QUANTIFICATION PROTOCOL FOR BIOFUEL PRODUCTION AND USAGE

ABRIDGED

Submitted to:

Alberta Environment

and

Alberta Agriculture, Food and Rural Development

May, 2007

Prepared by Baseline Emissions Management Inc.

Disclaimer

The following document presents an abridged version of the Biofuel Production and Usage 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.

The full-length version of this protocol is largely based on the *Greenhouse Gas Protocol: Biofuels in Transportation Projects* dated April, 2006. This work was completed by The Delphi Group and GHGm.com as part of a Climate Change Technology Early Action Measures (TEAM) under the System of Measurement and Reporting for Technologies (SMART).

Table of Contents

List of Figures

List of Tables

1.0 Project and Methodology 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 biofuel production facilities. The protocol quantifies the emission reductions from the avoidance of fossil fuel consumption, replaced by biofuels on an equivalent energy potential basis. It also specifically includes reductions in GHG emissions due to any heat/power production and electricity generation related to the process, and from the avoidance of landfilling any materials which may be diverted for conversion to biofuel. Emissions from downstream offsetting of petrochemicals is not included under this protocol.

Biofuels can include charcoal, bio-diesel, ethanol, and other similar gas, liquid and solid fuels from renewable sources. These biofuels can be blended with other fuels, including fossil fuels, prior to final use. **FIGURE 1.1** offers a project element life cycle chart for a typical project.

The biofuels protocol does not prescribe the configuration of the scheme. Rather, this protocol serves as a generic 'recipe' for project proponents to follow in order to meet the measurement, monitoring and GHG quantification requirements. The project must achieve some level of greenhouse gas emission reductions relative to the baseline situation.

The baseline condition includes the use of fossil fuels by downstream users (calculated on an equivalent energy potential basis), the production of heat/power using fossil fuels at facilities that rely on heat/power from the biofuels facility, the generation of electricity by other facilities to cover the net generation capacity of the biofuels facility, and the possible landfilling of any materials which would become feedstocks for the biofuels facility. **FIGURE 1.2** offers an element life cycle chart for a typical baseline configuration.

The boundary of the biofuels protocol encompasses the production of process feedstocks, production of biofuels, heat/power and electricity and their use downstream. To demonstrate that a project meets the requirements under this protocol, the project proponent must supply sufficient evidence to demonstrate that:

1. 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; and
2. Process emissions from biofuel production are not material to the emission reduction calculations as indicated by quantitative and/or qualitative analysis.

