QUANTIFICATION PROTOCOL FOR ENERGY EFFICIENCY PROJECTS:

ABRIDGED

Submitted to:

Alberta Environment

and

Alberta Agriculture, Food and Rural Development

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Disclaimer

The following document presents an abridged version of the Energy Efficiency protocol prepared for Alberta Environment and Alberta Agriculture, Food and Rural Development which has completed an initial round of technical review. This document has been prepared as a means of supporting a broader stakeholder consultation process. As such, this document should not be used as a quantification protocol.

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1.0 Project and Methodology Scope and Description

1.1 Protocol Scope and Description

This quantification protocol is applicable to the quantification of direct and indirect reductions of greenhouse gas (GHG) emissions resulting from the implementation of industrial, commercial and agricultural process changes and facility retrofits that result in overall efficiencies in energy use per unit of productivity. Process changes may include the mechanical, biological and/or chemical components of the operation and may impact upon on-site heat, electrical and power requirements. This protocol does not prescribe the configuration or nature of the process changes. Rather, this protocol serves as a generic 'recipe' for project proponents to follow in order to meet the measurement, monitoring and GHG quantification requirements. **FIGURE 1.1** offers a typical process flow diagram for a typical project.

While some procedures in this protocol may be transferable to other types of energy efficiency projects, there could be considerable differences which would lead to inaccuracy in the quantification of the GHG emission reductions.

The baseline condition for this protocol is defined as the process configuration prior to the process changes or facility retrofits. The energy and emissions footprint, per unit of production, of the baseline configuration would be established as part of an energy project assessment or similar method. The unit of production must be thoroughly justified in its application of incorporating functional equivalence across the calculations of emissions under the baseline and project conditions. **FIGURE 1.2** offers a process flow diagram for a typical baseline configuration.

The approach to quantifying the baseline will be projection based as there are suitable models for the applicable baseline condition that can provide reasonable certainty. The baseline scenario for this protocol is dynamic as the emissions profile for the baseline activities would be expected to change materially relative to the defined unit of production which may fluctuate relative to supply and demand dynamics, as well as other market conditions.

To demonstrate that a project meets the requirements under this protocol, the project proponent must supply sufficient evidence to demonstrate that:

1. The process changes or facility retrofits must rely on functionally equivalent inputs and outputs from the affected process as indicated by an attestation from the project proponent;
2. A suitable unit of production can be defined for incorporating functional equivalence within the calculation methodology as indicated by reasoned qualitative and quantitative analysis;

