Biomass Waste Combustion for Energy Generation Quantification Protocol

Technology Innovation and Emission Reduction regulation
Draft version 2.3 - Public Comment

Alberta

Biomass Waste Combustion for Energy Generation Quantification Protocol | Alberta Environment and Protected Areas

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Summary of Revisions

Version	Date	Summary of Revisions
2.3	January 2026	**Protocol Scope** updated to include quantifying emissions reductions from the combustion of biomass waste to generate and use energy that displaces fossil fuel sourced energy. The protocol has a flexibility mechanism that, if applicable, may generate credit from avoided GHG emissions due to changes in disposal practices for the eligible biomass wastes. This protocol was updated to remove levied emission sources. Any offset claims as of April 1, 2025 onwards must monitor, measure, and verify all 'Included' emission sources as outlined in this protocol. Updated quantification methodology to align with current data/resources. Combined Baseline and Project quantification methodologies into TABLE 5.
2.2	March 2018	Updated quantification methodology to align with the carbon levy. Added reporting requirements for biogenic carbon and levied fossil fuel emissions. Modified project and baseline Sources and Sinks to track but not credit fossil fuels subject to the carbon levy. Added P20/B20 source for reporting biogenic CO_2. Additional guidance provided on use of biogenic biomass and waste biomass eligibility. Project eligible scope expanded to include forest wildfire salvage. Flexibility mechanism for avoided stockpile methane emissions removed due to regulation of the activity. Added reference to the Standard for Offset Project Developers
2.1	March 2016	Changed name of Handbook to Carbon Offset Emission Factors Handbook. Changed name from ESRD to Environment and Parks. Added emission factor reference for combustion of biomass for N_2O and CH_4 in P15.
2.0	January 2014	The Quantification Protocol for Diversion of Biomass to Energy from Biomass Combustion Facilities was renamed Quantification Protocol for Energy Generation from the Combustion of Biomass Waste. The **Protocol Scope** was broadened to include the following new sources of biomass waste: forest harvest debris, mountain pine beetle salvage, municipal solid waste and agricultural residues. The **Protocol Scope** was broadened to include the following additional baseline disposal scenarios: incineration, open-air combustion, stockpiling, and land application. Quantification requirements for baseline disposal requirements have been provided.

		Project Sources/Sinks were revised to reflect changes in scope of eligible project scenarios. The **Quantification Methodology** for reductions from diversion from landfill is being revised by a separate review process to reflect current science and quantification requirements. Final quantification methodology developed through that process will stand in a separate handbook and will apply to all protocols, including this one, that generate emissions offsets from landfill or stockpile diversion. Clarification was provided on **Quantification Methodology** requirements for municipal solid wastes. Updated **Record Keeping** requirements and quantifications were added to reflect program changes and revised range of eligible program activities. The protocol has been updated to reflect new format requirements provided in the Technical Guidance for Offset Protocol Developers.
1.0	September 2007	Quantification Protocol for Diversion of Biomass to Energy from Biomass Combustion Facilities was published for use in the Alberta Offset System.

1

Contents

List of Tables

List of Figures

1.0 Offset Project Description

This protocol establishes the approved methodology for quantifying greenhouse gas (GHG) emission reductions from the diversion of eligible biomass wastes to generate energy that displaces fossil fuel sourced energy. The protocol applies to projects generating and using electricity and/or heat through the combustion of eligible biomass wastes in a biomass combustion system.

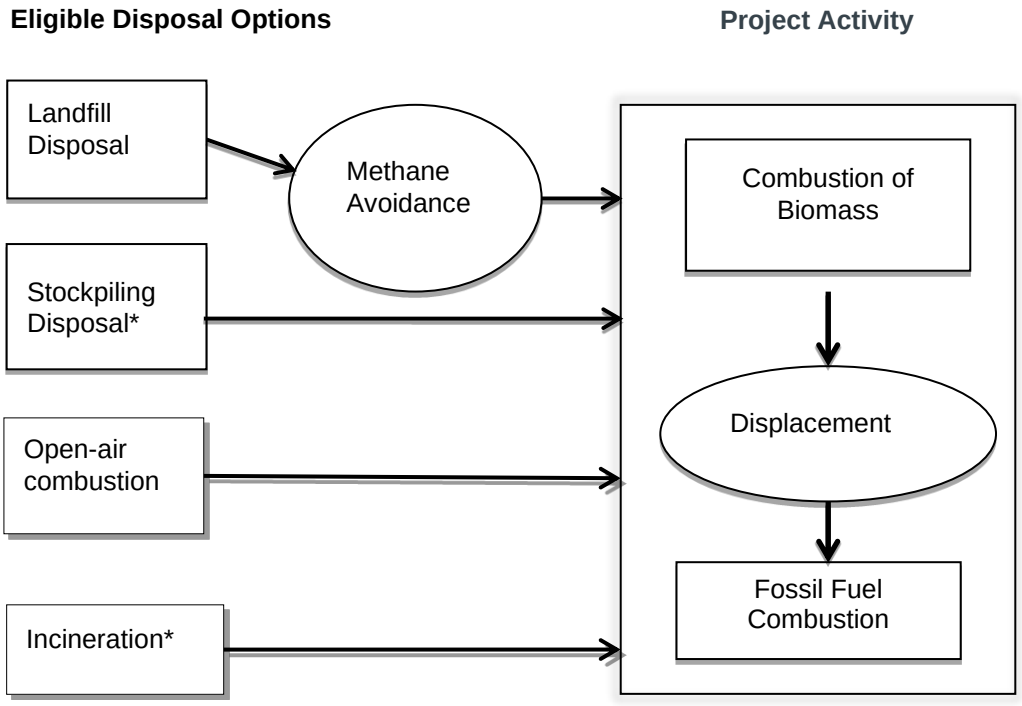
The protocol includes quantification of avoided GHG emissions from eligible activities of biomass waste disposal practices, such as diversion from landfilling or open-air combustion of harvest debris, where applicable. Specific eligibility requirements for these opportunities are discussed in Section 1.3. Eligible biomass waste types are listed in TABLE 1. These wastes when combusted generate heat and/or power that can reduce GHG emissions at a facility by displacing energy that would have been derived from fossil fuels.

FIGURE 1 provides an illustrative representation of the emissions offset generation opportunities for changes in biomass waste disposal available to offset projects using this protocol.

TABLE 1. ELIGIBLE BIOMASS WASTE TYPES

Biomass Source	Project Eligibility Notes
Forest mill residues (e.g., sawdust, bark, shavings, chips), woody by-products of sawmill operations	Projects must demonstrate origin of the waste biomass and method of disposal in the baseline.
Debris from forest harvesting occurring on Crown land (e.g., branches, tree tops, roots)	Projects must meet sustainability criteria set in their Forest Management Plans.
Agricultural crop residue (e.g., cereal stalks or stems left after harvest)	Projects must meet minimum retention requirements to meet soil conservation needs described in Section 5.1.7.
Agricultural processing residues (e.g., food processing plant wastes)	Projects that were using land application as a baseline disposal option must meet minimum retention requirements to meet soil conservation needs described in Section 5.1.7.
Other agricultural residues (e.g., manure, animal bedding, paunch)	Projects that were using land application as a baseline disposal option must meet minimum retention requirements to meet soil conservation needs described in Section 5.1.7.
Municipal solid waste	The organic fraction of municipal solid waste is eligible. See Appendix B and the Carbon Emission Factors Handbook for the landfill avoided methane emissions criteria and quantification methodology.
Standing trees killed by mountain pine beetle or wildfire on Crown land	Stands harvested purely for bioenergy are eligible only when they cannot be salvaged for traditional forest products and stand mortality is greater than 85 per cent.

FIGURE 1: EMISSION OFFSET GENERATION OPPORTUNITY FOR CHANGES IN DISPOSAL PRACTICES FOR BIOMASS WASTES



*Regulated activity (Environmental Code of Practice for Sawmill Plants) which is an eligible feedstock, but where emissions from methane avoidance are not eligible for emission offsets.

Ineligible biomass materials include all materials that are not wastes, specifically:

- Purpose grown crops for energy generation,
- Merchantable forest stands, or
- Unmerchantable stands with the exception of those with greater than 85 per cent mortality from mountain pine beetle or wildfire.

For example, agricultural residues may have higher value as a source of soil nutrients compared to their value as an energy source. Projects that are considering using agricultural residues listed in TABLE 1 – that are used in a farming application must conduct an economic net benefit assessment. This assessment should use the cost of displaced chemical fertilizer to the feedstock in comparison to its potential energy value.

Diversion to biomass energy projects for quantifying GHG emissions reductions is only permissible if the alternative has a lower net benefit or if no net benefit. A justification must also be provided to demonstrate that the alternative is not viable. For projects using agricultural residuals as the biomass wastes, the net benefit assessment must be included in the offset project plan and updated after any extension thereafter.

Projects that are producing biofuels are not covered under this protocol.

Project eligibility requires that net GHG emissions be lower in the Project condition than in the Baseline condition. Emissions must be monitored, measured and verified as outlined in the offset project plan and is quantified in each emission offset project report. Net reduction in GHG emissions must be demonstrated for all sources including fossil fuels and electricity use.

1.1 Protocol Scope

Emission offsets generated under this protocol are monitored, measured and quantified based on the displacement of fossil fuel-based energy through the combustion of biomass wastes.

Projects can use one or more of the flexibility options to quantify additional emission reductions from baseline biomass disposal activities where proof of historical practice exists and is verified during an independent third-party verification.

Eligible flexibility options include:

a) Diversion of biomass waste from landfill, and
b) Diversion of biomass waste from open-air combustion.

Incineration of forest mill waste was deemed to be an acceptable baseline scenario pre-2015, after which it was no longer allowed under provincial regulations. Stockpiling of mill waste is also a regulated activity and is not eligible for generating offsets from methane avoidance. However, stockpiled biomass can still be used as feedstock for combustion for energy generation.

The GHG emissions affected by the activities described in this protocol include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). A complete list of emission factors and GHGs regulated under the Regulation and the applicable Global Warming Potentials (GWP) for each gas is available in the Carbon Offset Emission Factors Handbook for Alberta offset projects (the Handbook) and/or the Standard for Completing Greenhouse Compliance and Forecasting Reports.

1.2 Protocol Applicability

The emission offset project developer must meet the following requirements to apply this protocol:

1. Emission reduction projects meet the following conditions:

    a) eligible biomass waste types in TABLE 1 are being combusted;
    b) biomass wastes are combusted to produce energy in a thermal energy system, cogeneration unit or an advanced energy system (systems that capture the chemical energy of biomass fuels); energy generated is based on actual measurement and monitoring;
    c) energy generated from the combustion of waste biomass partially or fully offsets fossil fuel based energy; and,
    d) emissions from bioenergy production are lower than would have occurred in the absence of the project.

2. If agricultural biomass residues are used in the combustion for energy generation, the project developer conducts a net benefit assessment with any assumptions and justifications to demonstrate that alternative use is not viable. Diversion to biomass energy for GHG emissions reductions is only permissible if the alternative has a lower or no net benefit. The net benefit assessment must be provided in the offset project plan and updated with any extension thereafter.

3. The emission offset project developer clearly demonstrates the offset project meets the eligibility criteria for offset projects under the Alberta Emission Offset System and Regulation, this quantification protocol and any related guidance document or criteria in the system.

4. The emission offset project developer must provide sufficient evidence to demonstrate that:

    a) the energy produced from biomass wastes is offsetting fossil fuel generated energy;

b) the offset project plan and project reports outline the systems in place that will generate electricity and / or heat, to be used by the project; and if any electricity will be exported to Alberta's grid;
c) the emissions reductions achieved by the project are based on actual measurement and monitoring, as indicated by the requirements of this protocol; and,
d) the project is implemented in accordance with the Standard for Greenhouse Gas Emission Offset Project Developers.

1.3 Protocol Flexibility

This protocol provides the following flexibility mechanisms for an emission offset project developer. Any use of a flexibility mechanism must be documented in the offset project plan and/or offset project report, with justification and rationale. A clear explanation of the flexibility and alignment with the protocol quantification must be demonstrated and be verified by a third-party assurance provider. Deviations from a protocol eligibility criterion may follow guidance in the Standard for Greenhous Gas Emission Offset Project Developers to obtain approvals.

Eligible Flexibility Options:

1. Diversion of biomass waste from baseline disposal in a landfill.

    - the waste stream must have been disposed of in a landfill for at least three years prior to project initiation.
    - All waste diverted from landfill must meet the eligibility requirement in TABLE 1.

    Compliance with minimum record requirements (Section 5.1.2) is required. If the record requirements are met, this may allow proponents to include the biomass as an eligible waste for fossil fuel displacement and be eligible for offsets from methane avoidance from the diversion of the wastes.

    Methodology for calculating avoided methane emissions from the diversion of biomass waste from landfills is outlined in the Carbon Offset Emission Factors Handbook.

    Wastes diverted from Class II landfills are eligible for methane avoidance emission offsets, and electricity and/or heat generation.

    Wastes from Class III, inert wastes, landfills are not eligible for methane avoidance emission offsets. However, wastes may be used for emission offsets from electricity and/or heat generation.

2. Diversion of biomass waste from open-air combustion.

    - The project developer must be able to demonstrate that the waste stream must have been disposed of by open-air combustion for a period of three years prior to project initiation.

    Compliance with minimum records requirements (Section 5.1.4) is required.

3. Energy measurement and emission factors.

    - Projects may use an energy balance approach to estimate biomass fuel consumed.
    - The project developer must be able to measure, monitor and record the energy flow of all streams in or out of the biomass combustion unit to generate an accurate energy balance for the project.

    Energy-based combustion emission factors for biomass and fossil fuel combustion are applied to quantify emissions for each stream and reductions.

Site-specific emission factors calculated on the basis of fuel analysis must be used when available. If site-specific factors cannot be obtained, emission factors from the Carbon Offset Emission Factors Handbook must be used.

In cases where an appropriate emissions factor is not found in the Handbook and the use for an equivalent emissions factor is proposed, approval must be granted in writing from the Director.

Note that mountain pine beetle kill salvage, wildfire salvage, stockpiled mill waste, and diversion of biomass wastes from land application are eligible biomass waste types but are not eligible for emission offsets for diversion from baseline disposal practices. Minimum record requirements for these waste types are discussed in Sections 5.1.3 and 5.1.6, respectively.