FIGURE 1.1: Project Element Life Cycle Chart

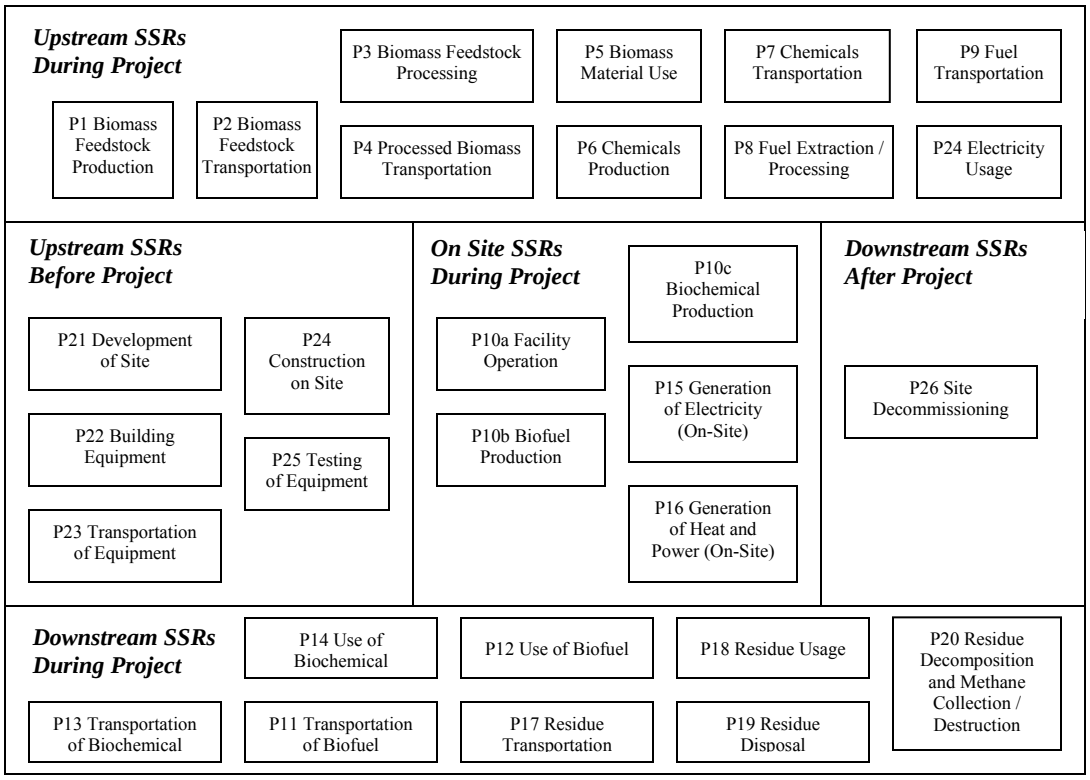
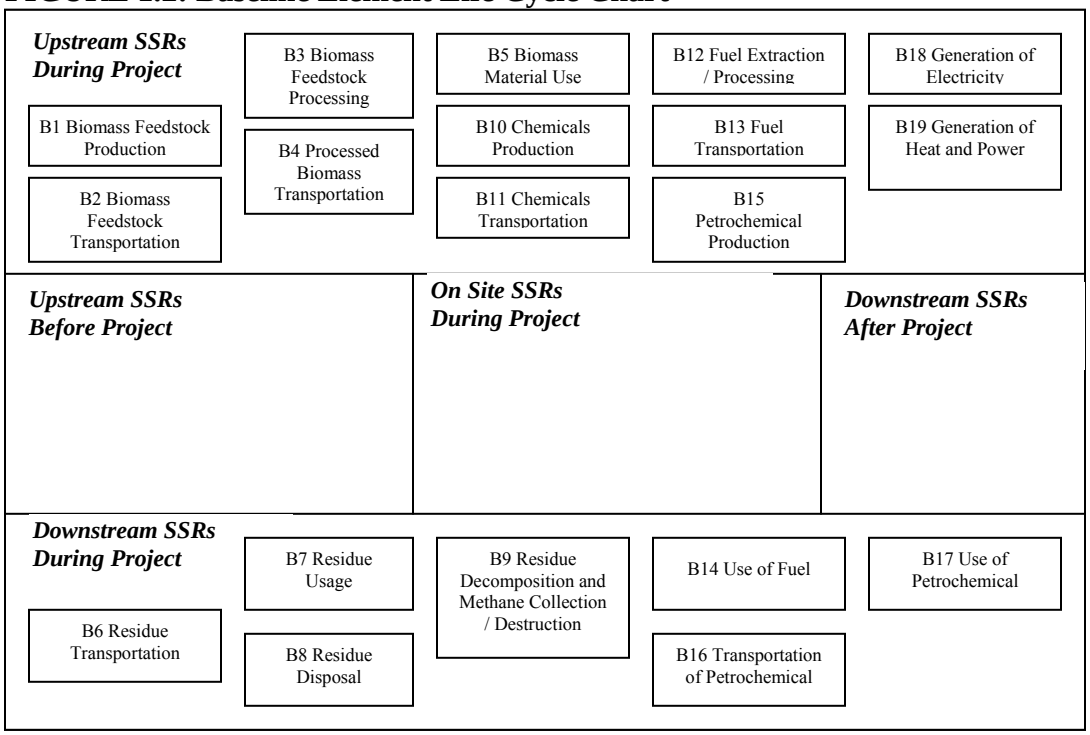


FIGURE 1.2: Baseline Element Life Cycle Chart



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

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

1. The heat and power component of the process may be dealt with outside the scope of the protocol as part of a *Waste Heat Recovery* protocol. However, the project proponent must justify the separation of this component of the project to ensure that the emission reductions are properly quantified between the two projects and that there is no risk of double counting;
2. The heat and power component of the project may provide some or all of the heat and power requirements for the facility. Flexibility is provided in terms of allowing the broadening of the project scope to include existing, new, or retrofit supplementary heating both on and off site to meet the project energy load;
3. In cases where the project proponent wishes to quantify the emission reduction from reduced transportation requirements for the biofuel, then the SSRs P9, P11 and B13 must all be quantified;
4. 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
5. In cases where the diversion of feedstocks from landfill cannot be attested to, the diversion of feedstocks from landfill components of the project may be ignored in both the baseline and project conditions.

