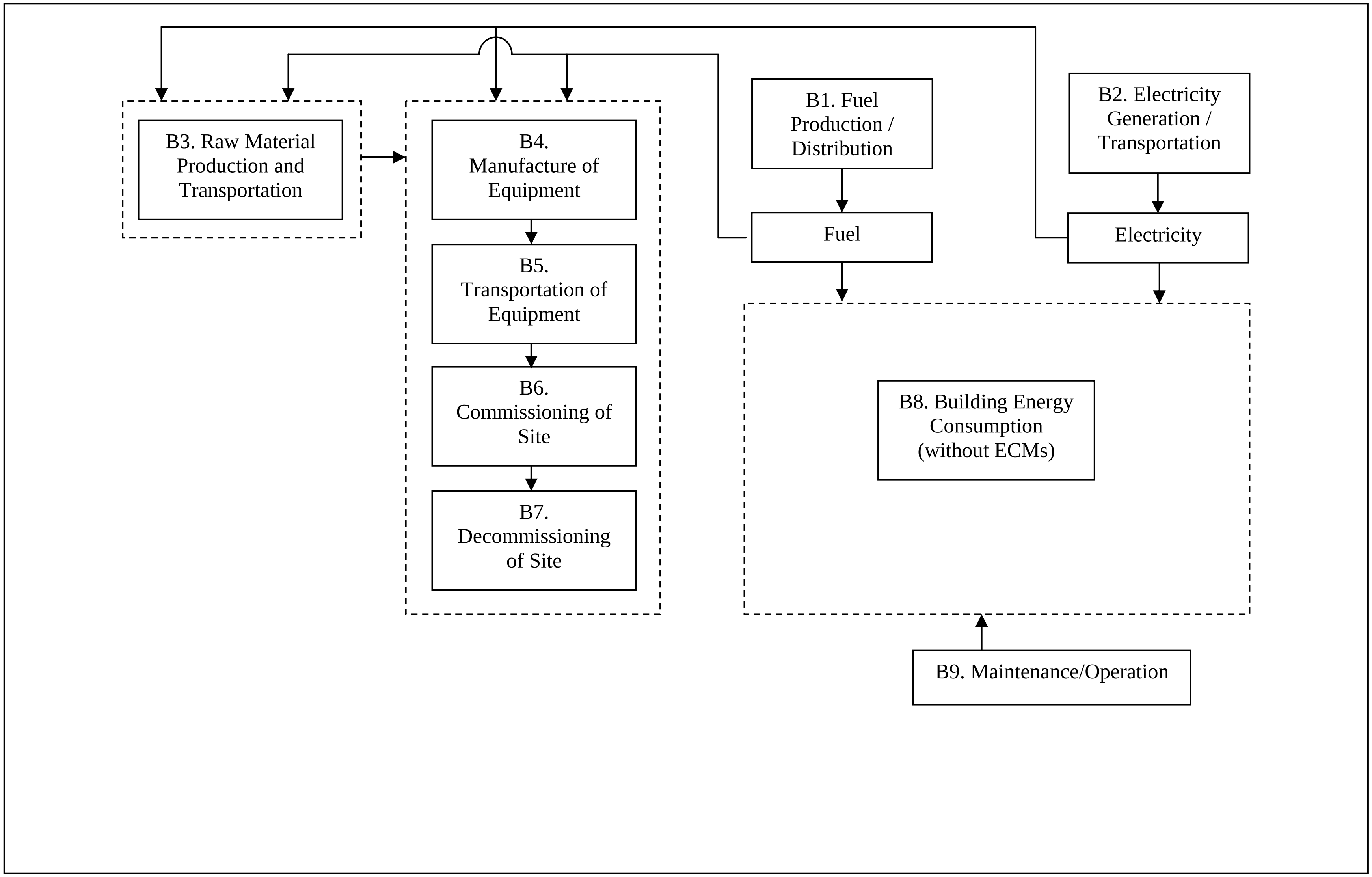

FIGURE 2.2: Baseline Element Life Cycle Chart

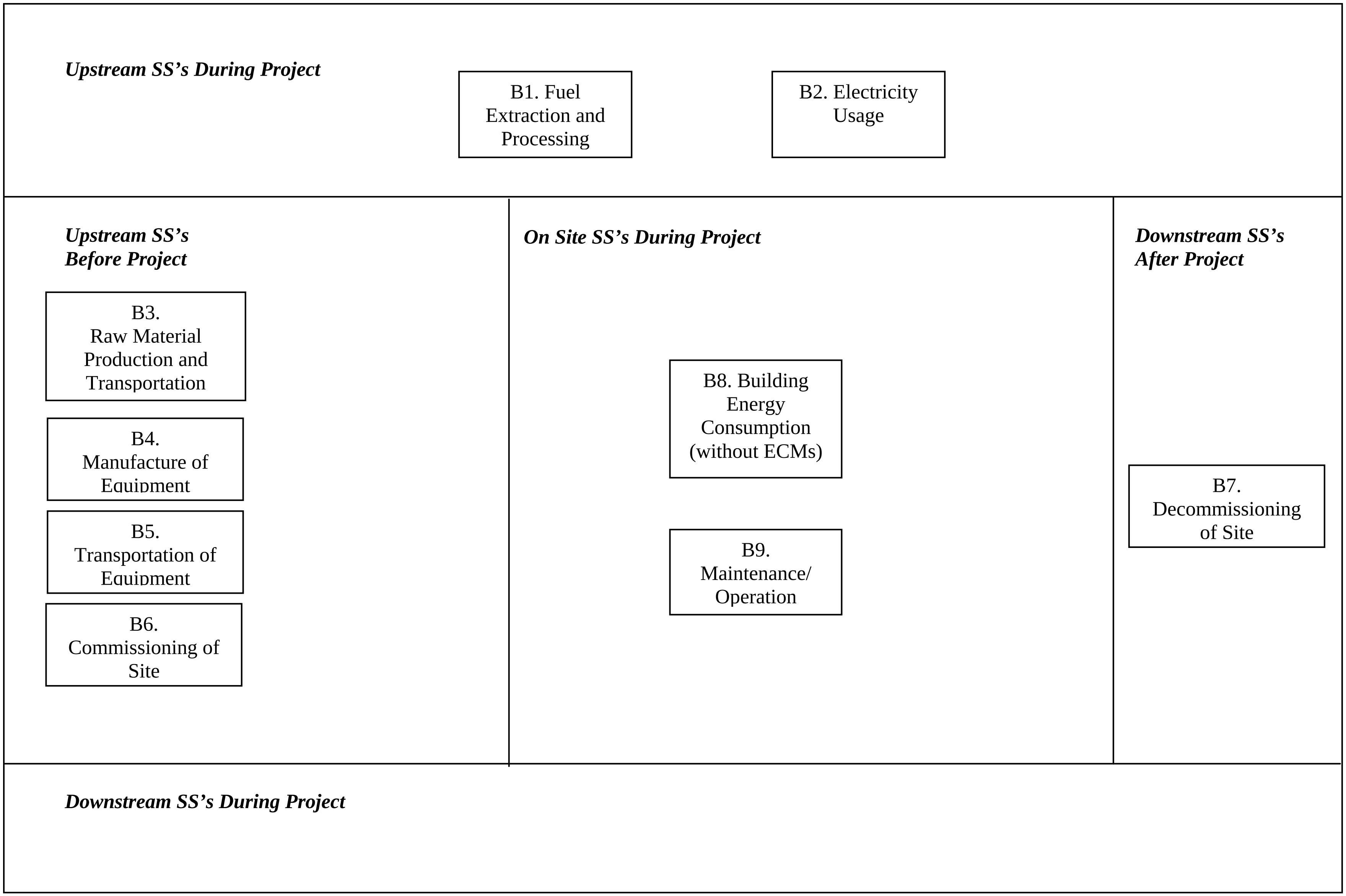

TABLE 2.1: Baseline Sources and Sinks

1. Sources, Sinks and Reservoirs (SS's)	2. Description	3. Controlled, Related or Affected
Upstream SS's Before Project Operation		
B3. Raw Material Production and Transportation	Raw materials, used in the manufacture of equipment for in the implementation of Energy Conservation Measure and conventional building operation. Usually produced offsite and transported to the manufacturing facility. Emissions will arise from the use of fossil fuels and electricity during these processes. These raw materials may include but are not limited to cement, plastic, aluminum, steel and/or rubber.	Related
B4. Manufacture of Equipment	Greenhouse gas emissions will arise from the manufacturing process of the equipment to implement the Energy Conservation Measures and conventional building operation in the project. Such emissions will likely be associated with the fossil fuels and electricity consumed during the manufacturing process.	Related
B5. Transportation of Equipment	Equipment used in the implementation of the Energy Conservation Measures and conventional building operation must be transported to the project site. Greenhouse gas emissions will primarily be attributed to the combustion of fossil fuels during the transportation process.	Related
B6. Commissioning of Site	The development of the site (technically on-site before project) and installation of equipment will result in greenhouse gas emissions, primarily from the use of fossil fuels and electricity during this process.	Related
Upstream SS's During Project Operation		
B1. Fuel Extraction and Processing	Each of the fuels used throughout the on-site component of the project will need to sourced and processed. This will allow for the calculation of the greenhouse gas emissions from the various processes involved in the production, refinement and storage of the fuels. The total volumes of fuel for each of the on-site SS's are considered under this SS. Volumes and types of fuels are the important characteristics to be tracked.	Related
B2. Electricity Usage	Electricity will be used in the project condition. This power may be sourced either from internal generation, connected facilities or the local electricity grid. Metering of electricity may be netted in terms of the power going to and from the grid. Quantity and source of power are the important characteristics to be tracked as they directly relate to the quantity of greenhouse gas emissions..	Related