1.4 Glossary of Terms

Alberta Electricity Grid	A system of conductors through which electrical energy is transmitted and distributed throughout the province. This electricity grid is an interconnected network of high voltage transmission and lower voltage distribution for delivering electricity from suppliers (generators) to consumers across the province.
Agricultural Crop Residues	The un-harvestable portions of a crop that includes leaves, stalks, chaff, etc. Residues may or may not be left on a field.
Agricultural Processing Residues	The material remaining after processing grains, food crops and animal products. Examples include husks or chaff of grain, paunch, etc.
Agriculture Residues, Other	Biomass residues from other agricultural activities, including manure, animal bedding, chicken litter, carcasses, etc.
Bioenergy	Bioenergy is any renewable energy or fuel derived from biological sources. There are several potential feedstocks for bioenergy in Alberta including agricultural products (such as corn or canola), forestry waste and livestock waste.
Biogenic CO_2	Carbon dioxide emitted during the storage, processing, and consumption of biologically-based feedstock, other than fossil fuels, through combustion, digestion, fermentation or decomposition processes. When biomass is burned, decays or is otherwise oxidized, chemical energy is released along with CO_2 into the atmosphere. As part of the natural carbon cycle, this CO_2 is taken up by growing plants and the energy is eventually re-captured through photosynthesis.
Biomass	Organic material both above and below-ground, and both living and dead (e.g., trees, sphagnum peat, agriculture and energy crops, grasses, tree litter, roots, etc.).
Biomass Residue	A by-product, residue or waste stream from agriculture, forestry or related industries, excluding municipal waste or other waste that contains fossilized and/or non-biodegradable material.
Biomass Waste	Any solid or liquid material or combination that is to be disposed of, stored, and/or treated until final disposal, but does not include recyclables.
Class II landfill	A landfill for the disposal of waste, not including hazardous waste (as per Section 1(j) of the EPEA Waste Control Regulation).
Class III landfill	A landfill for the disposal of inert waste (as per Section 1(k) of the EPEA Waste Control Regulation).

Cogeneration	The combined production of thermal energy and electricity for use in industrial facilities. Electricity not used within the plant may be offered to the electricity market.
Combustion	The oxidation of fuel/biomass that releases water and carbon dioxide from the exothermic reaction.
Combustion Residue	The residual materials (ash) from combustion that are disposed in a landfill or through other means.
Forest Block (Cutblock)	An area of land or timber that has been defined for management purposes. One block may be composed of stands of different tree species or ages.
Forest Mill Residues	A wood processing residue that is not the end product(s) that the production process directly seeks to produce. It is not the primary aim of the production process, and the process has not been deliberately modified to produce it. Any deliberate change to the production process to increase the volume of these residues would result in the end materials being classified as a product rather than as forest mill residues.
Forest Harvest Debris	Debris left as a result of forest harvesting or right-of-way development for access or oil and gas activities and other land-use activities (e.g., timber harvesting, thinning and pruning, road construction, seismic line clearing, etc.). Debris includes material such as logs, splinters or chips, tree branches and tops, uprooted stumps and broken or uprooted trees and shrubs. Forest Harvest Debris is sometimes referred to as slash.
Heat	The useful thermal energy that is generated in a heat generation unit (e.g., a boiler, a cogeneration unit, thermal solar panels, etc.) and transferred to a heat carrier (e.g., hot liquids, hot gases, steam, etc.) for use in thermal applications and processes, including power generation but excluding waste heat.
Incineration	A waste treatment process that involves the combustion of organic substances contained in waste materials. This document refers to incineration occurring in a closed-chamber incinerator regulated under Alberta’s Environmental Protection and Enhancement Act (EPEA).
Landfill	A waste management facility at which waste is disposed of by placing it on or in land, but does not include a land treatment facility, a surface impoundment, a salt cavern or a disposal well (as per Section 1(z) of the EPEA Waste Control Regulation).
Municipal Solid Waste	Non-hazardous waste materials picked up by a municipality or self-hauled to depots, transfer stations and disposal facilities for final disposal in a waste management facility. Municipal solid waste can include household wastes, construction, renovation and demolition wastes, and commercial and institutional wastes.
Waste Management Facility	A facility for the collection, storage, treatment or disposal of waste (as per Section 1(mm) of the EPEA Waste Control Regulation). In Alberta, all waste must be disposed in a waste management facility.

2.0 Baseline Condition

The baseline condition for all projects under this protocol is the production of energy from fossil fuels for electricity and/or heat occurring either on or off-site. Emissions per unit of energy output are quantified based on either historic performance (Historic Benchmark baseline) for existing facilities or heat high-performance benchmarks provided in the Technology Innovation and Emissions Reduction Regulation and grid emission factors for electricity displacement provided in the Carbon Offset Emission Factors Handbook for new facilities. The baseline is quantified using equivalent energy units between baseline and project to ensure reductions being quantified represent actual GHG emission reductions from displaced fossil fuel-based energy.

Projects that are replacing an existing facility use a Static Historic Benchmark based on an average of three years' baseline emissions per unit of energy output. The emission profile established from an average of at least three years prior to project initiation does not change during the project crediting period. For existing facilities, the project must be able to establish, based on records, that historical practice is fossil fuel energy generation and that the total emissions from all sources is greater in the baseline condition compared to the project. The baseline GHG emissions are calculated annually using the project output energy, boiler efficiency, and measured biomass input to estimate baseline fossil fuel use in the absence of the project. Projects cannot claim emissions offsets for generated energy that is not being used (e.g., when biomass is combusted in an energy system, but the heat is dumped).

For new facilities, this protocol uses a dynamic Performance Standard baseline. New facility baseline emissions are projected using the most current published grid emission factors for electricity displacement (Handbook) and the heat high-performance benchmarks for the corresponding year of the reporting period for any heat that is being displaced. The baseline is considered dynamic because the baseline scales in relation to project activity.

Projects quantifying GHG emissions reductions under a flexibility mechanism must be able to establish a three-year historic baseline practice for the biomass waste disposal, based on records. If a three-year historic baseline for disposal practices cannot be established, but it can be established that the materials are an eligible waste (see TABLE 1), the biomass waste is eligible to generate emission offsets for GHG emission reductions from fossil fuel displacement, but not for changes in disposal practices resulting in avoided methane emissions.

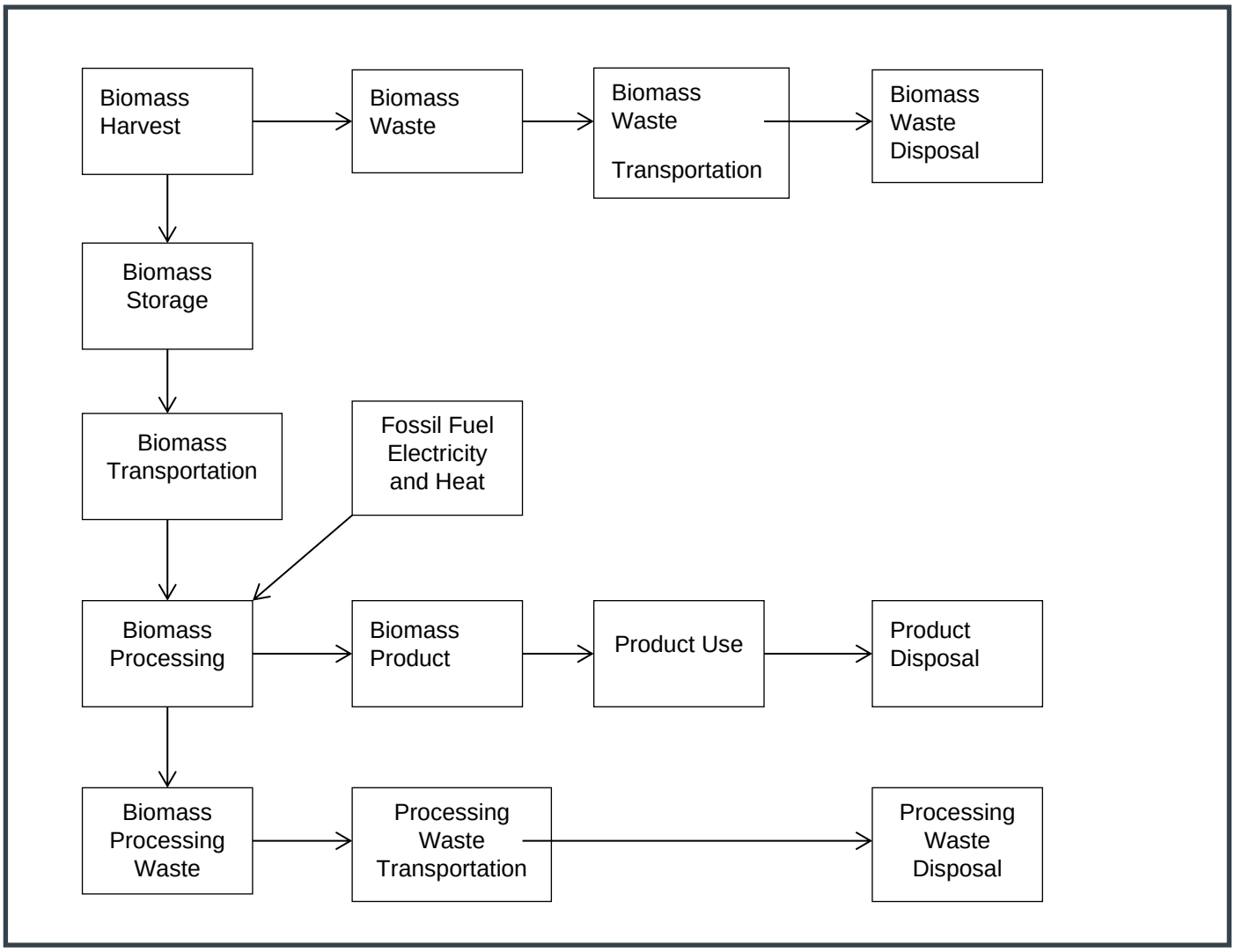
Diversion of biomass waste from open-air combustion is an eligible baseline scenario. To be eligible, the project developer must be able to demonstrate the baseline activity for the biomass waste was open-air combustion for a period of three years immediately prior to project implementation.

Diversion of biomass wastes from landfill is an eligible baseline scenario. To be eligible for emission offsets for avoided methane emissions from landfill, the project developer must be able to demonstrate the baseline activity for the biomass waste was landfill disposal for a period of three years immediately prior to project implementation. The baseline GHG emissions are calculated based on the mass of biomass diverted from an eligible disposal practice that are used to generate energy in the project condition and the GHG emissions that would have occurred from the baseline disposal activity for an equivalent mass of biomass.

Biomass waste diverted from forest stands that have high mountain pine beetle infestation rates or wildfire losses (mortality equal to or greater than 85 per cent) with re-growth to a lower carbon stock, from stockpile and from land application where minimum nutrient requirements are met, are eligible waste types for energy displacement but are not eligible emission offsets for changes in disposal practices. Minimum records requirements are discussed in Sections 5.1.3 and 5.1.6.

Projects that cannot establish a baseline based on records are not eligible. The baseline condition, including the relevant sources, sinks and processes is shown in FIGURE 2. More detail on each of these sources and sinks is provided in Section 2.1.

FIGURE 2: SIMPLIFIED PROCESS FLOW DIAGRAM FOR BASELINE CONDITION



2.1 Identification of Baseline Condition Sources and Sinks (SSs)

The identification of emissions sources and sinks in the baseline condition is based on International Organization for Standardization 2019, ISO 14064-2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements.

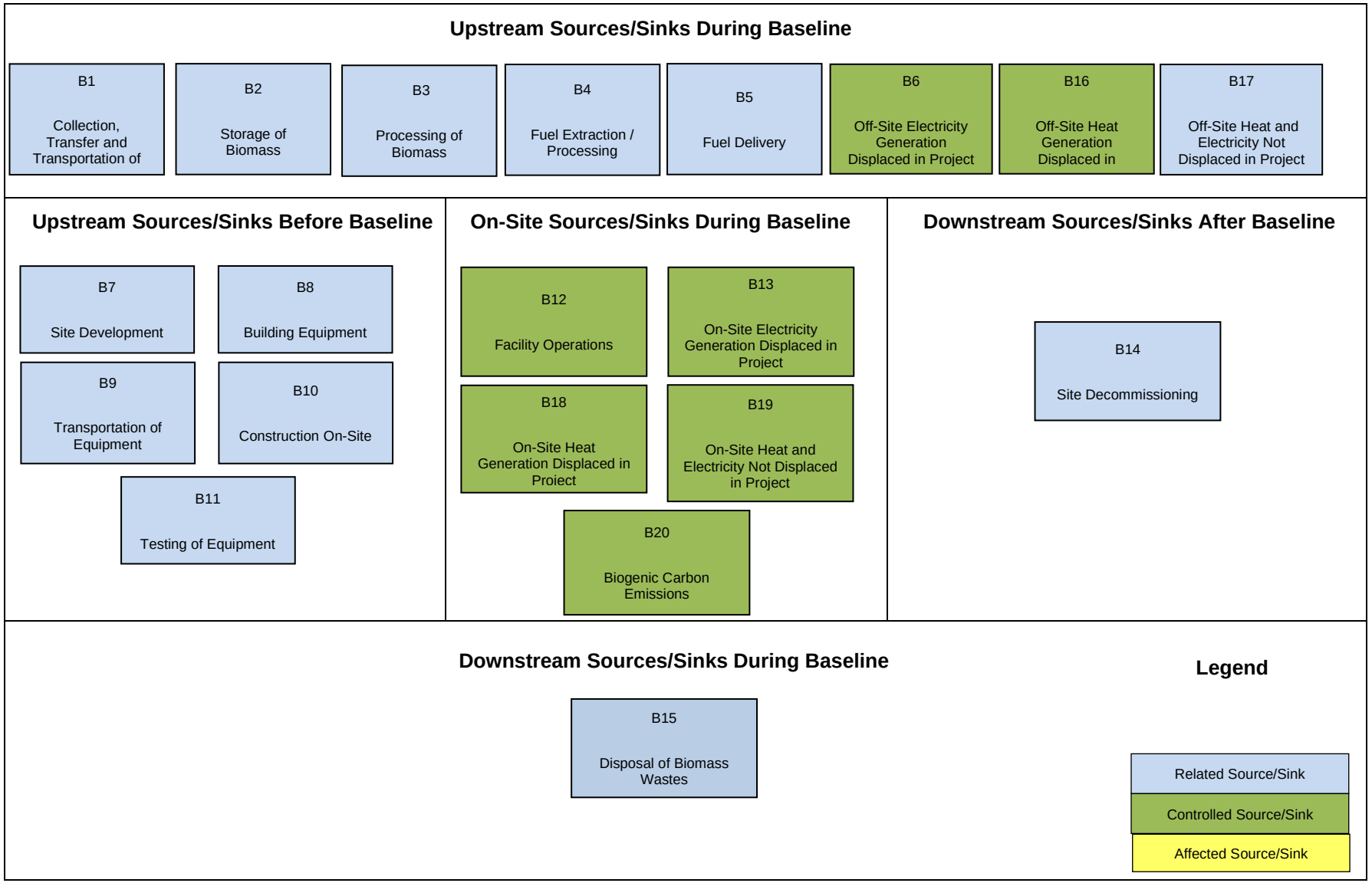
Sources and sinks are determined to be either controlled, related or affected by the projects' activity and are defined as follows:

Controlled	The behaviour or operation of a controlled source/sink is under the direction and influence of a project developer through financial, policy, management or other instruments.
Related	A related source/sink has material and/or energy flows into, out of or within a project but is not under the reasonable control of the project developer.
Affected	An affected source/sink is influenced by the project activity through changes in market demand or supply for projects or services associated with the project.