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

2.0 Quantification of Identified Sources, Sinks and Reservoirs

Quantification of the reductions, removals and reversals of relevant SSRs for each of the greenhouse gases will be completed using the methodologies outlined in **TABLE 2.4**, 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.

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

$$\begin{aligned}\text{Emissions}_{\text{Baseline}} = {} & \text{Emissions}_{\text{Fuel Extraction / Processing}} + \text{Emissions}_{\text{Use of Fuel}} \\ & + \text{Emissions}_{\text{Electricity Generation}} + \text{Emissions}_{\text{Gen Heat and Power}} \\ & + \text{Emissions}_{\text{Decomposition, Collection and Destruction}}\end{aligned}$$

$$\begin{aligned}\text{Emissions}_{\text{Project}} = {} & \text{Emissions}_{\text{Fuel Extraction / Processing}} + \text{Emissions}_{\text{Facility Operation}} \\ & + \text{Emissions}_{\text{Use of Biofuel}} \\ & + \text{Emissions}_{\text{Distribute Heat and Power}} + \text{Emissions}_{\text{Gen Heat and Power}} \\ & + \text{Emissions}_{\text{Transfer / Conversion}}\end{aligned}$$

TABLE 2.1: Quantification Procedures

1. Project / Baseline SSR	2. Parameter / Variable	3. Unit
Project SSRs		
P8 Fuel Extraction and Processing	$Emissions_{Fuel\ Extraction\ /\ Processing} = \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CO2}) ; \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4}) ; \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ N2O})$	
	$Emissions_{Fuel\ Extraction\ /\ Processing}$	kg of CO2e
	Volume of Fuel Combusted for P10a, P13, and P14 / Vol. Fuel	L/ m^3/ other
	CO_2 Emissions Factor for Fuel Including Production and Processing / $EF\ Fuel_{CO2}$	kg CO_2 per L/ m^3/ other
	CH_4 Emissions Factor for Fuel Including Production and Processing / $EF\ Fuel_{CH4}$	kg CH_4 per L/ m^3/ other
	N_20 Emissions Factor for Fuel Including Production and Processing / $EF\ Fuel_{N2O}$	kg N2O per L/ m^3/ other
P10a Facility Operation	$Emissions_{Facility\ Operation} = \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CO2}); \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4}) ; \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ N20})$	
	$Emissions_{Facility\ Operation}$	kg of CO_2 ; CH_4 ; N_2O
	Volume of Each Type of Fuel for Unit Operation / $Vol.\ Fuel_i$	L/ m^3/ other
	CO_2 Emissions Factor for Combustion of Each Type of Fuel / $EF\ Fuel_{i\ CO2}$	kg CO_2 per L/ m^3/ other
	CH_4 Emissions Factor for Combustion of Each Type of Fuel / $EF\ Fuel_{i\ CH4}$	kg CH_4 per L/ m^3/ other
	N_20 Emissions Factor for Combustion of Each Type of Fuel / $EF\ Fuel_{i\ N2O}$	kg N2O per L/ m^3/ other
P12 Use of Biofuel	$Emissions_{Use\ of\ Biofuel} = \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4}) ; \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ N20})$	
	$Emissions_{Use\ of\ Biofuel}$	kg of CO_2 ; CH_4 ; N_2O
	Volume of Each Type of Biofuel Consumed / $Vol\ Fuel_i$	L/ m^3/ other
P15 Electricity Generation	$Emissions_{Elec\ Gen} = \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CO2}); \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4}) ; \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ N20})$	
	$Emissions_{Elec\ Gen}$	kg of CO_2 ; CH_4 ; N_2O
P16 Generation of Heat and Power	$Emissions_{Gen\ Heat\ and\ Power} = \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CO2}); \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4}) ; \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ N20})$	
	$Emissions_{Gen\ Heat\ and\ Power}$	kg of CO_2 ; CH_4 ; N_2O
P20 Residue Decomposition and Methane Collection / Destruction	$Emissions_{Decomposition,\ Collection\ and\ Destruction} = (Mass_{Residue\ Disposed} * MCF * DOC * DOC_F * F * 16/12 - R) * (1 - OX)$	
	$Emissions_{Decomposition,\ Collection\ and\ Destruction}$	kg of CH_4
	Mass of Residue Material Sent for Disposal (wet) / $Mass_{Residue\ Disposed}$	kg
	Methane Correction Factor / MCF	-
	Degradable Organic Carbon / DOC	-
	Fraction of Degradable Organic Carbon Dissimilated / DOC_F	-
	Fraction of CH_4 in Landfill Gas / F	-
	Recovered CH_4 at Landfill / R	kg of CH4
	Oxidation Factor / OX	-
Baseline SSRs		
B9 Residue Decomposition and Methane Collection / Destruction	$Emissions_{Decomposition,\ Collection\ and\ Destruction} = (Mass_{Residue\ Disposed} * MCF * DOC * DOC_F * F * 16/12 - R) * (1 - OX)$	
	$Emissions_{Decomposition,\ Collection\ and\ Destruction}$	kg of CH_4
	Mass of Residue Material Sent for Disposal (wet) / $Mass_{Residue\ Disposed}$	kg