On Site SS's During Project Operation		
B8. Building Energy Consumption (without Energy Conservation Measures)	Energy (including fossil fuel and electricity) is required on-site to operate the building. Equipment utilizing this energy includes boilers, lighting systems, HVAC Systems, ventilation systems, etc...	Controlled
B9. Maintenance/Operation	The facility and systems within the facility will require will require maintenance (both routine and non-routine). greenhouse gas emissions will arise from the use of fuels and electricity in maintenance and/or operational procedures.	Controlled
Downstream SS's During Project Operation		

None		
Downstream SS's After Project Operations		
B7. Decommissioning of Site	Once the site is no longer in operation, the site will most likely need to be decommissioned. Greenhouse gas emissions will arise from the use of fossil fuels and electricity during equipment disassembly, disposal, and other required activities during the process.	Related

3.0 Identification of Sources and Sinks for the Project

Greenhouse gas emissions reductions are quantified as the difference in emissions associated with project sources and sinks compared against the baseline sources and sinks. **FIGURE 3.1** provides a list of common sources and sinks associated with energy efficiency projects. All sources and sinks applicable to the project must be identified in the Offset Project Plan. If a source or sink is not applicable to the project, sufficient justification must be provided to support the exclusion.

Common sources and sinks found in energy efficiency projects related to buildings include, but are not limited to:

- On Site fuel burning
- Materials manufacturing
- Transportation of equipment
- Electricity production (on-site or purchased from grid), fossil fuel production and delivery to the site
- Maintenance, operation, construction and decommission (energy consumed during these activities)

Based on the process flow diagrams provided in **FIGURE 3.1**, the project sources and sinks were organized into life cycle categories in **FIGURE 3.2**. Descriptions of each of the sources and sinks and their classification as controlled, related or affected are provided in **TABLE 3.1**.