Baseline sources were identified by reviewing the relevant process flow diagrams, consulting with technical experts and reviewing best practice guidance. This iterative process confirmed the sources/sinks in the process flow diagrams covered the full scope of activities under this protocol.

Based on the process flow diagram provided, the baseline sources/sinks were organized into lifecycle categories in FIGURE 3. Descriptions of each source/sink and its classification as controlled, related or affected are provided in TABLE 2.

FIGURE 3: BASELINE CONDITION SOURCES AND SINKS



1 **TABLE 2. BASELINE CONDITION SOURCES AND SINKS**

Sources/Sinks	Description	Controlled, Related, or Affected
Upstream Sources and Sinks Before Baseline		
B7 - Site Development	Baseline site development could include civil infrastructure such as access to electricity, natural gas and water supply, sewer, etc. This may include clearing, grading, building access roads, etc. This can include building of structures for the facility such as storage areas and offices, and structures to enclose, support and house any equipment. GHG emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to develop the site including but not limited to graders, backhoes, trenching machines, etc.	Related
B8 - Building Equipment	Equipment may need to be built either on or off site. This can include components for the storage, handling and processing of the biomass. These components may be sourced as pre-made standard equipment or custom built to specification. GHG emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment for the extraction of the raw materials, processing, fabricating and assembly.	Related
B9 - Transportation of Equipment	Equipment built off site, and the materials to build equipment on-site must be delivered to the site. Transportation may be completed by truck or rail. GHG emissions would be primarily attributed to the use of fossil fuels to power the equipment delivering the equipment to the site.	Related
B10 - Construction On-site	The process of construction at the site will require a variety of heavy equipment, smaller power tools, cranes and generators. The operation of this equipment will have associated GHG emission from the use of fossil fuels and electricity.	Related
B11 -Testing of Equipment	Equipment may need to be tested to ensure that it is operational. These activities may result in GHG emissions associated with the combustion of fossil fuels and the use of electricity.	Related
Upstream Sources and Sinks During Baseline		
B1 - Collection, Transfer and Transportation of Biomass	Biomass may be collected from the source of generation (e.g., the forest floor, industrial facilities, farm fields, municipal pick-up, etc.) using heavy equipment or conveyors. Biomass may be transferred between locations at a site or transported to other sites. Collection, transfer and transportation of biomass is done by heavy equipment, trucks, and rail. GHG emissions from these activities are associated with fuel used, and may include diesel, gasoline, natural gas or electricity. Other fuels may be used in some rare cases.	Related
B2 - Storage of Biomass	Biomass may be stored in piles where anaerobic decomposition may occur, resulting in methane emissions. These piles may consist of storage piles at waste management facilities, forestry, agricultural or industrial sites. The characteristics of the storage piles (e.g., size, shape, composition and duration of storage) influence emissions from this source. Any energy inputs to this source/sink, such as for wetting of biomass or agitation of biomass, are included in B3.	Related
B3 - Processing of Biomass	Biomass may be processed off site (e.g., source separated, bundled, compressed, chipped, wetted, agitated, etc.) using a series of mechanical processes, heavy equipment and conveyors. This equipment would be fueled by diesel, gasoline, natural gas or electricity resulting in GHG emissions. Other fuels may be used in some rare cases.	Related

Sources/Sinks	Description	Controlled, Related, or Affected
B4 - Fuel Extraction / Processing	Each of the fuels used throughout the on-site component of the baseline must be sourced and processed to account for GHG emissions from the various processes involved in the production, refinement and storage of the fuels. The total volume of fuel for each fuel type used on-site is included in this source/sink.	Related
B5 - Fuel Delivery	Each of the fuels used throughout the on-site component of the project must be transported to the site. This may include shipments by truck or pipeline, resulting in GHG emissions.	Related
B6 – Off-Site Electricity Generation Displaced in Project	Emissions associated with generation of electricity off site which have been displaced through the project activity. This occurs either through the export of electricity off-site and/or reduced import of grid electricity.	Controlled
B16 – Off-Site Heat Generation Displaced in Project	Emissions associated with generation of thermal energy off site which have been displaced through the project activity. This occurs through the export of thermal energy off-site and/or reduced import of thermal energy that was generated off site.	Controlled
B17 – Off-Site Heat and Electricity Not Displaced in Project	The remainder of off-site emissions associated with thermal energy and electricity generation which has not been displaced in the project condition.	Related
Onsite Sources and Sinks During Baseline		
B12 - Facility Operations	This source/sink includes baseline facility operations such as vehicle use, onsite biomass transfer, onsite biomass treatment or onsite processing, etc. that are directly affected by the project implementation. These activities may involve using a combination of loaders, cranes, conveyors and other mechanized devices. This equipment would be fueled by diesel, gasoline, natural gas or electricity, resulting in greenhouse gas emissions. Other fuels may be used in some rare cases.	Controlled
B13 – On-Site Electricity Generation Displaced in Project	If there was on-site generation of electricity in the baseline condition, this source represents the emissions from on-site generation which has been displaced by the project. This could be all or part of the historic electricity generation on-site. The emissions from this source are calculated using site specific factors.	Controlled
B18 – On-Site Heat Generation Displaced in Project	If there was on-site generation of thermal energy in the baseline condition this source represents the emissions from on-site generation which have been replaced by the project. This could be all or part of the historic thermal energy generation on-site. The emissions from this source are calculated using site specific factors tied to the historic methods of thermal energy production on-site. Changes in heat demand or other forms of efficiency which reduce the heat load of the facility should not be included but may be eligible under other offset protocols.	Controlled
B19 – On-Site Heat and Electricity Not Displaced in Project	On-site emissions related to electricity and thermal energy which continue after the project is implemented. These emissions are a continuation of the baseline condition. If the overall thermal energy generation system has changed such that there is no continuity with the baseline practice the offset project boundary should reflect this and this source should be omitted.	Related
B20– Biogenic Carbon Emissions	Emissions resulting from the combustion of biomass. For baseline conditions where biomass is currently being combusted on site the biogenic emissions are tracked and reported for completeness.	Controlled
Downstream Sources and Sinks During Baseline		

Sources/Sinks	Description	Controlled, Related, or Affected
B15 - Disposal of Biomass	Eligible baseline biomass disposal includes open air combustion and anaerobic decomposition in landfill. Materials may also be disposed by incineration, stockpile, decomposition of forest stands with regrowth to a lower carbon stock, land application, or composting, however, diversion from these types of disposal practices are not eligible for emission offsets. Disposal practices may result in releases of carbon dioxide, methane and nitrous oxide. For landfill disposal, methane emissions arising from biomass disposal will be reduced by the amount of any methane collected and destroyed at the landfill.	Related
Downstream Sources and Sinks After Baseline		
B14 - Site Decommissioning	Once the facility is no longer operational, the site must be decommissioned. This will involve the disassembly of the equipment, demolition of onsite structures, disposal of some materials, environmental restoration, re-grading, planting or seeding, and transportation of materials offsite. Emissions from the use of fossil fuels and electricity used to power equipment required for decommissioning.	Related

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3.0 Project Condition

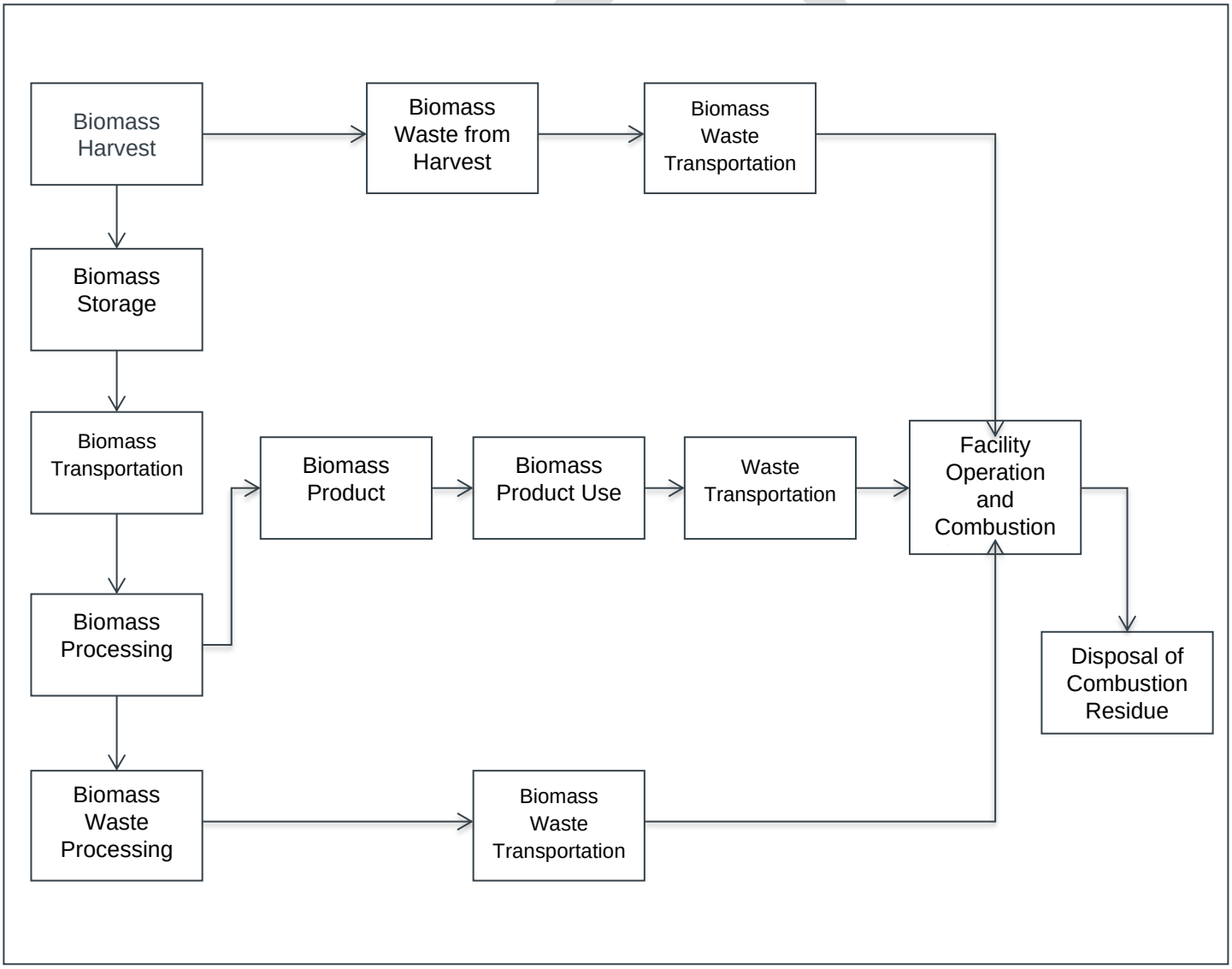
The project condition is the use of eligible biomass wastes to generate energy that displace baseline fossil fuel-based energy for all or part of a facility's thermal energy and/or electricity needs and includes electricity exported to the Alberta Electricity Grid.

Projects that can demonstrate a diversion from landfill of eligible baseline disposal practices discussed in Section 2.0 may be eligible to generate emission offsets from methane avoidance, refer to Sections 4.0, and 5.0 for more information. Projects sourcing from new waste streams qualify only for displacement.

Projects combusting biomass that was land applied in the baseline must demonstrate that diversion does not have a negative impact on soil. Records required to demonstrate that soil conservation and amendment needs are met are discussed in Section 5.1.7.

The project condition, including the relevant sources, sinks and processes is shown in FIGURE 4. More detail on each of these sources/sinks is provided in Section 3.1

FIGURE 4: SIMPLIFIED PROCESS FLOW DIAGRAM FOR THE PROJECT CONDITION



3.1 Identification of Project Condition Sources and Sinks (SSs)

The emissions SSs for this protocol were identified throughout the protocol review processes. This confirmed that the SSs in the process flow diagram (FIGURE 4) covered the scope of eligible project activities under this protocol in FIGURE 5.