B12 Fuel Extraction and Processing	$Emissions_{Fuel\ Extraction\ /\ Processing} = \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CO2}) ; \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4}) ; \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ N2O})$	
	$Emissions_{Fuel\ Extraction\ /\ Processing}$	kg of CO2e
	Volume of Fuel Combusted for B14 and B16 / Vol. Fuel	L/ m^3/ other
B14 Use of Fuel	$Emissions_{Use\ of\ Fuel} = \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CO2}); \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4}) ; \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ N20})$	
	$Emissions_{Use\ of\ Fuel}$	kg of CO_2 ; CH_4 ; N_2O
	Volume of Each Type of Fuel offset with Biofuel / $Vol.\ Fuel_i$	L/ m^3/ other
B18 Electricity Generation	$Emissions_{Electricity} = Electricity * EF_{Elec}$	
	$Emissions_{Electricity}$	kg of CO2e
	Incremental Electricity Exported from the Project Site / Electricity	kWh
	Emissions Factor for Electricity / EF_{Elec}	kg of CO2e per kWh
B19 Generation of Heat and Power	$Emissions_{Gen\ Heat\ and\ Power} = \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CO2}); \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4}) ; \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ N20})$	
	$Emissions_{Gen\ Heat\ and\ Power}$	kg of CO_2 ; CH_4 ; N_2O
	Volume of Each Type of Fuel Consumed to Generate Equivalent Heat and Power Load / $Vol.\ Fuel_i$	L/ m^3/ other

APPENDIX A: Glossary of New Terms

The following definitions are critical to the appropriate interpretation of this quantification protocol.

Biofuel:	Any fuel that is derived from biomass. It is a renewable energy source, unlike other natural resources such as petroleum, coal, and nuclear fuels.
Biomass:	Previously living organisms or their metabolic by-products (ie. manure from cows). This includes plant material, vegetation, agricultural and agri-food materials that can be used as a fuel or energy source. This may include silage, energy crops, wood materials (construction waste, slash, bark, etc.), oils and fats, etc.
Landfill:	A landfill is a site at which materials are stored where they can undergo anaerobic decomposition. This may include the materials being buried, piled, mixed with other waste materials, or otherwise. Landfills classified as either controlled or uncontrolled are included in this definition. The designation of controlled or uncontrolled refers to the level of permitting and technical controls in place at the disposal site. Uncontrolled landfills may exist where although there is no expressly stated goal to leave the materials in place, there is a track record of material residing in that place for extended periods (greater than 10 years) and there are no plans or regulatory requirements for the material to be transferred to another disposal site.