FIGURE 3.1: Process Flow Diagram for Project Condition

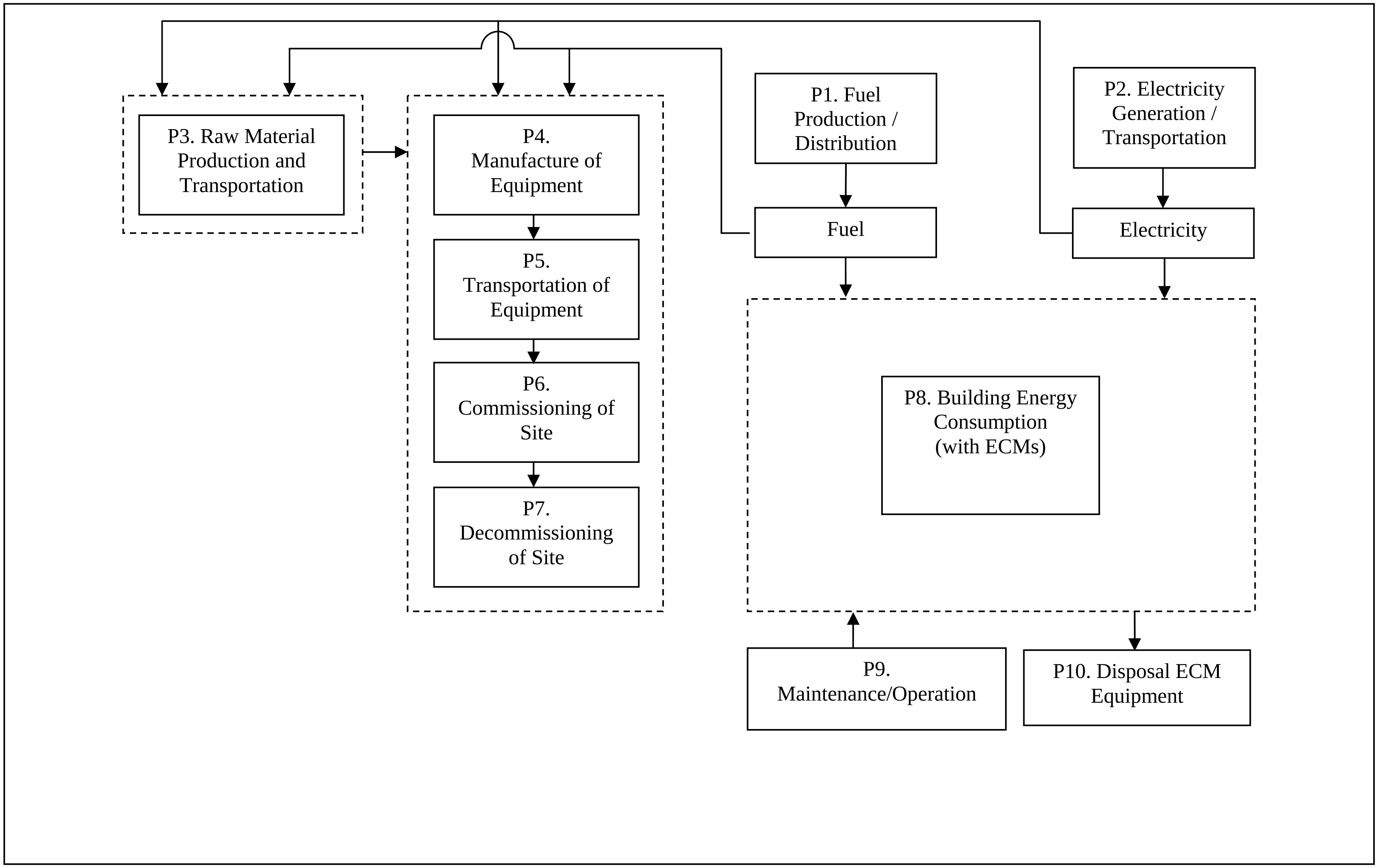

FIGURE 3.2: Project Element Life Cycle Chart

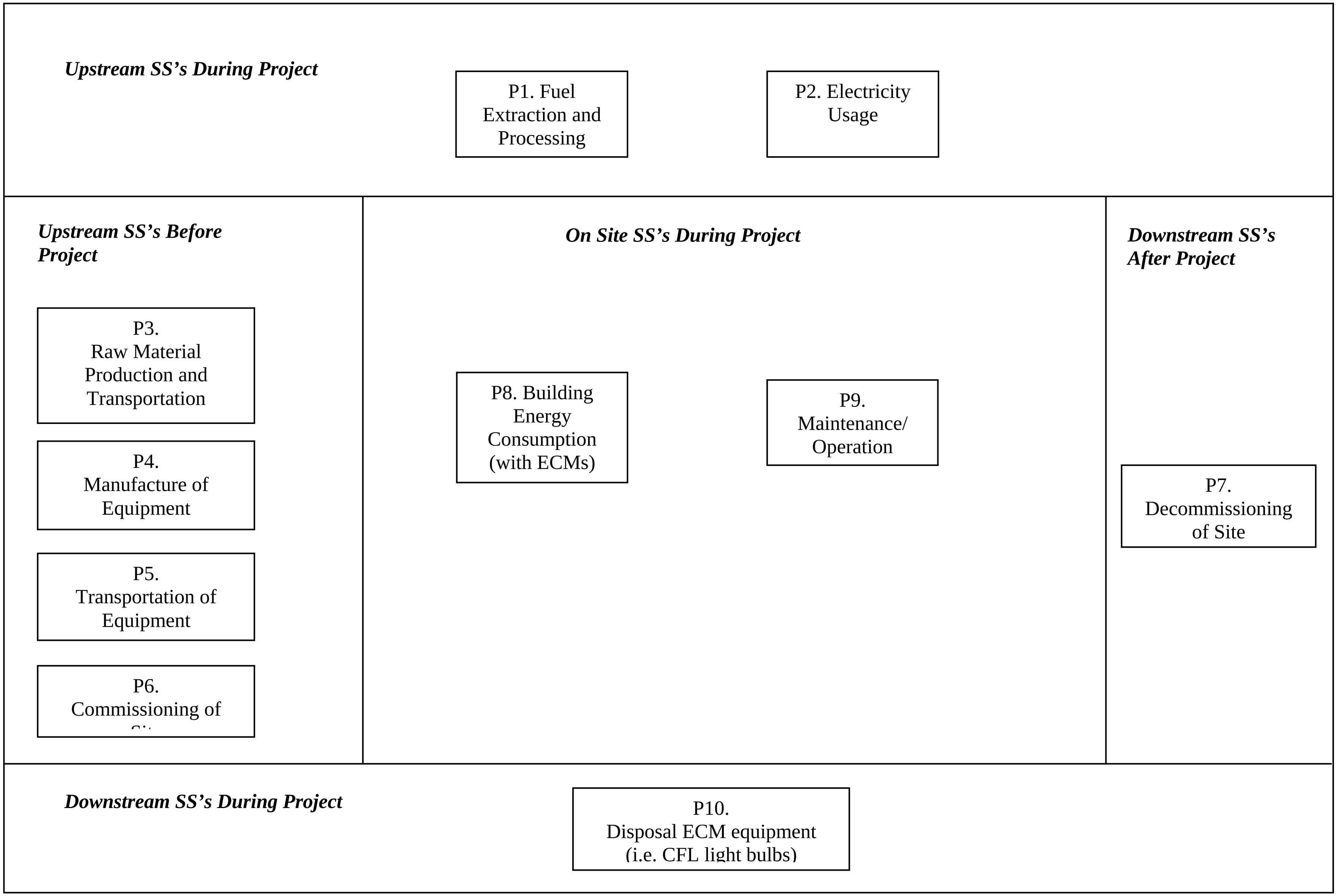

TABLE 3.1: Project Sources and Sinks

1. Sources, Sinks and Reservoirs (SS's)	2. Description	3. Controlled, Related or Affected
Upstream SS's Before Project Operation		
P3. Raw Material Production and Transportation	Raw materials, used in the manufacture of equipment for in the implementation of Energy Conservation Measure and conventional building operation. Usually produced offsite and transported to the manufacturing facility. Emissions will arise from the use of fossil fuels and electricity during these processes. These raw materials may include but are not limited to cement, plastic, aluminum, steel and rubber.	Related
P4. Manufacture of Equipment	Greenhouse gas emissions will arise from the manufacturing process of the equipment to implement the Energy Conservation Measures and conventional building operation in the project. Such emissions will likely be associated with the fossil fuels and electricity consumed during the manufacturing process.	Related
P5. Transportation of Equipment	Equipment used in the implementation of the Energy Conservation Measures and conventional building operation must be transported to the project site. Greenhouse gas emissions will primarily be attributed to the combustion of fossil fuels during the transportation process.	Related
P6. Commissioning of Site	The development of the site (technically on-site before project) and installation of equipment will result in greenhouse gas emissions, primarily from the use of fossil fuels and electricity during this process.	Related
Upstream SS's During Project Operation		
P1. Fuel Extraction and Processing	Each of the fuels used throughout the on-site component of the project will need to sourced and processed. This will allow for the calculation of the greenhouse gas emissions from the various processes involved in the production, refinement and storage of the fuels. The total volumes of fuel for each of the on-site SS's are considered under this SS. Volumes and types of fuels are the important characteristics to be tracked.	Related
P2. Electricity Usage	Electricity will be used in the project condition. This power may be sourced either from internal generation, connected facilities or the local electricity grid. Metering of electricity may be netted in terms of the power going to and from the grid. Quantity and source of power are the important characteristics to be tracked as they directly relate to the quantity of greenhouse gas emissions..	Related
On Site SS's During Project Operation		
P8. Building Energy Consumption (with Energy Conservation Measures)	Energy (including fossil fuel and electricity) is required on-site to operate the building. Equipment utilizing this energy includes but is not limited to boilers, lighting systems, HVAC Systems and ventilation systems.	Controlled