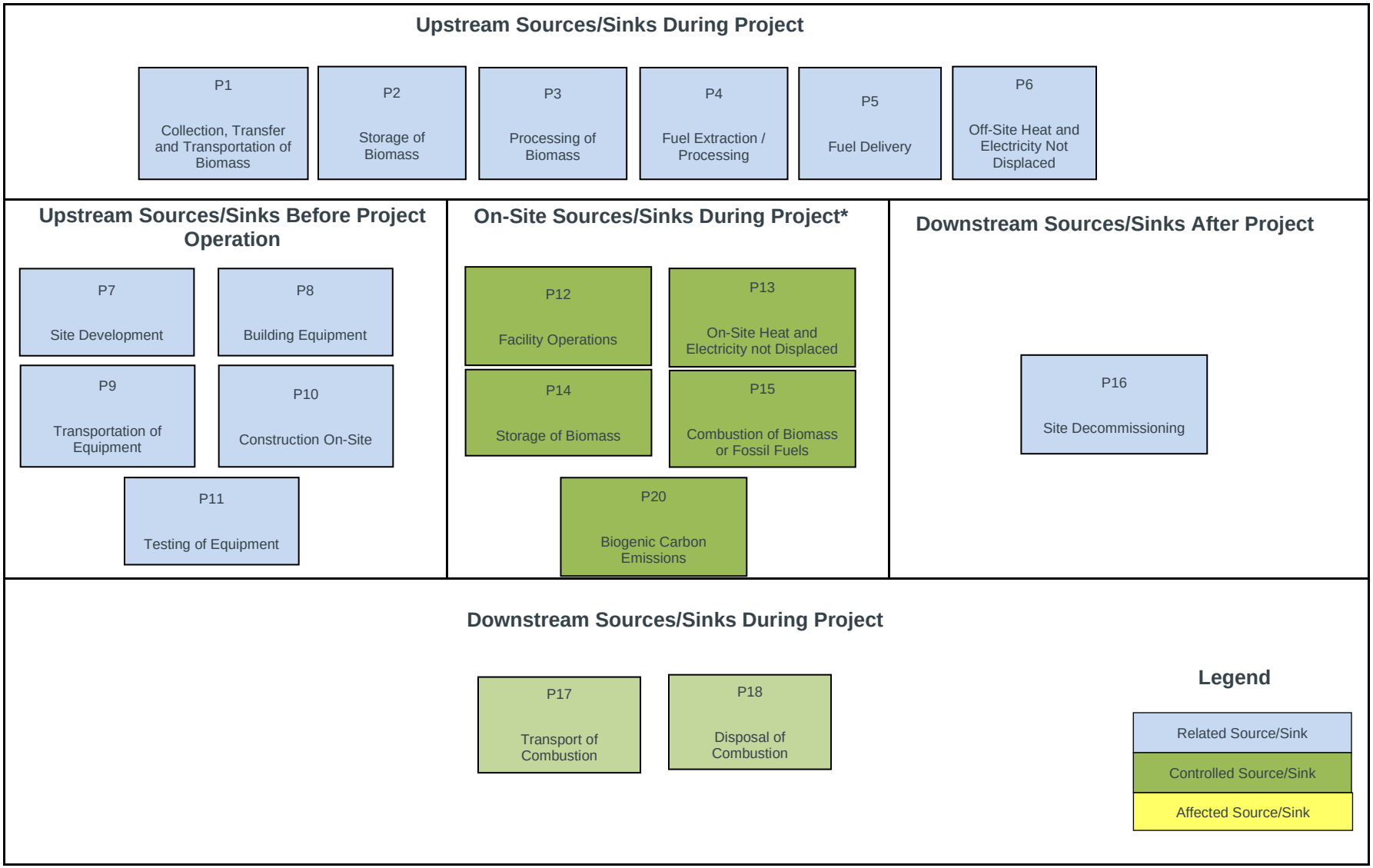
Sources and sinks are determined to be either controlled, related or affected by the project activity and are defined as follows:

Controlled	The behaviour or operation of a controlled source/sink is under the direction and influence of a project developer through financial, policy, management or other instruments.
Related	A related source/sink has material and/or energy flows into, out of or within a project but is not under the reasonable control of the project developer.
Affected	An affected source/sink is influenced by the project activity through changes in market demand or supply for projects or services associated with the project.

Based on the process flow diagram provided, the project sources were organized into lifecycle categories in FIGURE 5. Descriptions of each source/sink and its classification as controlled, related or affected are provided in TABLE 3.

This protocol covers a range of baseline flexibility options and associated project GHG emission reductions. The emission offset project developer is responsible for ensuring that all applicable sources/sinks relevant to their project are included, and documented in the Offset Project Plan and Offset Project Report.

FIGURE 5: PROJECT CONDITION SOURCES AND SINKS



*P19 does not exist in the project scenario as emissions associated with B19 in the baseline, are accounted for in P13 and P15.

TABLE 3. PROJECT CONDITION SOURCES AND SINKS

Sources and Sinks	Description	Controlled, Related or Affected
Upstream Sources and Sinks Before Project Operation		
P7 - Site Development	Site preparation and development of the biomass energy site releases GHG emissions associated with preparing civil infrastructure such as access to electricity, natural gas and water supply, sewer, clearing, grading, building access roads, construction of structures for the facility such as storage areas, storm water drainage, offices, vent stacks, firefighting water storage lagoons.	Related
P8 - Building Equipment	New equipment may need to be built, either on or off site. This includes all of the components of the new system, including, but not limited to, storage, handling, processing, combustion, air, system controls and safety systems. These may be sourced as pre-made standard equipment or custom built to specification. These activities generate GHG emissions by using fossil fuels and electricity to power equipment for the extraction of the raw materials, processing, fabricating and assembly.	Related
P9 - Transportation of Equipment	Equipment built off site, and the materials to build equipment on-site must be transported to the site. Transportation methods may include, but are not limited to, truck and train. These activities generate GHG emissions by using fossil fuels to power the equipment delivering the equipment to the site.	Related
P10 - Construction On-site	Construction at the site will require a variety of heavy equipment, smaller power tools, cranes and generators. Equipment operations have associated GHG emission from the use of fossil fuels and/or electricity.	Related
P11 - Testing of Equipment	Equipment is tested in order to ensure that the equipment runs properly. These activities will result in GHG emissions associated with the combustion of fossil fuels and the use of electricity.	Related
Upstream Sources and Sinks During Project		
P1 - Collection, Transfer and Transportation of Biomass	Biomass is collected from the point of generation (e.g., forest floor, farm fields, industrial facilities, municipal pick-up, etc.) or from the point of disposal (e.g., landfill or stockpile) using heavy equipment or conveyors. Biomass may be transferred between locations onsite or transported to other sites. Collection, transfer and transportation of biomass are typically done by heavy equipment, trucks and rail. These activities are fueled by diesel, gasoline or natural gas, resulting in GHG emissions. Other fuels may be used in some rare cases.	Related
P2 - Storage of Biomass	Upstream biomass storage is typically done in piles at waste management facilities, forestry, agricultural or industrial sites. This can result in anaerobic decomposition, yielding methane gas emissions. Storage pile characteristics (e.g., size, shape, composition, moisture content and duration of storage) affect the generation of GHG emissions. Energy inputs to activity from wetting or agitation of biomass are addressed under P3 Processing of Biomass.	Related
P3 - Processing of Biomass	Biomass may be processed on or offsite (e.g., bundled, compressed, chipped, wetted, agitated, etc.) using mechanical processes, heavy equipment and conveyors. This equipment would be fueled by diesel, gasoline, natural gas or electricity resulting in GHG emissions. Other fuels may be used in some rare cases.	Related
P4 - Fuel Extraction / Processing	Each of the fuels used throughout the onsite component of the project will have GHG emissions associated with the various processes involved in the production, refinement and storage. The total volume of fuel for each of the on-site sources/sinks is included in this source/sink.	Related

Sources and Sinks	Description	Controlled, Related or Affected
P5 - Fuel Delivery	Each of the fuels used throughout the on-site component of the project must be transported to the site. This may include shipments by truck, rail or pipeline, resulting in GHG emissions.	Related
P6 - Off-Site Heat and Electricity Not Displaced	Emissions associated with off-site electricity and thermal energy generation that has not been displaced by the project activity.	Related
Onsite Sources and Sinks During Project		
P12 - Facility Operations	This source includes electricity use for biomass to energy facility operations pertaining to the offset project such as energy use during shutdown or maintenance, on-site vehicle use, on-site biomass transfer, biomass processing, etc. Biomass may be handled using a combination of loaders, cranes, conveyors and other mechanized devices. Equipment fueled by diesel, gasoline, or natural gas is included in P20.	Controlled
P13 - On-Site Heat and Electricity Not Displaced	The emissions associated with pre-existing or non-project related on-site thermal energy and electricity generation that have not been displaced by the thermal energy or electricity produced by the project.	Controlled
P14 - Storage of Biomass	Biomass storage onsite for the purpose of the project activity may result in anaerobic decomposition, which releases GHG emissions. Storage pile characteristics (e.g., size, shape, composition, moisture content and duration of storage) affect the generation of GHG emissions.	Controlled
P15 - Combustion of Biomass or Fossil Fuels	Biomass combustion emits GHG emissions. The CO_2 component of these emissions may be biogenic and reported in P20. The N_2O and CH_4 emissions from biomass are always included. The emissions resulting from the combustion of fossil fuels for the production of energy in the project are also included.	Controlled
P20 - Biogenic Carbon Emissions	Emissions resulting from the combustion of biogenic biomass. The biogenic emissions are tracked and reported for completeness. Although reported on, these are considered emissions that are not included in the calculation of offsets.	Controlled
Downstream Sources and Sinks During Project		
P17 - Transport of Combustion Residue	Combustion residue is transported to disposal sites by truck, train or other. Emissions are associated with transportation of combustion residues is associated with the distance travelled, fuel source and method of transport.	Controlled
P18 - Disposal of Combustion Residue	Combustion residues are deposited at a disposal site (typically landfill or land application location) by transferring the waste from the transportation container, spreading, burying, processing and otherwise handling the waste using a combination of loaders, conveyors and other mechanized devices. This equipment would be fueled by diesel, gasoline or natural gas, resulting in GHG emissions. Other fuels may be used in some cases.	Controlled
Downstream Sources and Sinks After Project		
P16 - Site Decommissioning	Once the facility is no longer operational, the site must be decommissioned. This involves the disassembly of the equipment, demolition of onsite structures, disposal of some materials, environmental restoration, re-grading, planting or seeding, and transportation of materials off site. Emissions are generated from fossil fuel combustion and electricity used to power equipment required to decommission the site.	Related

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4.0 Quantification

The baseline and project conditions were assessed against each other to determine the scope for GHG emissions and reductions quantified under this protocol. Sources and sinks are either included or excluded depending on how they are impacted by the projects' activity. Sources and sinks that are not expected to change between the baseline and project conditions are excluded from the projects' quantification.

All sources/sinks identified in TABLE 2 and TABLE 3 are listed in TABLE 4, which compares each source and sink.

To be eligible, offset projects must be able to demonstrate real, quantifiable and verifiable emissions reductions using replicable quantifiable methodologies to identify and quantify GHG emissions reductions that would not otherwise have occurred had the project not been implemented. Demonstration of project eligibility is separate from quantification of emissions offsets and must be provided in the offset project plan and offset project reports, and is subject to independent verification. Demonstration of net emission reductions thus includes changes in the use of fossil fuels for example, with most projects the collection and transportation of biomass will increase and this increase must be estimated and later tracked to ensure that the project remains eligible and are real quantifiable net reduction of GHG emissions.

Sources/sinks identified as "Included" in TABLE 4 require quantification of GHG emissions from all fuel types. Within each source/sink, fossil fuels subject to the carbon levy and non-levied fuels are quantified and reported separately in the project report for reporting periods prior to April 1, 2025. As of April 1, 2025, emissions from all fuel types within each source/sink are quantified and reported as offset eligible emission reductions in the project report. In the event that there is a change in regulatory requirements or implementation of a new carbon charge or tax, the emission offset project developer is responsible for assessing their "Offset-Eligible Reductions" and "Levied Emissions Reductions" equations and sources to ensure "levied sources" are not included in the Net Offset-Eligible Reductions. For project reports where levied emissions are reported but not quantified for emission offsets, the report must also include: total of levied fuels and non-levied fuels for baseline and project scenarios, total baseline and total project emissions from all fuel types, and sum of baseline – project emissions. See Section 4.1.3 for details.

Sources/sinks identified as "Included" in TABLE 4 require monitoring, measurement, and quantification.

1 **TABLE 4. COMPARISON OF SOURCES AND SINKS FOR BASELINE AND PROJECT CONDITIONS**

Identified Sources and Sinks	Baseline (C, R ,A)*	Project (C, R, A)*	Include or Exclude	Justification
Upstream Sources/Sinks				
B7 - Site Development	R	N/A	Excluded	Emissions associated with site development are minimal relative to overall project emissions and are expected to be comparable between baseline and project site development.
P7 - Site Development	N/A	R		
B8 - Building Equipment	R	N/A	Excluded	Emissions associated with building equipment are expected to be similar between the baseline and project conditions.
P8 - Building Equipment	N/A	R		
B9 - Equipment Transportation	R	N/A	Excluded	Emissions associated with the transportation of equipment are expected to be similar in the baseline and project conditions.
P9 - Equipment Transportation	N/A	R		
B10 - Construction on-site	R	N/A	Excluded	Emissions associated with construction on-site are expected to be similar in the baseline and project conditions.
P10 - Construction on-site	N/A	R		
B11 - Testing of Equipment	R	N/A	Excluded	Emissions associated with the testing of equipment are expected to be similar in the baseline and project conditions.
P11 - Testing of Equipment	N/A	R		
Upstream Sources/Sinks During Project				
B1 - Collection, Transfer and Transport of Biomass	R	N/A	Included*	Collection, transfer and transport of biomass may change in the project condition depending on the type of biomass residues being used.
P1 - Collection, Transfer and Transport of Biomass	N/A	R		*Emissions associated with biomass collection, transfer, and transport must be quantified and tracked during project operations and when establishing baseline to ensure project eligibility.
B2 - Storage of Biomass	R	N/A	Excluded	The off-site storage of biomass prior to its intended final disposal (B2) or delivery to the project site (P2) is likely to be short-term and within the prescribed limits. Emissions from anaerobic decomposition are therefore expected to be negligible and functionally equivalent. Any emissions from short-term biomass storage arising from the biomass to energy project condition and activity are captured under P14.
P2 - Storage of Biomass	N/A	R		
B3 - Processing of Biomass	R	N/A	Included*	Processing of biomass is variable by biomass waste type and conditions.
P3 - Processing of Biomass	N/A	R		*Projects must evaluate processing emissions and where processing emissions change between baseline and project, any emissions from fossil fuels and electricity use need to be included in the quantification of project emissions
B4 - Fuel Extraction / Processing	R	N/A	Included	

Identified Sources and Sinks	Baseline (C, R ,A)*	Project (C, R, A)*	Include or Exclude	Justification
P4 - Fuel Extraction / Processing	N/A	R		Baseline emissions are expected to be higher than project emissions. Volumes and types of fuels used must be tracked.
B5 - Fuel Delivery	R	N/A	Excluded	Baseline emissions are expected to be higher than project emissions. It is conservative to exclude these emissions from the quantification.
P5 - Fuel Delivery	N/A	R		
B6 - Off Site Electricity Generation Displaced in Project	R	C	Included	These are the off-site emissions displaced through the export of electricity off- site or the reduced import of electricity to the site as a result of the project.
B16 - Off Site Heat Generation Displaced in Project	R	C	Included	Emissions associated with generation of thermal energy off site which have been displaced through the project activity. This occurs through the export of thermal energy off-site and/or reduced import of thermal energy that was generated off-site. Changes in fossil fuel use must be tracked during operations and when establishing baseline to ensure project eligibility and quantification completeness.
B17 – Off-Site Heat and Electricity Not Displaced in the Project	R	R	Excluded	Assuming the project does not alter provincial demand for thermal energy or electricity, emissions for this generation will be the same in the baseline and project conditions.
P6 – Off-Site Heat and Electricity Not Displaced in the Project	R	R		
On-site Sources/Sinks During Project				
B12 - Facility Operations	C	N/A	Included	Emissions from electricity use for operation of the biomass to energy facility including the processing and handling of biomass on-site must be quantified. This source/sink includes emissions associated with electrically powered heavy equipment, conveyors, etc. used to manipulate, move, and transfer the biomass on-site. Emissions from equipment fueled by diesel, gasoline, natural gas or other hydrocarbon fuels are quantified.
P12 - Facility Operations	N/A	C		
B13 - On-Site Electricity Generation Displaced in Project	R	C	Included	These are emissions which occurred on-site to generate electricity in the baseline condition which have been displaced by the activity of the project.
B18 - On-Site Heat Generation Displaced in Project	R	C	Included	Emissions associated with generation of thermal energy on site which have been displaced through the project activity. Emissions from diesel, gasoline, natural gas or other hydrocarbon fuels are quantified. Changes in fossil fuel use must be tracked during operations and when establishing baseline to ensure project eligibility and quantification completeness.
B19 - On-Site Heat and Electricity Not Displaced	R	R	Excluded	These emissions from on-site thermal energy or electricity generation are not displaced by the project and remain the same between the baseline and project conditions.