FIGURE 1.1: Project Element Life Cycle Chart

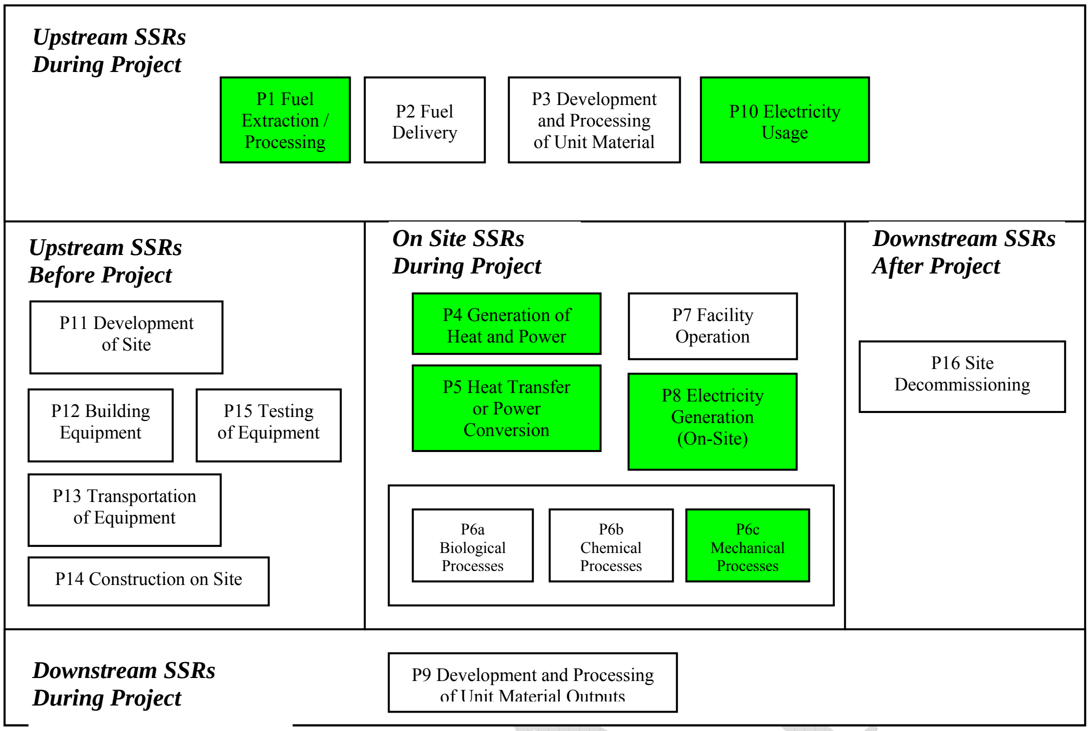
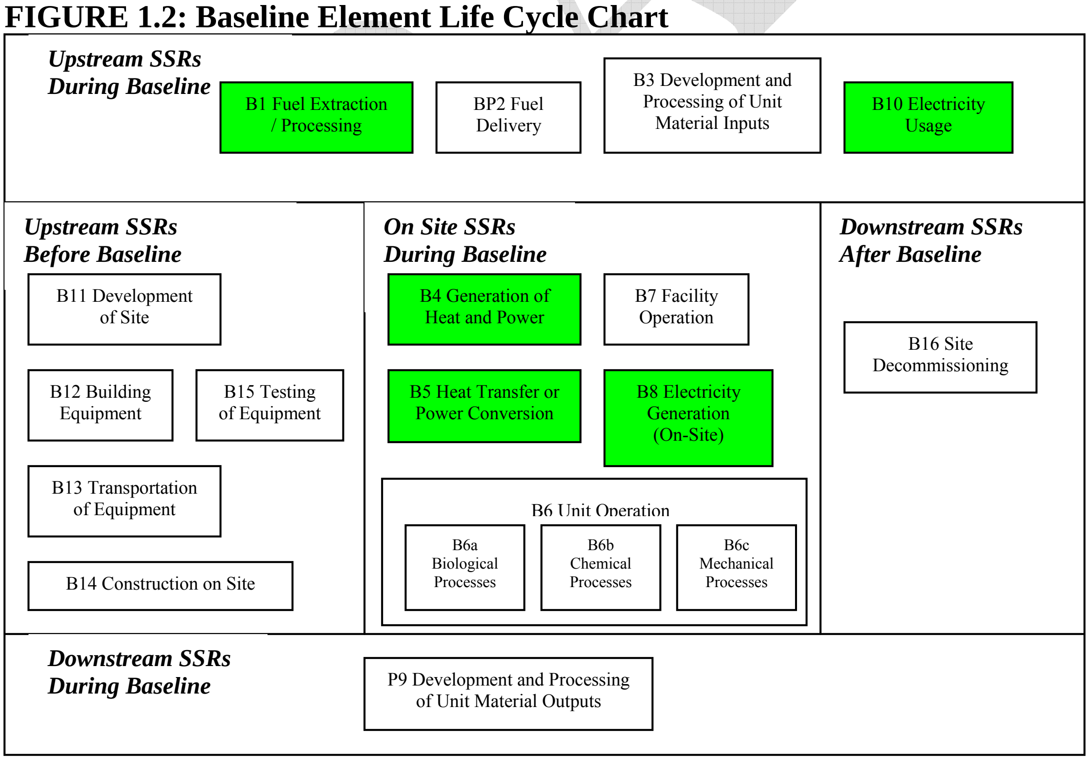


FIGURE 1.2: Baseline Element Life Cycle Chart



* Sources, sinks and reservoirs selected for measurement and monitoring under this protocol are highlighted.

3. Biological or chemical components of the operation must not yield any increase in non-biogenic greenhouse gas emissions under the project condition as compared to the baseline condition, unless these are accounted for under the applicable flexibility mechanisms as indicated by an attestation from the project proponent; and
4. The quantification of reductions achieved by the project is based on actual measurement and monitoring (except where indicated in this protocol) as indicated by the proper application of this protocol.

Flexibility in applying the quantification protocol is provided to project developers in eight ways:

1. The project proponent must provide and justify an appropriate model for any biological or chemical processes impacted at the facility. However, if these processes do not exist or are not impacted, the project proponent may exclude these SSRs under this protocol;
2. The requirement for an energy project assessment may be waived in situations were the baseline energy use per unit of production can be justified using available records;
3. New processes and/or facilities may be included under this protocol where a justification of a baseline condition can be made with reasonable certainty based on current industry practise, per unit of production;
4. Sources, sinks and reservoirs that can be shown to be functionally equivalent or not applicable for the project condition can be excluded from the analysis by the project proponent;
5. Project proponents may link to external ambient temperature data as a means of adjusting for functional equivalence;
6. The process changes may occur within a single unit or across multiple units. Further, the affected units may include multiple processes, equipment, etc. Defining the units impacted is to be justified by the project proponent;
7. Site specific emission factors may be substituted for the generic emission factors indicated in this protocol document. The methodology for generation of these emission factors must be sufficiently robust as to ensure reasonable accuracy; and
8. The process changes may impact the production efficiency and gross production. However, the project proponent must justify any changes in this regard and ensure that the impact of these changes are appropriately handled as part of the per-unit-production means of calculation.