P9. Maintenance/Operation	The facility and systems within the facility will require maintenance (both routine and non-routine).Greenhouse gas emissions will arise from the use of fuels and electricity in maintenance and/or operational procedures.	Controlled
Downstream SS's During Project Operation		
P10. Disposal of Energy Conservation Measure Equipment	The disposal of some materials/equipment which compose all or a component of the Energy Conservation Measures may result in greenhouse gas emissions. E.g. the disposal of Compact Fluorescent Light (CFL) bulbs to appropriately remove mercury, disposal of transformer containing SF_6	Related
Downstream SS's After Project Operation		
P7. Decommissioning of Energy Conservation Measure equipment	Once the Energy Conservation Measure equipment comes to the end of its life Greenhouse gas emissions may arise from the incremental use of fossil fuels and electricity during equipment disassembly, disposal, and other required activities during the process, compared to the baseline.	Related

4.0 Quantification

Each of the sources and sinks from the project and baseline condition were compared and evaluated as to their relevancy using the guidance provided in Annex VI of the "Guide to Quantification Methodologies and Protocols: Draft", dated March 2006 (Environment Canada). The justification for the exclusion or conditions upon which sources and sinks may be excluded is provided in **TABLE 4.1** below. All other sources and sinks listed previously are included.

TABLE 4.1: Comparison of Sources and Sinks

1. Identified SS's	2. Baseline (C, R, A)	3. Project (C, R, A)	4. Included or Excluded	5. Justification for Exclusion
Upstream SS's				
P1/B1 Fuel Extraction and Processing	Related	Related	Excluded	Excluded since emissions from fuel production/distribution are expected to be greater under the baseline condition†
P2/B2 Electricity Usage	Related	Related	Excluded	Excluded since emissions from electricity generation/distribution are expected to be greater under the baseline condition†
P3/B3 Raw Material Production and Transportation	Related	Related	Excluded	Excluded as per good practice guidance from Environment Canada; These greenhouse gas emission are expected to be insignificant over the course of the project.
P4/B4 Manufacture of Equipment	Related	Related	Excluded	Excluded as per good practice guidance from Environment Canada; These greenhouse gas emissions are expected to be insignificant over the course of the project.
P5/B5 Transportation of Equipment	Related	Related	Excluded	Emissions from transportation of equipment are not expected to be material given the long project life and the minimal transportation of equipment typically required.
P6/B6 Commissioning typically required for Energy Conservation Measure implementation on Site	Related	Related	Excluded	Emissions from the commissioning of the site are not material given the long project life and minimal construction
On Site SS's				
P8/B8 Building Energy Consumption (with/without Energy Conservation Measures)	Controlled	Controlled	**Included**	The difference in emissions from the baseline to the project period are mainly due to implemented Energy Conservation Measures.
P9/B9 Maintenance and Operations	Controlled	Controlled	**Included**	Emissions from maintenance/operational changes in baseline and project period must be tracked in order to claim emission reductions.
Downstream SS's				
P7/B7 Decommissioning of Site	Related	Related	Excluded	Excluded as per good practice guidance from Environment Canada; These greenhouse gas

				emissions are expected to be insignificant over the course of the project.
P10 Disposal of Equipment for Energy Conservation Measure	N/A	Related	Excluded	Excluded as emissions from equipment disposal are expected to be minimal‡

†In the case that the project results in increased fuel consumption or increased electricity consumption, greenhouse gas emissions from this source will be higher for the project scenario than baseline and must be quantified and subtracted from gross greenhouse gas reductions.

‡Sources of greenhouse gas emissions from Energy Conservation Measure equipment/material must be reviewed as inclusion should be determined on a case-by-case basis. Any greenhouse gas emissions from this SS should be noted and quantified or excluded with justification while other environmental impacts should be noted.

4.1 Quantification Methodology

4.1.1 Quantification Approaches

The project may generate greenhouse gas emission reductions through the introduction of eligible energy conservation measures which affect the greenhouse gas emission output of the project sources and sinks. Eligible energy savings are comprised of energy reductions achieved through the implementation of a project, and not through a decrease in operating capacity. Outlined below is the general approach to quantifying greenhouse gas emission reductions as stated in ISO 14064-2:2006.

$$\text{Emission Reduction} = \text{Emissions}_{\text{Baseline}} - \text{Emissions}_{\text{Project}}$$

$$\text{Emissions}_{\text{Baseline}} = \text{Emissions}_{\text{Building Energy Consumption (without ECMs)}}$$

$$\text{Emissions}_{\text{Project}} = \text{Emissions}_{\text{Building Energy Consumption (with ECMs)}}$$

Where:

$\text{Emissions}_{\text{Baseline}}$ = sum of the emissions under the baseline condition.

$\text{Emissions}_{\text{Building Energy Consumption (without ECMs)}}$ = emissions under SS B8 Building Energy Consumption (without energy conservation measures)

$\text{Emissions}_{\text{Project}}$ = sum of the emissions under the project condition.

$\text{Emissions}_{\text{Building Energy Consumption (with ECMs)}}$ = emissions under SS B8 Building Energy Consumption (with energy conservation measures)

The emission reductions from the energy conservation measures will be quantified using methodology with the same principle as above. The project's greenhouse gas emission reductions are quantified for each energy type (i) saved as:

$$\textbf{Greenhouse Gas Emission Reduction}_{i} = \sum (\textbf{Eligible Energy Savings}_{i} \times \textbf{Emission Factor}_{i})$$

Where:

Eligible Energy Savings $_i$ comes from the procedures defined below, for each energy type $_i$
Emission Factor $_i$ comes from the procedures defined in this section of the protocol and **APPENDIX A**.

Greenhouse gas emission reductions shall be expressed in metric tonnes of CO_2 equivalent.

Determination of Energy Savings
Quantification of greenhouse gas emission reduction is performed based on the energy savings created by the project (difference between the baseline scenario and the project). The IPMVP suggests four (4) energy savings quantification options, defined in **TABLE 4.2**. Should IPMVP Option A or Option B be applied, secondary effects (described in **TABLE 4.2.3**) must be taken into consideration.