Identified Sources and Sinks	Baseline (C, R ,A)*	Project (C, R, A)*	Include or Exclude	Justification
P13 - On-Site Heat and Electricity Not Displaced	R	R		
P14 - Storage of Biomass	N/A	C	Included*	Storage of biomass can result in GHG emissions if the material begins to degrade anaerobically. Biomass storage must be documented and monitored. *Storage duration within the maximum limit (Appendix A) is then excluded from the project quantification. Waste that is stored beyond these limits is not eligible for generation of emissions offsets.
P15 - Combustion of Biomass or Fossil Fuels	N/A	C	Included	Emissions (CH_4 and N_2O) resulting from the combustion of biomass must be quantified. Biogenic CO_2 emissions are excluded from offsets but must be tracked and reported in B20. Emissions resulting from the combustion of fossil fuels must be quantified.
B20 – Biogenic Carbon Emissions	C	N/A	Included	Emissions from biogenic biomass fuel consumption to produce energy.
P20 – Biogenic Carbon Emissions	NA	C		*Although not considered in the calculation of offsets, these emissions must be quantified to ensure comprehensiveness and consistency of reporting GHG emissions.
Downstream Sources/Sinks During the Project				
B15 - Disposal of Biomass	R	N/A	Included	Disposal of biomass varies according to type and source as do the associated GHG emissions. Only projects eligible for use of the flexibility mechanisms can quantify disposal emissions under B15. In the case where diversion of feedstock is not from an eligible disposal practice and/or the baseline cannot be verified, this source must be omitted from baseline quantification. Emissions related to biomass handling prior to disposal are captured under B1, P1, B2, P2, B3 and P3.
P17 - Transport of Combustion Residue	N/A	C	Excluded	Under the majority of project configurations, the volume of combustion residue generated and transported is assessed to be immaterial.
P18 - Disposal of Combustion Residue	N/A	C	Excluded	The emissions covered under this source result from the transport and operation of equipment and machinery required to dispose of the residue. Given the nominal volumes of material being disposed of, this source is excluded.
Downstream Sources and Sinks After the Project				
B14 - Site Decommissioning	R	N/A	Excluded	Energy demands for decommissioning a biomass facility are similar in scope to the energy demands associated with the decommissioning other fossil fuel power facilities that could be built to provide a similar power source. The emissions from decommissioning are similar.
P16 - Site Decommissioning	N/A	R		

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4.1 Quantification Methodology

Quantification of the emission reductions of relevant sources/sinks for each of the greenhouse gases are to be completed using the methodologies outlined in TABLE 5. These calculation methodologies serve to complete the following three equations for calculating the emission reductions through comparison of the baseline and project conditions emissions. Emissions reductions are quantified by calculating the difference in emissions.

4.1.1 Net Emissions Reductions

Outlined below is the general approach to quantifying greenhouse gas emissions as stated in ISO 14064-2:2019. Net Emissions Reductions are the total emissions quantified, using the approach defined in this section.

$$\textbf{Net Emission Reductions} = \textbf{Emissions}_{\textbf{Baseline}} - \textbf{Emissions}_{\textbf{Project}}$$

Where baseline emissions are calculated according to the following equation:

$$\textbf{Emissions}_{\textbf{Baseline}} = \text{Emissions}_{\text{Collection, Transfer, Transport}} + \text{Emissions}_{\text{Processing of Biomass}} + \text{Emissions}_{\text{Fuel Extraction and Processing}} + \text{Emissions}_{\text{Off-Site Electricity}} + \text{Emissions}_{\text{Facility Operations}} + \text{Emissions}_{\text{On-Site Electricity}} + \text{Emissions}_{\text{Biomass Disposal}}[1] + \text{Emissions}_{\text{Off-Site Heat}} + \text{Emissions}_{\text{On-Site Heat}}$$

Baseline emission sources include the following:

$\text{Emissions}_{\text{Baseline}}$ = Sum of the emissions under the baseline condition.
= Emissions from Collection, Transfer and Transport of Biomass (B1)
+ Emissions from Processing of Biomass (B3)
+ Emissions from Fuel Extraction and Processing (B4)
+ Emission from Displaced Off-site Electricity Generation (B6)
+ Emission from Facility Operations (B12)
+ Emission from Displaced On-site Electricity Generation (B13)
+ Emissions from Biomass Disposal (*B15 as applicable*)
+ Emission from Displaced Off-site Heat Generation (B16)
+ Emission from Displaced On-site Heat Generation (B18)

Where project emissions are calculated according to the following equation:

$$\textbf{Emissions}_{\textbf{Project}} = \text{Emissions}_{\text{Collection, Transfer, Transport}} + \text{Emissions}_{\text{Biomass Processing}} + \text{Emissions}_{\text{Fuel Extraction and Processing}} + \text{Emissions}_{\text{Facility Operations}} + \text{Emissions}_{\text{Combustion of Biomass/Fossil Fuels}}$$

Project emissions sources include the following:

$\text{Emissions}_{\text{Project}}$ = Sum of emissions under the project condition.
= Emissions from Collection, Transfer and Transport of Biomass (P1)
+ Emissions from Processing of Biomass (P3)
+ Emissions from Fuel Extraction and Processing (P4)
+ Emission from Facility Operations (P12)
+ Emissions from Combustion of Biomass and Fossil Fuels (P15)

[1] Inclusion of B15 subject to meeting requirements of the Flexibility Mechanism.

P14 - Storage of Biomass: Storage duration within the maximum limit (Appendix A) is then excluded from the project quantification. Waste that is stored beyond these limits is not eligible for generation of emissions offsets.

B20/P20 – Biogenic Carbon Emissions: Baseline and Project emissions source is monitored and measured according to this protocol but is not quantified for emission offsets (all biogenic CO_2 emissions are reported in B20/P20.)

4.1.2 Offset-Eligible Reductions

Offset-eligible reductions are the emission reductions eligible for the calculation of emission offsets. They are calculated from a comparison of project and baseline emissions for all offset-eligible sources and sinks[2]. Offset-eligible reductions must be calculated using the equation below:

$$\textbf{Eligible Emissions Reductions} = \textbf{Emissions}_{\textbf{Non-Levied Baseline}} - \textbf{Emissions}_{\textbf{Non-Levied Project}}$$

Where offset-eligible baseline emissions are calculated according to the following equation:

$$\textbf{Emissions}_{\textbf{Non-Levied Baseline}} = \text{Emissions}_{\text{Processing of Biomass}} + \text{Emissions}_{\text{Fuel Extraction and Processing}} + \text{Emissions}_{\text{Off-Site Electricity}} + \text{Emissions}_{\text{Facility Operation}} + \text{Emissions}_{\text{On-Site Electricity}} + \text{Emissions}_{\text{Disposal of Biomass}} + \text{Emissions}_{\text{Off-Site Heat}} + \text{Emissions}_{\text{On-Site Heat}}$$

Baseline offset-eligible emission sources include the following:

$\text{Emissions}_{\text{Non-levied Baseline}}$ = Sum of the emissions under the baseline condition that are <u>not</u> subject to the carbon levy.

= Emissions from Processing of Biomass (B3)
+ Emissions from Fuel Extraction and Processing (B4)
+ Emission from Displaced Off-site Electricity Generation (B6)
+ Emission from Facility Operations (B12)
+ Emission from Displaced On-site Electricity Generation (B13)
+ Emissions from Biomass Disposal (*B15 as applicable*)
+ Emission from Displaced Off-site Heat Generation (B16)
+ Emission from Displaced On-site Heat Generation (B18)

Where offset-eligible project emissions are calculated according to the following equation:

$$\textbf{Emissions}_{\textbf{Non-levied Project}} = \text{Emissions}_{\text{Processing of Biomass}} + \text{Emissions}_{\text{Fuel Extraction and Processing}} + \text{Emissions}_{\text{Facility Operation}} + \text{Emissions}_{\text{Combustion of Biomass}}$$

Project offset-eligible emission sources include the following:

$\text{Emissions}_{\text{Non-levied Project}}$ = Sum of the emissions under the project condition that are <u>not</u> subject to the carbon levy.

= Emissions from Processing of Biomass (P3)
+ Emissions from Fuel Extraction and Processing (P4)
+ Emission from Facility Operation (P12)
+ Emissions from Combustion of Biomass (P15)

[2] CRCM recognizes that some SSRs may contain emissions from both levied and non-levied emissions sources. It is the responsibility of the project proponent to ensure that where SSRs contain both levied and non-levied emissions sources are disaggregated and supported by appropriate documentation.

The protocol quantification methodologies are outlined in TABLE 5, TABLE 6 (flexibility mechanisms) and TABLE 7. TABLE 7 describes methodology for project tracked biogenic emissions that are not emission offset eligible.

4.1.3 Levied Emissions Reductions (reported but only included in offset calculation per assessment)

The Government of Canada has made regulations that cease the application of the federal fuel charge, effective April 1, 2025, and is also removing requirements for provinces and territories to have a consumer-facing carbon price as of that date.

Levied emissions must be reported under the "Levied Emission Reductions" category and cannot be included in the quantification of offset-eligible credits for reporting periods prior to April 1, 2025.

As of April 1, 2025, these previously levied emission sources can be included in the quantification of emission offsets-eligible credits.

In the event that there is a change in regulatory requirements or implementation of a new carbon charge or tax, the emission offset project developer is responsible for assessing their "Offset-Eligible Reductions" and "Levied Emissions Reductions" equations and sources to ensure "levied sources" are not included in the Offset-Eligible Reductions.

Emissions from levied fuels are quantified and reported where there is a difference in the project and baselines emissions. Levied emissions must be calculated for each fuel combustion-related sources and sinks, as per the equation below.

$$\textbf{Levied Emissions Reductions} = \textbf{Emissions}_{\textbf{Levied Baseline}} - \textbf{Emissions}_{\textbf{Levied Project}}$$

Where levied baseline emissions are calculated according to the following equation:

$$\textbf{Emissions}_{\textbf{Levied Baseline}} = \text{Emissions}_{\text{Collection, Transfer, Transport}} + \text{Emissions}_{\text{Processing of Biomass}} + \text{Emissions}_{\text{Facility Operations}} + \text{Emissions}_{\text{Off-Site Heat}} + \text{Emissions}_{\text{On-Site Heat}}$$

Baseline levied emission sources include the following:

$\text{Emissions}_{\text{Levied Baseline}}$ = Sum of the emissions under the levied baseline condition.
= Emissions from Collection, Transfer and Transport of Biomass (B1)
+ Emissions from Processing of Biomass (B3)
+ Emissions from Facility Operations (B12)
+ Emission from Displaced Off-site Heat Generation (B16)
+ Emission from Displaced On-site Heat Generation (B18)

Where levied project emissions are calculated according to the following equation:

$$\textbf{Emissions}_{\textbf{Levied Project}} = \text{Emissions}_{\text{Collection, Transfer, Transport}} + \text{Emissions}_{\text{Biomass Processing}} + \text{Emissions}_{\text{Facility Operations}} + \text{Emissions}_{\text{Combustion of Biomass and Fossil Fuels}}$$

Project levied emission sources include the following:

$\text{Emissions}_{\text{Levied Project}}$ = Sum of emissions under the levied project condition.
= Emissions from Collection, Transfer and Transport of Biomass (P1)
+ Emissions from Processing of Biomass (P3)
+ Emission from Facility Operation (P12)
+ Emissions from Combustion of Biomass and Fossil Fuels (P15)

4.2 Quantification Methodologies

Transparent and accurate data are needed to support project implementation and facilitate the independent review of any emission reduction claims.

TABLE 5. QUANTIFICATION METHODOLOGY FOR BIOMASS COMBUSTION FOR ENERGY PROJECTS

Source/ Sink	Parameter/Variable	Unit	Measured/ Estimated/ Calculated	Method	Frequency	Justify measurement or estimation and frequency
B1/P1 - Collection, Transfer and Transport of Biomass	$Emissions_{Collection, Transfer and Transport} = \{\Sigma [Volume\ of\ Fuel_i * EF_{i, CO2}] + \Sigma [GWP_{CH4} * Volume\ of\ Fuel_i * EF_{i, CH4}] + \Sigma [GWP_{N2O} * Volume\ of\ Fuel_i * EF_{i\ N2O}]\} / 1000$					
	$Emissions_{Collection, Transfer and Transport}$ Emission from Biomass Collection, Transfer and Transport	tonnes CO_2e	N/A	N/A	N/A	Quantity being calculated in aggregate form as fuel use on-site is likely aggregated for each of these source/sinks. Calculated separately for each fuel type.
	$Volume\ of\ Fuel_i$ Volume of each Fuel Combusted	L, m^3, or Other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous Metering or Monthly Reconciliation	Both methods are standard practice. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence and must be conservative.
	$EF_{i, CO2}$ CO_2 Emission Factor for each Fuel	kg CO_2 per L, m^3 or other	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook.
	$EF_{i, CH4}$ CH_4 Emission Factor for each Fuel	kg CH_4 per L, m^3 or other	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook.
	$EF_{i, N2O}$ N_2O Emission Factor for each Fuel	kg N_2O per L, m^3 or other	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook.