If applicable, the proponent must indicate and justify why flexibility provisions have been used.

This quantification protocol is written for those familiar with process change and energy efficiency projects. Some familiarity with, or general understanding of, the operation of these practices and processes is expected.

2.0 Quantification of Identified Sources, Sinks and Reservoirs

Quantification of the reductions, removals and reversals for the sources, sinks and reservoirs selected for measurement and monitoring under this protocol will be completed using the methodologies outlined in **TABLE 2.1**, below. These calculation methodologies serve to complete the following three equations for calculating the emission reductions from the comparison of the baseline and project conditions.

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

$$\begin{aligned}\text{Emissions}_{\text{Project}} = {} & \text{Emissions}_{\text{Fuel Extraction / Processing}} + \text{Emissions}_{\text{Gen Heat and Power}} \\ & + \text{Emissions}_{\text{Transfer / Conversion}} + \text{Emissions}_{\text{Unit Operation}} \\ & + \text{Emissions}_{\text{Electricity Generation}} + \text{Emissions}_{\text{Electricity Usage}}\end{aligned}$$

$$\begin{aligned}\text{Emissions}_{\text{Project}} = {} & \text{Emissions}_{\text{Fuel Extraction / Processing}} + \text{Emissions}_{\text{Gen Heat and Power}} \\ & + \text{Emissions}_{\text{Transfer / Conversion}} + \text{Emissions}_{\text{Unit Operation}} \\ & + \text{Emissions}_{\text{Electricity Generation}} + \text{Emissions}_{\text{Electricity Usage}}\end{aligned}$$

TABLE 2.1: Quantification Procedures

1. Project/Baseline SSR	2. Parameter / Variable	3. Unit
	Project SSRs	
P1 Fuel Extraction and Processing	Emissions $_{Fuel\ Extraction\ /\ Processing}$ = ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CO2}$) ; ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CH4}$) ; ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ N2O}$)	
	Emissions $_{Fuel\ Extraction\ /\ Processing}$	kg of CO2e
	Volume of Fuel Combusted for P4 and P6 / Vol. Fuel	L, m^3 or other
	CO_2 Emissions Factor for Fuel Including Production and Processing / EF Fuel $_{CO2}$	kg CO_2 per L, m^3 or other
	CH_4 Emissions Factor for Fuel Including Production and Processing / EF Fuel $_{CH4}$	kg CH_4 per L, m^3 or other
	N_20 Emissions Factor for Fuel Including Production and Processing / EF Fuel $_{N2O}$	kg N2O per L, m^3 or other
P4 Generation of Heat and Power	Emissions $_{Gen\ Heat\ and\ Power}$ = ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CO2}$); ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CH4}$) ; ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ N20}$)	
	Emissions $_{Gen\ Heat\ and\ Power}$	kg of CO_2 ; CH_4 ; N_2O
	Volume of Each Type of Fuel Consumed to Generate Heat and Power / Vol. Fuel $_i$	L, m^3 or other
	CO_2 Emissions Factor for Combustion of Each Type of Fuel / EF Fuel $_{i\ CO2}$	kg CO_2 per L, m^3 or other
	CH_4 Emissions Factor for Combustion of Each Type of Fuel / EF Fuel $_{i\ CH4}$	kg CH_4 per L, m^3 or other
	N_20 Emissions Factor for Combustion of Each Type of Fuel / EF Fuel $_{i\ N2O}$	kg N_2O per L, m^3 or other
P5 Heat Transfer or Power Conversion	Emissions $_{Transfer\ /\ Conversion}$ = ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CO2}$); ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CH4}$) ; ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ N20}$)	
	Emissions $_{Transfer\ /\ Conversion}$	kg of CO_2 ; CH_4 ; N_2O
	Volume of Each Type of Fuel Consumed for Heat Transfer or Power Conversion / Vol. Fuel $_i$	L, m^3 or other
P6c Unit Operation: Mechanical Processes	Emissions $_{Unit\ Operation}$ = ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CO2}$); ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CH4}$) ; ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ N20}$)	
	Emissions $_{Unit\ Operation}$	kg of CO_2 ; CH_4 ; N_2O
	Volume of Each Type of Fuel for Unit Operation / Vol. Fuel $_i$	L, m^3 or other
P8 Electricity Generation	Emissions $_{Elec\ Gen}$ = ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CO2}$); ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CH4}$) ; ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ N20}$)	
	Emissions $_{Elec\ Gen}$	kg of CO_2 ; CH_4 ; N_2O
	Volume of Each Type of Fuel for Electricity Generation / Vol. Fuel $_i$	L, m^3 or other
P10 Electricity Usage	Emissions $_{Electricity}$ = Electricity * EF $_{Elec}$	
	Emissions $_{Electricity}$	kg of CO2e
	Incremental Electricity Used at the Site for Unit Operation / Electricity	kWh
	Emissions Factor for Electricity / EF $_{Elec}$	kg of CO2e per kWh
	Baseline SSRs	
B1 Fuel Extraction and	Emissions $_{Fuel\ Extraction\ /\ Processing}$ = ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CO2}$) ; ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ CH4}$) ; ∑ (Vol. Fuel $_i$ * EF Fuel $_{i\ N2O}$)	