According to the IPMVP "energy savings cannot be directly measured, since savings represent the absence of energy use. Instead, savings are determined by comparing measured use before and after implementation of a program, making suitable adjustments for changes in conditions." For this Quantification protocol the energy savings are calculated according to the following formula taken from IPMVP:

Energy Savings = "Adjusted Baseline" Energy – "Project Period" Energy
+/- "Non Routine Adjustments" of baseline energy to project period conditions

Where,
"Adjusted Baseline Energy" is defined as the baseline energy plus any routine adjustments needed to adjust it to the conditions of the project period."
"Baseline energy", "Routine Adjustments", and "Non routine Adjustments" are discussed and defined below in this section of the protocol.

Typical baseline information required includes the following:

- energy consumption values with meter reading intervals at various locations depending on quantification option selected (A, B, C or D);
- static factors: "energy governing characteristics of the facility which do not normally change. For example: building size shape, type of usage, fixed schedules, indoor temperatures, light levels, ventilation rates, equipment nameplate data"[7]; and
- independent variables: "energy governing characteristics of the facility and its use or environment which are expected to routinely change." For example: weather, occupancy.

Options for Determining Energy Savings
The energy savings equation presented in above can be applied following 4 different options as defined by IPMVP and summarized in **TABLE 4.2** presented below.

[7] From IPMVP Volume I, 2009

TABLE 4.2: Site Savings Determination Options[8]

IPMVP Option	How Savings Are Calculated	Typical Applications
A. Retrofit Isolation: Key Parameter Measurement Savings are determined by field measurement of the key performance parameter(s) which define the energy use of the energy conservation measure's affected system(s) and/or the success of the project. Measurement frequency ranges from short-term to continuous, depending on the expected variations in the measured parameter, and the length of the project period. Parameters not selected for field measurement are estimated. Estimates can be based on historical data, manufacturer's specifications, or engineering judgment. Documentation of the source or justification of the estimated parameter is required. The plausible savings error arising from estimation rather than measurement is evaluated (need to evaluate the savings uncertainty associated with the estimation versus the savings uncertainty associated with actual measurements)	Engineering calculation of baseline and project period energy from: • Short-term or continuous measurements of key operating parameter(s); and • Estimated values. Routine and non-routine adjustments as required. Interactive effects must be examined to accurately determine net energy savings.	A lighting retrofit where power draw is the key performance parameter that is measured periodically. Estimate operating hours of the lights based on building schedules and occupant behaviour.
B. Retrofit Isolation: All Parameter Measurement Savings are determined by field measurement of the energy use of the energy conservation measure-affected system. Measurement frequency ranges from short-term to continuous, depending on the expected variations in the savings and the length of the project period.	Short-term or continuous measurements of baseline and reporting-period energy, and/or engineering computations using measurements of proxies of energy use. Routine and non-routine adjustments as required. Interactive effects must be	Application of a variable-speed drive and controls to a motor to adjust pump flow. Measure electric power with a kW meter installed on the electrical supply to the motor, which reads the power every minute. In the baseline period this meter is in place for a week to verify constant loading. The meter is in

[8] From IPMVP Volume 1, 2009

	examined to accurately determine net energy savings.	place throughout the project period to track variations in power use.
C. Whole Facility Savings are determined by measuring energy use at the whole facility or sub-facility level. Continuous measurements of the entire facility's energy use are taken throughout the project period.	Analysis of whole facility baseline and project period (utility) meter data. Routine adjustments as required, using techniques such as simple comparison or regression analysis. Non-routine adjustments as required.	Multifaceted energy management program affecting many systems in a facility. Measure energy use with the gas and electric utility meters for the greater of a twelve month or full operating cycle baseline period and throughout the project period.
D. Calibrated Simulation Savings are determined through simulation of the energy use of the whole facility, or of a sub-facility. Simulation routines are demonstrated to adequately model actual energy performance measured in the facility. This Option usually requires considerable skill in calibrated simulation. (see IPMVP volume 1- Section 4.10.1 titled "Option D: Types of Building Simulation Programs" for examples of simulation software)	Energy use simulation, calibrated with hourly or monthly utility billing data. (Energy end use metering may be used to help refine input data.)	Multifaceted energy management program affecting many systems in a facility but where no meter existed in the baseline period. Energy use measurements, after installation of gas and electric meters, are used to calibrate a simulation. Baseline energy use, determined using the calibrated simulation, is compared to a simulation of project period energy use.

TABLE 4.2 is only a brief summary of the four options presented in IPMVP. Additional guidance provided in volume 1 and 3 of the IPMVP may be useful to project proponent in developing the project document associated with their projects.

Guidance on Option Selection

IPMVP states that the selection of the option is a decision based on various factors including project conditions, analysis required, budget and professional judgment. The following figure (from IMPVP volume 1) presents a diagram meant to assist project developers in determining which option is best suited for their type of project.