Source/ Sink	Parameter/Variable	Unit	Measured/ Estimated/ Calculated	Method	Frequency	Justify measurement or estimation and frequency
	GWP_{CH4} Global Warming Potential for CH_4	Unitless	Estimated	Standard for Completing Greenhouse Gas Compliance and Forecasting Reports	N/A	Values referenced in Standard, subject to review.
	GWP_{N2O} Global Warming Potential for N_2O	Unitless	Estimated	Standard for Completing Greenhouse Gas Compliance and Forecasting Reports	N/A	Values referenced in Standard, subject to review.
B3/P3 - Processing of Biomass	$Emission_{Processing\ of\ Biomass} = \{\sum [Volume\ of\ Fuel_i * EF_{i, CO2}] + \sum [GWP_{CH4} * Volume\ of\ Fuel_i * EF_{i, CH4}] + \sum [GWP_{N2O} * Volume\ of\ Fuel_i * EF_{i, N2O}]\} / 1000$ And/or $Emission_{Processing\ of\ Biomass} = EF_{EG} * Quantity\ of\ Electricity\ Consumed$					
	$Emission_{Processing\ of\ Biomass}$ Emissions from Processing of Biomass	tonnes CO_2e	N/A	N/A	N/A	Quantity being calculated from electricity and or fuel use. Calculated separately for each energy source or fuel type.
	$Volume\ of\ Fuel_i$ Volume of each fuel used	L, m^3, or Other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous Metering or Monthly Reconciliation	Both methods are standard practice. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence and must be conservative.
	Quantity of Electricity Consumed	MWh	Measured	Direct metering or third-party invoiced data	Continuous Metering or Monthly Reconciliation	Both methods are standard practice. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence.
	EF_{EG} Grid Electricity Usage Factor	tonnes CO_2e/ MWh	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook.

Source/ Sink	Parameter/Variable	Unit	Measured/ Estimated/ Calculated	Method	Frequency	Justify measurement or estimation and frequency
	$EF_{i, CO2}$ CO_2 Emission Factor for each Fuel	kg CO_2 per L, m^3, or other	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook.
	$EF_{i, CH4}$ CH_4 Emission Factor for each Fuel	kg CH_4 per L, m^3, or other	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook.
	$EF_{i, N2O}$ N_2O Emission Factor for each Fuel	kg N_2O per L, m^3, or other	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook.
	GWP_{CH4} Global Warming Potential for CH_4	Unitless	Estimated	Standard for Completing Greenhouse Gas Compliance and Forecasting Reports	N/A	Values referenced in Standard.
	GWP_{N2O} Global Warming Potential for N_2O	Unitless	Estimated	Standard for Completing Greenhouse Gas Compliance and Forecasting Reports	N/A	Values referenced in Standard.
B4/P4 - Fuel Extraction and Processing	$Emissions_{Fuel\ Extraction\ and\ Processing} = [\sum (Volume\ of\ Fuel_i * EF_{i, CO2}) + \sum (Volume\ of\ Fuel_i * EF_{i, CH4}) \times GWP_{CH4} + \sum (Volume\ of\ Fuel_i * EF_{i, N2O}) \times GWP_{N2O}] / 1000$					
	$Emission_{Fuel\ Extraction\ and\ Processing}$ Emissions from Fuel Extraction and Processing	tonne CO_2e	N/A	N/A	N/A	Quantity being calculated.

Source/ Sink	Parameter/Variable	Unit	Measured/ Estimated/ Calculated	Method	Frequency	Justify measurement or estimation and frequency
	Volume of $Fuel_i$ Volume of each Fuel Combusted	L, m^3, or other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous metering or monthly reconciliation	Both methods are standard practice. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence and must be conservative.
	$EF_{i, CO2}$ CO_2 Emission Factor for Extraction and Processing of each Fuel	kg CO_2 per L or m^3	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook.
	$EF_{i, CH4}$ CH_4 Emission Factor for Extraction and Processing of each Fuel	kg CH_4 per L or m^3	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook.
	$EF_{i, N2O}$ N_2O Emission Factor for Extraction and Processing of each Fuel	kg N_2O per L or m^3	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook.
	GWP_{CH4} Global Warming Potential for CH_4	Unitless	Estimated	Standard for Completing Greenhouse Gas Compliance and Forecasting Reports	N/A	Values referenced in Standard.
	GWP_{N2O} Global Warming Potential for N_2O	Unitless	Estimated	Standard for Completing Greenhouse Gas Compliance and Forecasting Reports	N/A	Values referenced in Standard.

Source/ Sink	Parameter/Variable	Unit	Measured/ Estimated/ Calculated	Method	Frequency	Justify measurement or estimation and frequency
B12/P12 - Facility Operations	Emission $_{Facility\ Operations}$ = {∑ [Volume of Fuel$_i$ * $EF_{i, CO2}$] + ∑ [GWP_{CH4} * Volume of Fuel$_i$ * $EF_{i, CH4}$] + ∑ [GWP_{N2O} * Volume of Fuel$_i$ * $EF_{i, N2O}$]} / 1000 And/or Emission $_{Facility\ Operations}$ = EF_{EG} * Quantity of Electricity Consumed					
	Emission $_{Facility\ Operations}$ Emissions from Facility Operations	tonnes CO_2e	N/A	N/A	N/A	Quantity being calculated from electricity and fuel use in the project facility. Calculated separately for each energy source or fuel.
	Volume of Fuel$_i$ Volume of each Fuel Combusted	L, m^3, or other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous Metering or Monthly Reconciliation	Both methods are standard practice. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence and must be conservative.
	$EF_{i, CO2}$ CO_2 Emission Factor for each Fuel	kg CO_2 per L, m^3 or other	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook
	$EF_{i, CH4}$ CH_4 Emission Factor for each Fuel	kg CH_4 per L, m^3 or other	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook.
	$EF_{i, N2O}$ N_2O Emission Factor for each Fuel	kg N_2O per L, m^3 or other	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook.
	GWP_{CH4} Global Warming Potential for CH_4	Unitless	Estimated	Standard for Completing Greenhouse Gas Compliance and Forecasting Reports	N/A	Values referenced in Standard.

Source/ Sink	Parameter/Variable	Unit	Measured/ Estimated/ Calculated	Method	Frequency	Justify measurement or estimation and frequency
	GWP_{N2O} Global Warming Potential for N_2O	Unitless	Estimated	Standard for Completing Greenhouse Gas Compliance and Forecasting Reports	N/A	Values referenced in Standard.
	Quantity of Electricity Consumed	MWh	Measured	Direct metering or third-party invoiced data	Continuous Metering or Monthly Reconciliation	Both methods are standard practice. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence and must be conservative.
	EF_{EG} Grid Electricity Usage Factor	tonnes CO_2e/ MWh	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook.
B13 - On-site Electricity Generation Displaced in Project	If (Egproj – Ecproj) < 0, then: Displaced $Emissions_E$ On-Site = 0 Otherwise: Displaced $Emissions_E$ On-Site = EF_{EO} * lesser of [(Egproj – Ecproj), $Eghistoric_{Adjusted}$)] Where: $Egphistoric_{Adjusted}$ = Eghistoric * (Current Production / Historic Production)					
	Displaced $Emissions_E$ On-site Emission from Electricity Generation Displaced On-site	tonnes CO_2e	N/A	N/A	N/A	Quantity being calculated. See Appendix C for sample calculations.
	Egproj Electricity Generated by Project	MWh	Measured	Direct metering of all electricity produced by the project.	Continuous Metering	Continuous direct metering represents the industry practice and the highest level of detail.

Source/ Sink	Parameter/Variable	Unit	Measured/ Estimated/ Calculated	Method	Frequency	Justify measurement or estimation and frequency
	Ecproj Electricity Consumed by the Project	MWh	Measured	Direct metering of all electricity consumed by the project.	Continuous Metering	Continuous direct metering represents the industry practice and the highest level of detail.
	$Eghistoric_{Adjusted}$ Electricity scaled to current operations	MWh	Calculated	Calculated	Annual	Scaling adjusts for operational variability.
	Eghistoric Historic level of on-site generation	MWh	Calculated	Average of measured on-site generation for three years preceding the project	Continuous Metering	On-site displacement should not exceed historic levels of on-site generation.
	EF_{EO} Site-Specific Electricity Emissions Factor	tonnes CO_2e/ MWh	Estimated	Calculated Based on Historic Performance of On-site electricity generation (emissions of three previous years for electricity generation divided by total generation for three previous years).	Annual	Site specific emissions factor must be used. New builds must use the grid factor published in the Carbon Offset Emission Factors Handbook.
	EF_{EG} Grid Electricity Usage Factor	tonnes CO_2e/ MWh	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook, subject to reviews.
	Current Production	Host site-specific units of product	Measured	Direct measurement of site production in the current year.	Annual	Scaling adjusts for operational variability.
	Historic Production	Host site-specific units of product	Measured	Direct measurement of average historic site production for three years immediately prior to project implementation.	Annual	Scaling adjusts for operational variability.

Source/ Sink	Parameter/Variable	Unit	Measured/ Estimated/ Calculated	Method	Frequency	Justify measurement or estimation and frequency
B6 – Off Site Electricity Generation Displaced in Project	Displaced Emissions$_E$ Off-Site = EF_{EG} * max of (Egproj – Ecproj – Eghistoric$_{Adjusted}$, 0) Where: Egphistoric$_{Adjusted}$ = Eghistoric * (Current Production / Historic Production)					
	Displaced Emissions$_E$ Off-Site Emissions from electricity generation off site displaced by reduced import of grid electricity or export to the grid of project electricity	tonnes CO_2e	N/A	N/A	N/A	Quantity being calculated. See Appendix C for sample calculations.
	Egproj Electricity Generated by Project	MWh	Measured	Direct metering of all electricity produced by the project.	Continuous Metering	Continuous direct metering represents the industry practice and the highest level of detail.
	Ecproj Electricity Consumed by the Project	MWh	Measured	Direct metering of all electricity consumed by the project.	Continuous Metering	Continuous direct metering represents the industry practice and the highest level of detail.
	Eghistoric$_{Adjusted}$ Electricity scaled to current operations	MWh	Calculated	Calculated	Annual	Scaling adjusts for operational variability.
	Eghistoric Historic level of on-site electricity generation	MWh	Calculated	Average of measured on-site generation for three years preceding the project	Continuous Metering	On-site displacement should not exceed historic levels of on-site generation. See Appendix C for more information.

Source/ Sink	Parameter/Variable	Unit	Measured/ Estimated/ Calculated	Method	Frequency	Justify measurement or estimation and frequency
	Current Production	Host site specific units of product	Measured	Direct measurement of site production in the current year.	Annual	Scaling adjusts for operational variability.
	Historic Production	Host site specific units of product	Measured	Direct measurement of average historic site production for three years immediately prior to project implementation.	Annual	Scaling adjusts for operational variability.
	EF_{EG} Grid Electricity Usage Factor	tonnes CO_2e per MWh	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook, subject to reviews.
B18 - On-site Heat Generation Displaced by Project	If (Hgproj – Hcproj) < 0, then: Displaced $Emissions_H$ On-Site = EF_{HO} * (Hgproj - Hcproj) Otherwise: Displaced $Emissions_H$ On-Site = EF_{HO} * lesser of [(Hgproj - Hcproj), $Hghistoric_{Adjusted}$] Where: $Hghistoric_{Adjusted}$ = Hghistoric * (Current Production / Historic Production)					
	Displaced $Emission_H$ On-Site Emission from Heat Production Displaced On-Site	tonnes CO_2e	N/A	N/A	N/A	Quantity being calculated. Calculated separately for each fuel type. See Appendix C for sample calculations.
	Hgproj Thermal energy Generated by Project	GJ	Measured	Direct metering of thermal energy produced by the project.	Continuous Metering	Continuous direct metering represents the industry practice and the highest level of detail.

Source/ Sink	Parameter/Variable	Unit	Measured/ Estimated/ Calculated	Method	Frequency	Justify measurement or estimation and frequency
	Hcproj Thermal energy Consumed by the Project	GJ	Measured	Direct metering of all thermal energy consumed by the project.	Continuous Metering	Continuous direct metering represents the industry practice and the highest level of detail.
	$Hghistoric_{Adjusted}$ Thermal energy scaled to current operations	GJ	Calculated	Calculated	Annual	Scaling adjusts for operational variability.
	Hghistoric Historic level of on-site thermal energy generation	GJ	Calculated	Average of measured on-site generation for three years preceding the project	Continuous Metering	Historic thermal energy generated must be shown to go to a useful purpose. The baseline for new facilities assumes that thermal energy was produced on-site using natural gas.
	Current Production	Units of product	Measured	Direct measurement of site production in the current year.	Annual	Scaling adjusts for operational variability.
	Historic Production	Units of product	Measured	Direct measurement of average historic site production for three years immediately prior to project implementation.	Annual	Scaling adjusts for operational variability.
	EF_{HO} Heat Emissions Factor	tonnes CO_2e per GJ	Estimated	Calculated Based on Historic Performance of On-site thermal energy generation (emissions of three previous years for thermal energy generation divided by total generation for three previous years)	Annual	Site specific emissions factor must be used. New facilities must assume natural gas usage.

Source/ Sink	Parameter/Variable	Unit	Measured/ Estimated/ Calculated	Method	Frequency	Justify measurement or estimation and frequency
B16 – Off-Site Heat Generation Displaced by Project	Displaced Emissions$_H$ Off-Site = EF$_{HE}$ * max of [(Hgproj – Hcproj – Hghistoric$_{Adjusted}$), 0] Where: Hghistoric$_{Adjusted}$ = Hghistoric * (Current Production / Historic Production)					
	Displaced Emissions$_H$ Off-Site Emissions from thermal energy generation off-site displaced by reduced import of heat or export of project heat	tonnes CO_2e	N/A	N/A	N/A	Quantity being calculated. Thermal energy exported must be shown to go to a useful purpose. Calculated separately for each fuel type. See Appendix C for sample calculations.
	Hgproj Heat Generated by Project	GJ	Measured	Direct metering of all thermal energy produced by the project.	Continuous Metering	Continuous direct metering represents the industry practice and the highest level of detail.
	Hcproj Heat Consumed by the Project	GJ	Measured	Direct metering of all thermal energy consumed by the project.	Continuous Metering	Continuous direct metering represents the industry practice and the highest level of detail.
	Hghistoric$_{Adjusted}$ Heat scaled to current operations	MWh	Calculated	Calculated	Annual	Scaling adjusts for operational variability.
	Hghistoric Historic level of on-site heat generation	GJ	Calculated	Average of measured on-site generation for three years preceding the project	Continuous Metering	Historic thermal energy generated must be shown to go to a useful purpose. The baseline for new facilities assumes that thermal energy was produced on-site using natural gas.
	Current Production	Units of product	Measured	Direct measurement of site production in the current year.	Annual	Scaling adjusts for operational variability.