Processing	Emissions $_{\text{Fuel Extraction / Processing}}$	kg of CO2e
	Volume of Fuel Combusted for B4 / Vol. Fuel	L, m^3 or other
B4 Generation of Heat and Power	$\text{Emissions}_{\text{Gen Heat and Power}} = \sum (\text{Vol. Fuel}_i * \text{EF Fuel}_{i\,CO2}); \sum (\text{Vol. Fuel}_i * \text{EF Fuel}_{i\,CH4}) ; \sum (\text{Vol. Fuel}_i * \text{EF Fuel}_{i\,N20})$	
	Emissions $_{\text{Gen Heat and Power}}$	kg of CO_2 ; CH_4 ; N_2O
	Volume of Each Type of Fuel Consumed to Generate Heat and Power / Vol. Fuel $_i$	L, m^3 or other
B5 Heat Transfer or Power Conversion	$\text{Emissions}_{\text{Transfer / Conversion}} = \sum (\text{Vol. Fuel}_i * \text{EF Fuel}_{i\,CO2}); \sum (\text{Vol. Fuel}_i * \text{EF Fuel}_{i\,CH4}) ; \sum (\text{Vol. Fuel}_i * \text{EF Fuel}_{i\,N20})$	
	Emissions $_{\text{Transfer / Conversion}}$	kg of CO_2 ; CH_4 ; N_2O
	Volume of Each Type of Fuel Consumed for Heat Transfer or Power Conversion / Vol. Fuel $_i$	L, m^3 or other
B6c Unit Operation: Mechanical Processes	$\text{Emissions}_{\text{Unit Operation}} = \sum (\text{Vol. Fuel}_i * \text{EF Fuel}_{i\,CO2}); \sum (\text{Vol. Fuel}_i * \text{EF Fuel}_{i\,CH4}) ; \sum (\text{Vol. Fuel}_i * \text{EF Fuel}_{i\,N20})$	
	Emissions $_{\text{Unit Operation}}$	kg of CO_2 ; CH_4 ; N_2O
	Volume of Each Type of Fuel for Unit Operation / Vol. Fuel $_i$	L, m^3 or other
B8 Electricity Generation	$\text{Emissions}_{\text{Elec Gen}} = \sum (\text{Vol. Fuel}_i * \text{EF Fuel}_{i\,CO2}); \sum (\text{Vol. Fuel}_i * \text{EF Fuel}_{i\,CH4}) ; \sum (\text{Vol. Fuel}_i * \text{EF Fuel}_{i\,N20})$	
	Emissions $_{\text{Elec Gen}}$	kg of CO_2 ; CH_4 ; N_2O
	Volume of Each Type of Fuel for Electricity Generation / Vol. Fuel $_i$	L, m^3 or other
B10 Electricity Usage	$\text{Emissions}_{\text{Electricity}} = \text{Electricity} * \text{EF}_{\text{Elec}}$	
	Emissions $_{\text{Electricity}}$	kg of CO2e
	Incremental Electricity Exported from the Site / Electricity	kWh
	Emissions Factor for Electricity / EF $_{\text{Elec}}$	kg of CO2e per kWh

APPENDIX A: Glossary of New Terms

Energy Project Assessment
A detailed analysis completed by an independent, competent professional of the efficiency of heating, cooling, ventilation and other energy systems within a facility. The analysis must be systematic, replicable, verifiable and reasonable encompassing all components of the facility included within, and directly related to, the project unit.

Project Unit
The project unit is defined as the equipment, processes and facilities that are being serviced and impacted by the energy efficiency project. The project unit must be clearly defined and justified by the project proponent.

Unit of Productivity
The unit of productivity is to be defined by the project proponent as a basis for incorporating functional equivalence within the calculation methodology. Examples of units of productivity could be: energy requirements per mass of beef/pork/chicken from feeding operations, per resident over 6 years of age for residential buildings, per square foot of front of house commercial space, per kg/L/m^2/m^3 of output from manufacturing facilities, etc. In all cases the project proponent must thoroughly justify their assessment of the appropriate unit of productivity.