FIGURE 4.1: IPMVP Suggested Option Selection Process

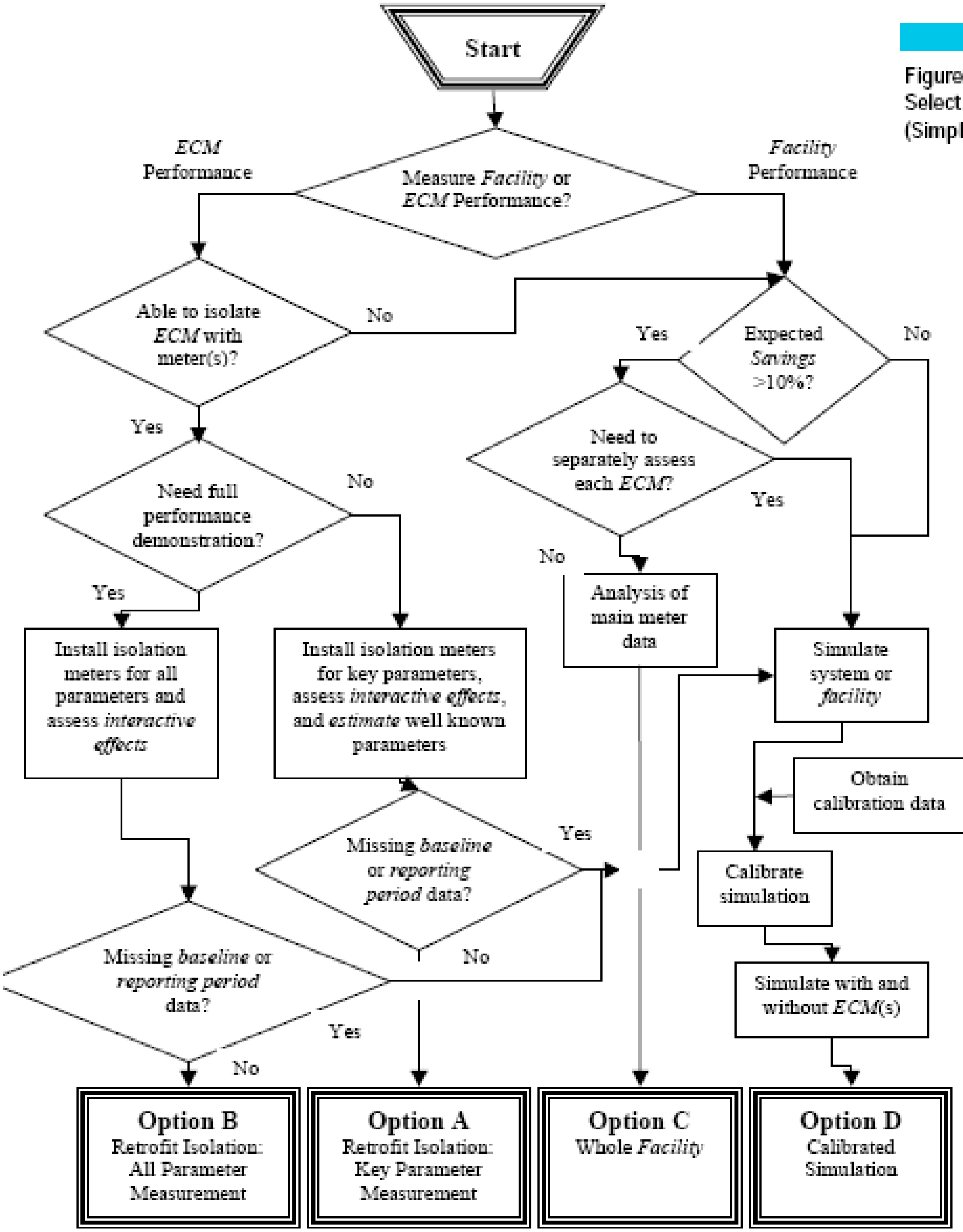

Figure 3 Option Selection Process (Simplified)

In addition IPMVP provides the following table to further assist project developers in selecting an option. **TABLE 4.2.1** presents key characteristics that suggest commonly favoured options.

TABLE 4.2.1: Suggested Option Selection Based on Project Key Characteristics

Table 3 Suggested (not the only) Options - Marked by X

ECM Project Characteristic	Suggested Option			
	A	B	C	D
Need to assess *ECMs* individually	X	X		X
Need to assess only total facility performance			X	X
Expected *savings* less than 10% of utility meter	X	X		X
Multiple *ECMs*	X		X	X
Significance of some *energy* driving variables is unclear		X	X	X
Interactive effects of ECM are signficant or unmeasurable			X	X
Many future changes expected within *measurement boundary*	X			X
Long term performance assessment needed	X		X	
Baseline data not available				X
Non-technical persons must understand reports	X	X	X	
Metering skill available	X	X		
Computer simulation skill available				X
Experience reading utility bills and performing regression analysis available			X	

Secondary Effects for Option A and B (sometimes D): Retrofit Isolation

The application of the retrofit isolation techniques requires that no significant energy effects be excluded from the measurement boundary. When the measurement boundary is selected, care should be taken to ensure that energy flows affected by the energy conservation measures but outside the measurement boundary are considered. The project document must list all potential effects of an energy conservation measure (positive or negative) on any energy stream, along with an estimate of the likely annual savings magnitude of each. The method of estimating each listed impact must be described, noting the factors affecting the accuracy of each estimate.

The largest energy effect (herein called Primary Effect) must be measured. All other energy effects (herein called Secondary Effects) must be treated as described in Section 4.1.3.

4.1.2 Determining Eligible Energy Savings

The fraction of the Energy Savings eligible under this protocol depends upon the approach to accuracy chosen by the project proponent. A multiplier factor must be applied to the energy savings otherwise calculated, to ensure that greenhouse gas emission reductions are not over-estimated due to uncertainty related to the monitoring techniques selected.

Eligible Energy Savings = Energy Savings * M

Where:

"Energy Savings" are derived from the equation in Section 4.1.1

"M" is the Eligibility Multiplier dictated by the choice between Simple and Advanced Approaches to measurement and analysis accuracy, as defined in Section 4.1.3

4.1.3 Accuracy Approaches

Accuracy is not readily defined. However for purposes of this Protocol two standards are set: Simple and Advanced approaches in determining savings. Simple Approaches must at least adhere to the requirements of Section 4.1.3.1. They are allowed to use an M of 0.90 in the equation of Section 4.1.2. This ensures a conservative energy savings calculation when using the simplified approach.[9] More accurate approaches adhere to at least the characteristics of Advanced Approaches shown in Section 4.1.3.2. and may use an M of 1.0.

4.1.3.1. Simple Approaches (M = 0.90)

Measurement equipment used in Simple Approaches shall have the minimum characteristics shown in **TABLE 4.2.2**.

TABLE 4.2.2: Minimum Meter Accuracy Requirements - Simple Approach

Meter Type	Confidence Interval	Precision	Additional Information
Whole facility energy meters	N/A	N/A	Utility Quality Metering

[9] The 0.90 eligibility multiplier was determined based on the following: Monitoring and quantification procedures prescribed for the simple approaches (particularly selection of secondary effects), are designed to err on the conservative side in order to not over-estimate GHG emission reductions. The EE industry has found that monitoring and verification of "acceptable" quality can be done at a cost of 3% of annual savings for large projects over several years. "Acceptable" in this case can be defined in terms of buyers and sellers of ESCO services being comfortable with the amounts to be paid under a performance contract. The industry also gives guidance that monitoring &verification costs should not exceed 10% of savings. However, for the purpose of a GHG transaction due to incremental revenue and public interest, we might consider 10% of savings as a guidepost for what might be paid for an Advanced approach, recognizing the need for greater confidence when dealing with the atmosphere rather than 'acceptability' to buyer and seller of ESCO services. So, simple approaches may have monitoring & verification costs of 2-3% of the savings, and advanced approaches closer to 10%. The requirements prescribed herein for both approaches aim to achieve this balance. So project developers or protocol users may see a net savings differential of 7-8% by moving from the simple to advanced methods. The 10% discount (0.9 multiplier) on the carbon value of simple approaches aims to offset some of the extra costs of advanced approaches (plausibly 10% of the annual energy savings), encouraging serious consideration of advanced approaches. The incremental amount of GHG emission reductions that can be claimed by moving from the simple approach to the advanced approach will have to be assessed for each project, in order to determine if the additional effort and cost associated with the advanced approach is worth pursuing from a net value perspective.

Electrical sub-meters	95%	±2%	No more than 15% of the expected measured values will exceed the selected meter's range, and no more than 1% of the expected measured values will exceed it by more than 20% the meter's range maximum or minimum.
Liquid flow meters		±10%	
Liquid flow meters (used to compute energy flow)		±3%	
Air flow meters		±10%	
Air flow meters (used to compute energy flow)		±3%	
Steam flow meters		5%	
Simple temperature		3%	
Differential temperature readings with matched sensors		0.5%	
Pressure or differential pressure		3%	
Operating hours		0.1%	

If measured data comes from an independent source (e.g. government weather data, electricity grid emission factor accepted by Alberta Environment) precision is presumed ±0%.
Any measurement of a sample of components rather than all components shall involve random sampling, and provide 20% precision at 80% confidence level showing proper statistical analysis.