Source/ Sink	Parameter/Variable	Unit	Measured/ Estimated/ Calculated	Method	Frequency	Justify measurement or estimation and frequency
	Historic Production	Units of product	Measured	Direct measurement of average historic site production for three years immediately prior to project implementation.	Annual	Scaling adjusts for operational variability.
	EF_{HE} Heat Export Emissions Factor	tonnes CO_2e per GJ	Estimated	Use heat high-performance benchmark for the corresponding year of the reporting period for new facilities, Or Calculated Based on Historic Performance of Off-site thermal energy generation (emissions of three previous years for heat generation divided by total generation for three previous years) for existing facilities.	Reference Annual	Value referenced in the Technology Innovation and Emissions Reduction Regulation. Or Site specific emissions factor must be used where possible.
P15 – Combustion of Biomass and Fossil Fuels	$Emission_{Fuel} = \sum [MBF_i * (EF_{i, CH4} * GWP_{CH4} + EF_{i, N2O} * GWP_{N2O})] + \sum [V_{Fuel,j} \times (EF_{j, CO2} + EF_{j, CH4} * GWP_{CH4} + EF_{j, N2O} * GWP_{N2O})] / 1000$ Where: Biogenic emissions from combustion of biomass → Excluded and reported in B20					
	$Emission_{Fuel}$ Emissions from Combustion of Biomass and fossil fuels	tonnes CO_2e	N/A	N/A	N/A	Quantity being calculated. Calculated separately for each fuel type.

Source/ Sink	Parameter/Variable	Unit	Measured/ Estimated/ Calculated	Method	Frequency	Justify measurement or estimation and frequency
	MBF_i Mass of Biomass Fuel Combusted	tonnes	Measured	Direct measurements of mass of representative units of biomass consumed in the offset project for combustion measured either at the facility or at load origin, prorated to number of loads received. Agreement must be maintained between the emissions factors used and the mass measured. Dry basis emissions factors will also require quantification of fuel moisture content.	Continuous or monthly reconciliation	This represents best industry practice. Measurements must be justified and verifiable. Note: It is recommended that the project developer directly measure the weight of biomass fed to the combustor.
	$EF_{i, CH4}$ CH_4 Emissions Factor for Biomass Fuel	tonnes CH_4 per GJ	Estimated	From the National Inventory Report, Environment Canada	Reference	Must use most current emission factors for biomass combustion.
	$EF_{i, N2O}$ N_2O Emissions Factor for Biomass Fuel	tonnes N_2O per GJ	Estimated	From the National Inventory Report, Environment Canada	Reference	Must use most current emission factors for biomass combustion.
	GWP_{CH4} Global Warming Potential for CH_4	Unitless	Estimated	Standard for Completing Greenhouse Gas Compliance and Forecasting Reports	Reference	Values referenced in Standard.
	GWP_{N2O} Global Warming Potential for N_2O	Unitless	Estimated	Standard for Completing Greenhouse Gas Compliance and Forecasting Reports	Reference	Values referenced in Standard.

Source/ Sink	Parameter/Variable	Unit	Measured/ Estimated/ Calculated	Method	Frequency	Justify measurement or estimation and frequency
	$V_{Fuel, j}$ Volume of Fossil Fuels	m^3/hr	Measured	Direct metering	Continuous	Supplemental Fossil Fuel Use for combustion of biomass waste in the project must be directly metered. Calculated separately for each fuel type.
	$EF_{j, CO2}$ CO_2 Emissions Factor for Fossil Fuel	kg CO_2 per L, m^3 or other	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook.
	$EF_{j\ CH4}$ CH_4 Emission Factor for Fossil Fuel	kg CH_4 per L, m^3 or other	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook.
	$EF_{j\ N2O}$ N_2O Emission Factor for Fossil Fuel	kg N_2O per L, m^3 or other	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook.
	GWP_{CH4} Global Warming Potential for CH_4	Unitless	Estimated	Standard for Completing Greenhouse Gas Compliance and Forecasting Reports	Reference	Values referenced in Standard.
	GWP_{N2O} Global Warming Potential for N_2O	Unitless	Estimated	Standard for Completing Greenhouse Gas Compliance and Forecasting Reports	Reference	Values referenced in Standard.

1

4.3 Quantification for Flexibility Mechanism

TABLE 6. QUANTIFICATION METHODOLOGY FOR FLEXIBILITY MECHANISMS

Source/Sink	Parameter/ Variable	Unit	Measured/ Estimated/ Calculated	Method	Frequency	Justify measurement or estimation and frequency
B15 - Disposal of Biomass	B15 Flexibility Mechanism (1): CH_4 from Anaerobic Decomposition in Landfill					
	Emissions $_{Decomposition} = Q * GWP_{CH4}$					
	Emission $_{Decomposition}$ CO_2e Emissions from Decomposition of Biomass	tonnes CO_2e /time	N/A	N/A	N/A	Quantity being calculated.
	$Wt_{Biomass}$ Biomass weight Diverted from Landfill	tonnes	Measured	Scale used for each truck load diverted from landfill or stockpile and delivered to the energy facility or per-load estimate. Agreement must be maintained between the emissions factors used and the weight measured (dry or wet weight basis).	Periodic	Measurement is more accurate than estimation and must be used when available.
	Q Amount of Methane Emitted from Landfill	tonnes CH_4/time	Calculated	Carbon Offset Emission Factors Handbook (takes $Wt_{Biomass}$ as input)	Reference	Must use most recent methodology published in the Handbook.
	GWP_{CH4} Methane Global Warming Potential	Unitless	Estimated	Standard for Completing Greenhouse Gas Compliance and Forecasting Reports	Reference	Values referenced in Standard.
	B15 Flexibility Mechanism (2): CH_4 and N_2O from Open-air combustion of biomass waste					

Source/Sink	Parameter/ Variable	Unit	Measured/ Estimated/ Calculated	Method	Frequency	Justify measurement or estimation and frequency
	$Emissions_{Open\text{-}Air\ Combustion} = \sum (Wt_{Biomass,i} * EF_{i,\ CH4} * GWP_{CH4}) + \sum (Wt_{Biomass,i} * EF_{i,\ N2O} * GWP_{N2O})$					
	$Emissions_{Open\text{-}Air\ Combustion}$	tonnes of CO_2e	Estimated	N/A	N/A	Quantity being calculated.
	$Wt_{Biomass,i}$ Biomass weight Diverted from Open Air Combustion	tonnes	Measured	Scale used for each truckload delivered to the energy facility or per-load estimate. Agreement must be maintained between the emissions factors used and the weight measured (dry or wet weight basis).	Periodic	Measurement is more accurate than estimation and must be used when available.
	$EF_{i,\ CH4}$	tonnes of CH_4 / tonne of biomass combusted	Estimated	Prescribed in AP-42, 13.1 Wildfires and Prescribed burning, or other comparable source.	Annual	Use of AP-42 emission factors is preferred. Other references may be used with sufficient justification and prior approval (section 1.3)
	$EF_{i,\ N2O}$	tonnes of N_2O / tonne of biomass combusted	Estimated	Prescribed in AP-42, 13.1 Wildfires and Prescribed burning, or other comparable source.	Annual	Use of AP-42 emission factors is preferred. Other references may be used with sufficient justification and prior approval (section 1.3)
	GWP_{CH4} Global Warming Potential for CH_4	Unitless	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook.
	GWP_{N2O} Global Warming Potential for N_2O	Unitless	Estimated	Standard for Completing Greenhouse Gas Compliance and Forecasting Reports	N/A	Values referenced in Standard.
	P15 Flexibility Mechanism (3): CO_2e Emissions from Combustion of Biomass and/or Fossil Fuels					

Source/Sink	Parameter/ Variable	Unit	Measured/ Estimated/ Calculated	Method	Frequency	Justify measurement or estimation and frequency
P15 - Combustion of Biomass (Energy based approach)	$Emission_{Fuel} = [(Q_{Generation}/\%\eta_{Eff}) - \sum Q_{Fossil\ Fuel,i}] \times (EF_{CH4} * GWP_{CH4} + EF_{N2O} * GWP_{N2O}) + \sum(Q_{Fossil\_Fuel,i})/LHV_{Fossil\ Fuel} * (EF_{i,CO2} + EF_{i,CH4} * GWP_{CH4} + EF_{i,N2O} * GWP_{N2O}) / 1000$ Where: Biogenic emissions from the combustion of biomass → Excluded and reported in B20					
	$Emission_{Fuel}$ Emissions from Combustion of Biomass and Fossil Fuels	tonnes CO_2e	N/A	N/A	N/A	Quantity being calculated. Calculated separately for each fuel type and by carbon levied and non-levied fuels.
	$Q_{Fossil\ Fuel,i}$ Energy Produced from Fuel Combustion	GJ	Measured	Direct measurements fossil fuel consumed in the offset project for combustion measured at the facility on a lower heating value basis.	Continuous	Supplemental Fossil Fuel Use for combustion of biomass waste in the project must be directly metered. Energy production is typically metered continuously and represents a high degree of accuracy to the measurement.
	$Q_{Generation}$ Energy Generation from Combustion System	GJ or equivalent	Measured	Direct metering	Continuous	Energy generation in the project must be directly metered.
	EF_{CH4} CH_4 Emissions Factor for Biomass	tonnes CH_4 per GJ	Estimated	From the National Inventory Report, Environment Canada.	Annual	Must use most current emission factors for biomass combustion. (section 1.3)
	EF_{N2O} N_2O Emissions Factor for Biomass	tonnes N_2O per GJ	Estimated	From the National Inventory Report, Environment Canada.	Annual	Must use most current emission factors for biomass combustion. (section 1.3)

Source/Sink	Parameter/ Variable	Unit	Measured/ Estimated/ Calculated	Method	Frequency	Justify measurement or estimation and frequency
	$EF_{i, CO2}$ CO_2 Emissions Factor for Fossil Fuel	kg CO_2 per m^3 fossil fuel	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook
	$EF_{i, CH4}$ CH_4 Emission Factor for Fossil Fuel	kg CH_4 per m^3 fossil fuel	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook.
	$EF_{i, N2O}$ N_2O Emission Factor for Fossil Fuel	kg N_2O per m^3 fossil fuel	Estimated	Carbon Offset Emission Factors Handbook	Reference	Values referenced in Handbook.
	GWP_{CH4} Global Warming Potential for CH_4	Unitless	Estimated	Standard for Completing Greenhouse Gas Compliance and Forecasting Reports	Reference	Values referenced in Standard.
	GWP_{N2O} Global Warming Potential for N_2O	Unitless	Estimated	Standard for Completing Greenhouse Gas Compliance and Forecasting Reports	Reference	Values referenced in Standard.
	$\%\eta_{Eff}$	Unitless	Estimated	Manufacturer's thermal efficiency of boiler or other combustion equipment on a lower heating value basis.	Once	Boiler efficiency is required to back calculate heating value of biomass fuel supplied.
	$LHV_{Fossil\ Fuel}$	GJ per m^3 of fossil fuel	Measured (fuel analysis)	Heating value of supplemental fossil fuel calculated from measured composition (via gas analysis or ultimate analysis) of fossil fuel	Annual	Periodic confirmation of energy contribution from fossil fuels is required.

TABLE 7. QUANTIFICATION METHODOLOGY FOR BIOGENIC CO_2e

Source/Sink	Parameter /Variable	Unit	Measured/ Estimated	Method	Frequency	Justify measurement or estimation and frequency
P20/B20				Emission Biogenic = $\sum [MBF_i * EF_{i, CO2}]$		
Biogenic Carbon Emissions[3] (not emission offset eligible)	Emission Biogenic Biogenic emissions from the combustion of biomass	tonnes CO_2e	N/A	N/A	N/A	Quantity being calculated. Biogenic CO_2 is reported separately. CH_4 and N_2O emissions are reported with the project (P15).
	MBF_i Mass of Biomass Fuel Combusted	tonnes	Measured	Direct measurements of mass of representative units of biomass consumed in the offset project for combustion measured either at the facility or at load origin, prorated to number of loads received. Agreement must be maintained between the emissions factors used and the mass measured. Dry basis emissions factors will also require quantification of fuel moisture content.	Continuous or monthly reconciliation	This represents the industry best practice. Measurements must be justified and verified. Note: It is recommended that the project developer directly measure the weight of biomass fed to the combustor.
	$EF_{i, CO2}$ CO_2 Emissions Factor for Biomass Fuel	tonnes CO_2 per tonnes of biomass	Estimated	From the National Inventory Report, Environment Canada, Part 2, Emission Factors for Biomass Combustion.	Annual	To be consistent with provincial reporting standards the most current emission factors in use for industry *Regulation* biomass reporting and facility type must be used. (e.g., NCASI, Environment Canada)

[3] Biogenic emissions are reported as a source of GHGs but are not included in the calculation of offsets. Methods for quantification and reporting of biogenic emissions should follow the standard set for the industry and be compliant with Regulation requirements for facilities combusting similar biomass types.

5.0 Data Management and Records

Data collection, records and data quality management must be able to support verification by a qualified third-party assurance provider in order to support quantification of greenhouse gas emissions reductions. In all cases, greenhouse gas emission reductions must be substantiated with records and must meet the minimum data requirements specified in this protocol and the Alberta Emissions Offset System.

Project data must be managed in a manner that substantiates all emission offset claims and are complete accurate, and replicable via an auditable data management system and records.

Record keeping requirements include, but are not limited to:

- raw baseline period energy, and biomass management 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 model(s);
- records of waste type and landfilling practices;
- all data and analysis used to support estimates and factors used for quantification;
- make, model, serial numbers and expected end of life date of equipment used for the project;
- common practices relating to possible greenhouse gas reduction scenarios discussed in this protocol (such as biomass management practices);
- metering equipment specifications (model number, serial number, manufacturer's calibration procedures);
- a record of changes in static factors along with all calculations for non-routine adjustments;
- all calculations of greenhouse gas emissions/reductions and emission factors;
- measurement equipment maintenance activity logs;
- measurement equipment calibration records;
- electronic recording of values of logged primary parameters for each measurement interval;
- filing monthly back-up copies of all logged data;
- written logs of operations and maintenance of the project system including notation of all shutdowns, start-ups and process adjustments;
- retention of copies of logs and all logged data; and
- retaining verification records and results.