Any estimated parameter(s) in IPMVP Option A must be selected to yield savings that are lower than would be obtained from 90% of the probable actual values of the estimated item.[10] The project report must present the range of possible values, their likely distribution, and the statistical analysis to justify the selection.

Simple Approaches for Retrofit Isolation Options A or B must include the:

- Secondary Effects of at least the energy conservation measures listed in **TABLE 4.2.3**, by estimation (not necessarily measurement), and
- Secondary Effects in the situations listed in **TABLE 4.2.4**, by measurement or estimation.

TABLE 4.2.3 Secondary Effects of Selected Energy Conservation Actions For Simple Approaches

Energy Conservation Measure	Secondary Effects that must be included by estimation
Lighting efficiency improvement	Heating, Cooling

[10] 90% of all values in a normally distributed range are above a value that is 1.28 standard deviations below the mean (z = 1.28, see standard normal distribution tables). Example – Under Option A, measured chiller efficiency improvement will be multiplied by estimated annual cooling load. Suppose the plausible values of annual cooling loads ranged between 2,000,000 ton-hours and 2,500,000 ton hours and can be assumed to be normally distributed over the range. The mean is 2,250,000 ton-hours. Assuming the 500,000 ton-hours range represents 99% of all possible values (and six standard deviations), one standard deviation is 83,300 ton-hours. The mean is 2,250,000 ton-hours. So, 1.28 standard deviations below the mean is 2,250,000 – (1.28 * 83,300) = 2,140,000 ton-hours. The estimated load should be 2,140,000 ton-hours, or lower to satisfy the 90% criterion.

Lighting operating period control	Heating, Cooling
Electric motor replacement with higher efficiency motor	Effect of higher motor speed on system performance and horsepower needs
Boiler or furnace replacement with higher efficiency units	Less heat recovered for use elsewhere
Chiller or refrigeration replacement with higher efficiency units	Condenser fan, condenser pump
Addition of a heat recovery device	Energy needed to overcome added resistance in associated air or water circulation system

TABLE 4.2.4 Additional Measurement or Estimation Requirements for Secondary Effects In Simple Approaches

Situation	Action
Estimated savings impact of a Secondary Effect is >30% of the Primary effect	Measure and include the Secondary Effect
Net estimated impact of all Secondary Effects *increases* energy savings by more than 30%	Measure and include any secondary effect larger than 10% (positive or negative) of the Primary effect
Secondary Effect is estimated to reduce energy savings	Estimate and include the Secondary Effect

Any regression model shall have an "R^2" statistic of at least 0.80. Any independent variable in a regression model shall have a "t" value of at least 1.8.

For Whole Facility Option C (without the on/off test method[11]):

- there can be no gaps in the baseline record;
- there shall be a minimum of 9 valid energy meter readings during the baseline period;
- no baseline data points can be excluded;

IPMVP Option D is *not* eligible for Simple Approaches.

4.1.3.2 Advanced Approaches (M = 1.0)

Advanced Approaches must:

- Present in the project report a full analysis of all quantifiable uncertainties expected in the energy savings reports. This analysis must use good statistical techniques[12].
- Have an expected quantifiable precision in average savings no higher than +/-10% at 90% confidence, assuming savings are achieved as planned.

Advanced Approaches for Retrofit Isolation Options A or B must include:

[11] Refer to IMPVP Vol 1 2009, Section 4.5.3, for detailed description of on/off test method

[12] IPMVP Vol I, 2009, Appendix B, gives some basic guidance on statistical concepts relevant to energy savings reports, but does not define all aspects of statistical analysis.

- Secondary Effects of at least the energy conservation measures listed in **TABLE 4.2.5**, by estimation or measurement as shown, and
- Measurement of all Secondary Effects equal to or larger than 10% of the Primary effect. Estimate all other Secondary Effects.

TABLE 4.2.5 Secondary Effects For Advanced Approaches

Energy Conservation Measure	Secondary Effects that must be included	
	By estimation	By measurement
Lighting efficiency improvement	Cooling	Heating
Lighting operating period control	Cooling	Heating
Electric motor replacement with higher efficiency motor		Effect of higher motor speed on system performance and horsepower needs
Boiler or furnace replacement with higher efficiency units		Less heat recovered for use elsewhere
Chiller or refrigeration replacement with higher efficiency units	Condenser pump	Condenser fan
Addition of a heat recovery device		Energy needed to overcome added resistance in associated air or water circulation system

Calibrated Simulation Option D[13] is only eligible for Advanced Approaches. The Coefficient of Variation of the Root Mean Squared Error, or CV (RMSE)[14], of the deviations between the actual calibration energy data and the simulation model's predicted energy data must be less than 15%, if using monthly calibration data, or 30% if using hourly data[15].

4.1.4 Greenhouse Gas Emission Factors

The emission factor in the equation in Section 4.1.1 is taken from the greenhouse gas emission factors accepted by Alberta Environment as provided in **TABLE A.1**.

4.1.5 Contingent Data Approaches

Contingent means for calculating or estimating the required data are outlined in the Simple Approach, Section 4.1.3.1.

4.2 Management of Data Quality

[13] Refer to IMPVP Vol 1 2009 for detailed description of Calibrated Simulation Option D, equation 1f).
[14] See IPMVP Vol I 2009, Appendix B-2.2.2
[15] See ASHRAE Guideline 14-2002 Section 5.3.2.4.f for examples of error ranges although these are not the only acceptable values but rather examples to guide the users

4.2.1 Record Keeping

For energy efficiency projects, the monitoring plan will be specific to the energy conservation measures implemented and the energy savings quantification approach selected. The monitoring plan shall be designed based on the accuracy requirements presented in this protocol.

Measurement system design and installation shall follow best practice in the industry, as defined in relevant standards and by the manufacturer of the measurement, communication and logging equipment.

Meters shall be selected and operated to meet the accuracy requirements specified in this protocol for both the simplified and the advanced approach.

The monitoring plan shall include, at a minimum, for all parameters measured:

a) Purpose of measurement, type of meter, units or measure, physical location, frequency of measurement
b) Manufacturer of sensor, model, serial number
c) Frequency of regular reading or polling of the sensor
d) Memory capacity of any instrument temporarily storing data,
e) Contingency procedures in case of memory overflow
f) Meter reading process (if readings are done manually)
g) Manufacturer of data logger, model, serial number
h) Sensor and logger range and precision
i) The expected range of values to be measured
j) Frequency of calibration, calibration method
k) Maintenance procedures
l) Address of data telemetry point, archive place for data and frequency of archiving
m) Monitoring/measurement roles and responsibilities

Meter systems may be designed to measure an accumulated quantity, or an instantaneous quantity by regular periodic sampling. Accumulating meters can have their values read on an irregular basis without impeding the quality of the resultant data because they report cumulative energy. However when instantaneous readings are taken periodically, the frequency of meter reading is critical to the quality of the resultant data. The measurement period for instantaneous quantities must be matched to the rate of change of the quantity.

When periodically sampling the values of a quantity by instantaneous rather than cumulative measurement, the project design document must show the expected rate of rate of change of the quantity. It must also show how the selected measurement frequency allows the net measurement error to meet the accuracy requirements of the simple or advanced approach.

Measurements may also be made by statistically valid random sampling of a group of many similar devices or systems operating in similar ways. The mean of the readings from such random samples can be taken as valid readings of the entire group, providing the random sampling error meets the requirements of the simple or advanced approach.

Alberta requires that Project Developers maintain appropriate supporting information for the project, including all raw data for the project for a period of 7 years **after** the end of the project crediting period. Where the Project Developer is different from the person implementing the activity, as in the case of an aggregated project, the individual building owner and the aggregator, must both maintain sufficient records to support the Offset Project. The project developer (owner and aggregator) must keep the information listed below. All information must be available to the verifier and/or government auditor upon request.

TABLE 4.2.6: Record Keeping Requirements

Kept for 7 Years After Project Crediting Period
Raw baseline and project period energy data, independent variable data, and static factors within the measurement boundary
A record of all adjustments made to raw baseline data with justifications
All analysis of baseline data used to create mathematical model(s)
All data and analysis used to support Option A estimates
Expected end of life date of equipment removed or renovated under the project
Efficiency standards or common practices relevant to each energy conservation measure at the date of project commitment
Metering equipment specifications (model number, serial number, manufacturer's calibration procedures)
A record of changes in static factors and non-surplus characteristics along with all calculations for non-routine adjustments
If Calibrated Simulation Option D1 is used: all input data, output data. Also the software name and version number, if public domain software is used. If private software is used (even if available for purchase), a copy of the software must remain available for the verifier's free use and evidence retained of why it is suited to the simulation task
All calculations of energy savings, emission factors and greenhouse gas emission reductions
Measurement equipment maintenance activity logs
Measurement equipment calibration records
Initial and annual verification records and audit results
All records outlining ownership of the offset credits

4.2.2 Quality Assurance/Quality Control (QA/QC)

QA/QC can also be applied to add confidence that all measurements and calculations have been made correctly. These include, but are not limited to:

a) Protecting monitoring equipment (sealed meters and data loggers);
b) Protecting records of monitored data (hard copy and electronic storage);

c) Checking data integrity on a regular and periodic basis (manual assessment, comparing redundant metered data, and detection of outstanding data/records);
d) Comparing current estimates with previous estimates as a 'reality check';
e) Provide sufficient training to operators to perform maintenance and calibration of monitoring devices;
f) Establish minimum experience and requirements for operators in charge of project and monitoring; and
g) Performing recalculations to make sure no mathematical errors have been made.

The project proponent will need to demonstrate that the offset project plan and project report are developed or reviewed by a Certified Measurement and Verification Professional (CMVP)[16], or a Certified Energy Manager (CEM)[17] with at least 3 years of experience in implementing and quantifying energy efficiency projects.

4.2.3 Liability

Offset projects must be implemented according to the approved protocol and in accordance with government regulations. Alberta Environment reserves the right to audit Offset Credits and associated projects submitted to Alberta Environment for compliance under the *Specified Gas Emitters Regulation* and may request corrections based on audit findings.

[16] The Efficiency Valuation Organization (EVO) and the Association of Energy Engineers (AEE) jointly operate the "Certified Measurement and Verification Professional" program (CMVP)
[17] AEE operates the Certified Energy Manager (CEM) program

APPENDIX A

Emission Factors for Electricity Generation and Fuel Combustion

TABLE A.1 lists the most recent emission factors available for typical energy used in buildings. Project proponents using this protocol must ensure they utilize the most recent available emission factors. More specific emission factors (i.e. site specific emission factors) can be used but must be justified.

TABLE A.1: Emission Factors

Emission factor	**Value**			
Electricity				
Alberta Electricity Grid	0.650 [t CO_2e/MWh]			
Combustion				
Fuel	**CO_2**	**CH_4**	**N_2O**	**CO_2e**
Natural gas	1891[g CO_2/m^3]	0.037[g CH_4/m^3]	0.035[g N_2O/m^3]	0.001903 [t CO_2e/m^3]
#2 Fuel Oil	2725[g CO_2/L]	0.026[g CH_4/L]	0.031[g N_2O/L]	0.002735 [t CO_2e/L]
Diesel	2663[g CO_2/L]	0.133[g CH_4/L]	0.4[g N_2O/L]	0.002790 [t CO_2e/L]

Other required emission factors, such as those for the production of raw materials, may be acquired from the Environment Canada National Inventory Report or, if not listed in the Inventory Report, a life cycle database (such as SimaPro). Should a required emission factor not be available from this source, an emission factor from another source may be used if justified appropriately.

Sources of Emission Factors Listed in TABLE A.1:

Electricity – Emission factor developed and approved by Alberta Environment, will be updated on an on-going basis

Natural Gas – Environment Canada National Inventory Report, Table A12-1: Emission Factors for National Gas and NGLs; Residential, Construction, Commercial/Institutional, Agriculture

#2 Fuel Oil – Environment Canada National Inventory Report, Table A12-2: Emission Factors for Refined Petroleum Products; Light Fuel Oil; Forestry, Construction, Public Administration, and Commercial/Institutional

Diesel - Environment Canada National Inventory Report, Table A12-2: Emission Factors for Refined Petroleum Products; Diesel

Note: It is the responsibility of the project developer to ensure that all emission factors used for quantification purpose are the most recent.

APPENDIX B

Key Steps for Protocol Users

Key Steps for Energy Efficiency – Commercial and Institutional Protocol Users

1. Determine and evaluate all energy conservation measures for the project
2. Determine if the energy conservation measures/project are eligible under the protocol
3. Identify all project sources and sinks, including those upstream and downstream (i.e. material production, disposal) if relevant
4. Select baseline quantification approach
5. Identify all baseline sources and sinks, including those upstream and downstream (i.e. material production, disposal) if relevant
6. Determine what adjustments may need to be applied to the baseline to allow for accurate comparison between project and baseline (routine and non-routine adjustments)
7. Select and justify quantification approach (IPMVP Option A, Option B, Option C, or Option D)
8. Gather required data and factors for quantification
9. Following method selected in Step 6, quantify energy consumption for project and baseline as well as eligible energy savings
10. Using the energy savings determined in Step 9 and appropriate emission factors, quantify greenhouse gas reductions resulting from project (consider if greenhouse gas emission must be netted out of greenhouse gas emission reductions quantified due to increase in energy consumption in the project compared to the baseline, or due to disposal of energy conservation measure equipment)
11. Develop monitoring and QA/QC procedures
12. Develop greenhouse gas project report