5.1 Baseline Documentation and Records

All emission offset projects must provide a range of documentation and evidence to support an offset claim. The project must provide both records to support the baseline condition, and ongoing data and information to support offset claims. Records and documentation to support the baseline condition are to be outlined in the Offset Project Plan and detailed in the Offset Project Report, forms are provided by the department and are subject to updates. All fields in the forms are to be completed.

5.1.1 Baseline Fossil Fuel Practice

The emission offset project developer must provide records to support the use of fossil fuel-based energy in the baseline condition, including:

- type of fuel;
- activity for which the fuel is used (energy production, vehicles, etc.);
- maker, model and serial numbers of devices of which the fuel is used;
- location where the fuel was used; and
- records that support that the fuel was used for the purposes claimed.

Records may include but are not limited to commercial records of fuel deliveries, including waybills, receipts and invoices.

5.1.2 Baseline Methane Emissions from Anaerobic Decomposition of Biomass in Landfill

For projects eligible for landfill diversion methane avoidance emission offsets, the location and characteristics of the disposal site in the baseline condition must be known in such a way as to allow estimation of the baseline methane emissions.

The project must provide records from the waste management facility(s) or supplier(s) or a combination of both, depending on where the waste is sourced from, that clearly support the long-term disposal of the biomass to landfill, including:

- the type of waste disposed;
- the name and contact of the source of the waste, where the waste would have been disposed,
- eligible waste types,
- eligible waste tonnage,
- default values for use in equations,
- landfill disposal records (including years);
- the year the project was initiated;
- proof that the project-specific waste stream, prior to implementation of the project, was being disposed of at a waste management facility with an EPEA registration or approval; and
- records showing how the waste was treated/disposed of at the waste management facility.

Records must be for a period of at least three years immediately prior to the implementation of the project activity.

In cases where large-scale natural disasters occur, and during which large amounts of waste biomass are generated (i.e. 50,000 tonnes of dry matter or more), where it is highly likely that the disposal practice will be landfilling, the director reserves the right to consider deviation requests from this records requirement.

Examples of records for the landfill include, but are not limited to:

- waste management facility registration/approval numbers and sufficient records to support that waste handling is accordance with the waste management facility's registration and/or approvals.
- weigh scale receipts/invoices/tracking records that identify:
    - date of disposal;
    - source of the waste material; and
    - waste type and description.
- proof of disposal in landfill:
    - records showing how the waste was treated/disposed of at the waste management facility (load screening, on-site receiving area records, how/where waste was disposed of on-site); and
    - percentage and type of material removed or diverted to other disposal options or uses including the quantities combusted for energy.

5.1.3 Additional Information to Support Stockpiling as a Baseline Condition

Stockpiling is a regulated activity and anaerobic conditions in a stockpile are not assured as the waste may be exposed to higher aeration, or be moved or removed before anaerobic decomposition occurs. There is no emission offset opportunity for diverting biomass from stockpile baseline disposal practices. Records of stockpiling may be used to prove eligibility (source and type) of biomass waste.

Additional records are needed to support stockpiling as the baseline condition and include:

- **Proof of permanence**: Records that demonstrate that the waste stream would have remained in the stockpile from which it was sourced for an indefinite period of time; and
- **Proof of source and type**: Records indicating the type and source of the biomass.

To demonstrate these conditions records should be from, at least, two sources thereby providing reasonable assurance of permanence and source. For example, demonstration of stockpiling could include records of the holder of the stockpile, permits from the Regulator (as required), municipal government permits or authorizations. For source records, these could include those of holder of the storage, those from entities using the facility for disposal, regulatory records (municipal or provincial), records from the transporter of material to the facility or from the facility to the project.

5.1.4 Baseline for Open-Air Combustion of Biomass

For projects with eligibility for GHG reductions from avoided baseline open-air combustion, the emission offset project developer must provide sufficient records to demonstrate it was the historical practice for disposing of biomass and an estimate of volumes burned.

Types of records[4] may include:

- forest management plans noting applicable forest management standards requiring combustion of harvest debris within the forest management area;
- annual operating plans detailing the harvest blocks where combustion was expected to occur;
- block inspection records showing where burning occurred;
- burn permits or contractor receipts for burning;
- thermal scanning records; and/or
- farm management plans.

Projects diverting forest-based feedstock from combustion must show that harvest levels or forest utilization standards are not generating more biomass feedstock than occurred in the baseline condition (e.g., that they are consistent in the baseline and project conditions).

Records may include:

- block inspections during the project showing utilization standards are being met;
- timber dues paid for use of undersize wood (Code 99 stumpage fees); and/or
- records from check load or check load process.

5.1.5 Baseline Incineration of Biomass Waste

Biomass waste that is incinerated in the baseline is not eligible for quantifying emissions from the disposal of biomass under baseline conditions (B15), but is eligible for generating offset credits due to energy generation and the displacement of fossil fuels-based energy. Incineration of forest mill waste was deemed to be an acceptable baseline scenario pre-2015 after which point this activity was no longer allowed under provincial regulations. Historical disposal by incineration may be used to establish eligibility of biomass as a waste stream for generating emission offsets due to energy generation and the displacement of fossil fuels-based energy.

The emission offset project developer must provide sufficient records to demonstrate the historical practice was the disposal of biomass wastes in an incinerator.

Types of records include:

- EPEA approval for an incinerator; and

[4] More than one type of evidence may be needed to establish the baseline behavior and demonstrate a practice change. For example, scale weights for Code 99 wood do not prove the wood was open air combusted in the baseline. Additional records such as burn permits would be needed to establish historic practices as burning.

- logs of hours, operations, and air contaminants from the incinerator.

5.1.6 Baseline Decomposition Mountain Pine Beetle Infestation or Wildfire

Any emission offset claims for baseline decomposition cut and burn of forest stands with high mortality from mountain pine beetle infestation or wildfire has the following considerations. Forest stands are determined to be eligible with greater than 85 per cent (or equal to) mortality due to mountain pine beetle infestation or wildfire are an eligible feedstock for biomass wastes combustion with energy displacement. Forested areas that are still of sufficient quality to be used for commercial purposes are excluded from this protocol.

Projects must demonstrate that stands harvested for energy feedstocks meet the following conditions:

- tree mortality equal to or greater than 85 per cent of the stand;
- the leading species of the stand is pine for beetle infested stands;
- there is less than 50 per cent conifer understory present in the stand;
- canopy is 15 metres; and
- stand age is at least six years.

Records are similar to those used to show that the stands would have qualified for the rehabilitation program. Records might include harvest plans approved by Alberta's forestry ministry, cutblock inspection forms, and all records associated with linking the harvested fibre with the Alberta Forest Revenue Scaling and Tenure System (FOREST), e.g. form TM44, TM35, TM262, etc.

Projects diverting forest-based feedstock for combustion must show that harvest levels or forest utilization standards are not generating more biomass feedstock than occurred in the baseline condition (e.g., that they are consistent in the baseline and project conditions).

Records may include, but are not limited to:

- block inspections during the project showing utilization standards are being met;
- timber dues paid for use of undersize wood (Code 99 stumpage fees);
- records from check load or check load process; and/or
- annual operating plans describing changes to the harvesting sequence to minimize the risk of spread and impact of the infestation.

5.1.7 Baseline Composting and Land Application of Agricultural Wastes (Crop Residue, Processing Residues, Other Agricultural Residues)

Materials diverted from land application, composting, and similar disposal options are acceptable baseline scenarios for some types of agricultural residues; depending on extent of biomass to energy use of these materials and assurance that diversion does not generate an unwanted impact on other environmental values.

Projects diverting agricultural biomass residues from land application must demonstrate that diversion is not having a negative impact on soil. Records that can be used to demonstrate that soil conservation and amendment needs are being met include, but not limited to:

- net benefit analysis meeting requirements described in Section 1.3;
- annual farm management plans demonstrating that crops are fertilized according to soil test recommendations and that frequency of removal of crop residue is no more than once every five to seven years on soils in the Dry Prairie region (Brown and Dark Brown soil zones) and no more than two years out of three on soils in the Parkland region (Black and Gray soil zones): the boundary line for the Dry Prairie – Parkland ecozones can be found at: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/cl11708
- manure management records required under the Agricultural Operation Practices Act (AOPA);
- soil tests once every three years for extractable nitrate-nitrogen from a soil depth of 0 to 60 cm and extractable phosphorous from a soil depth of 0 to 15 cm; and

- estimates done by a professional agrologist to assess the volume of biomass remaining meets soil erosion protection and/or crop needs.

5.2 Project Documentation and Records

The emission offset project developer must provide verifiable records to support the project condition as outlined in this protocol. The following is examples of minimum evidence required for an emission offset project to support the generation of emissions offsets.

Historic production for three years immediately prior to the project implementation.

Records may include but are not limited to: commercial records of fuel/biomass deliveries such as waybills, receipts, weight receipts, bills of lading, invoices, and scale logs supported with records of calibration.

Direct evidence of electricity production/consumption from biomass:

- quantity of electricity generated;
- quantity of biomass used for electricity production;
- the type of electricity generation system used including, but not limited to simple cycle, combined cycle, cogeneration, other;
- disposition of the electricity (used to support on-site loads or sent to the grid);
- when the electricity was generated from biomass waste; and
- quantity of electricity sourced from the Alberta Electricity Grid.

Direct evidence of biomass use for thermal energy production and use:

- quantity of thermal energy produced;
- quantify of biomass used for thermal energy production;
- disposition of the thermal energy (used to support on-site loads, sent off site for other uses, and/or vented to atmosphere);
- the type, make, model, of thermal energy generation system used; and
- when the thermal energy was produced from the biomass waste.

Information covering other fuels used on-site, including:

- type of fuel;
- quantity of fuel;
- activity for which the fuel is used (process heat, electricity production, vehicles, etc.); and
- location where the fuel was used (on-site, off-site delivery vehicles, etc.).

Records of biomass retention and storage on-site include:

- a biomass waste labelling system to track "batches[5]" of materials within the project. The labelling system must be sufficiently detailed to allow a verifier to assess whether materials are eligible as per waste storage time limits provided in Appendix A;
- waste type of each biomass "batch";
- particle size, dry matter content or identification as highly degradable/putrescible waste of each biomass "batch" as per Appendix A;
- mass of each biomass "batch";
- when the "batch" was received;
- when the 'batch" was used;
- locations of "batch" storage piles; and

[5] The project developer must establish the measurement unit used for the project and must include means of identifying and tracking units of biomass waste, or batch, as it moves through the process.

- site biomass storage management activities.

5.3 Measurement, Monitoring, and Verification

In order to quantify the GHG emissions reductions from a biomass-fired energy generation project, the project must accurately measure the quantity of biomass delivered or diverted to the facility. All projects must monitor and record the biomass being diverted to the facility, when it was delivered, when and the quantity of biomass was used in the generation unit, as shown in the example log shown below.

EXAMPLE OF A DAILY LOG FOR BIOMASS USED IN ENERGY GENERATING UNIT

Date & Time Delivered to Project Site*	Load Identifier	Biomass Type	Biomass Source	Date & Time Delivered to Energy Production Unit	Moisture Content	Quantity Biomass to Energy Generating Unit (tonnes)	Fate of Biomass in the Absence of the Project
YYYY.MM.DD	Unique alpha-numeric identification for load	Bark	Point of origin of fuel	YY.MM.DD	% water in load at time of delivery to production unit	Oven-dry or bone-dry mass of material at time of delivery to production unit	Landfill, stockpile, compost, landscaping material, also identify location if landfill, stockpile or compost

*Note if there is more than one possible location.

In addition, the project must retain all weigh scale receipts generated either on or off site indicating the weight and source of all delivered material to the facility. This information is necessary to aggregate the weight of eligible organic material/residue delivered to the site of each eligible waste type according to the guidance provided in Section 5.1.1 and to verify eligibility of the waste.

Implementation of quality assurance/quality control (QA/QC) procedures for the inspection and calibration of relevant meters must be included in the projects monitoring plan. All weigh scales that are not used for commercial activities must be inspected and calibrated in accordance with manufacturer's specifications.

The monitoring plan will serve as a basis to confirm that the monitoring and reporting requirements have been and will continue to be met, and that consistent, rigorous monitoring and record keeping is ongoing at the project site.

At a minimum the monitoring plan shall stipulate:

- the frequency of data acquisition;
- a record keeping plan;
- the frequency of instrument calibration activities; and
- the role of individuals performing each specific monitoring activity.

5.4 Quality Assurance/Quality Control Considerations

Emission offset project developers are required to ensure sufficient and appropriate quality assurance/quality control (QA/QC) procedures are developed to support both the baseline and project implementation. Developers are required to review the Standard for Emission Offset Project Developers to ensure they understand and meet system requirements; the government may request supporting information on an emission offset project at any time.

Stringent QA/QC procedures can add confidence that all measurements and calculations have been made correctly and include outlining the process related to data management and record keeping for emission offset projects and emission offset claims and include but not limited to:

- ensuring that any changes to operational procedures (including feed intake, biomass management, etc.) continue to function as planned and achieve greenhouse gas reductions;
- ensuring that the measurement and calculation system and greenhouse gas reduction reporting remains in place and accurate;
- checking the validity of all data before it is processed, including emission factors, static factors and acquired data;
- performing recalculations of quantification procedures to reduce the possibility of mathematical errors;
- storing the data in its raw form so it can be presented and re-calculated for verifications;
- protecting records of data and documentation;
- recording and explaining any adjustment made to raw data in the associated report and files; and
- having a contingency plan for potential data loss.

6.0 References

Alberta Environment and Protected Areas 2025. Standard for greenhouse gas emission offset project developers.

Alberta Environment and Protected Areas 2025. Standard for Completing Greenhouse Gas Compliance and Forecasting Reports.

International Organization for Standardization 2019. ISO 14064-2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements.

Intergovernmental Panel on Climate Change (IPCC) 2019. 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Calvo Buendia, E., Tanabe, K., Kranjc, A., Baasansuren, J., Fukuda, M., Ngarize S., Osako, A., Pyrozhenko, Y., Shermanau, P. and Federici, S. (eds). Published: IPCC, Switzerland.

APPENDIX A: Acceptable Limits to Storage of Biomass Feedstock

Acceptable limits to storage of biomass feedstock (P14)

The waste to energy facility (emission offset project) must develop an eligible waste incorporation plan. The emission offset project developer must ensure that the biomass wastes is not stored anaerobically on or off site/prior to its use at the facility and that the eligible waste is incorporated into the combustion process within the acceptable time limits below. **Waste that is stored beyond these limits is not eligible under this protocol**.

Woody Biomass	
Feedstock Size[6]	*Acceptable Storage Limits*
Fine particle size feedstock - If particle size is less than 30mm in diameter, the pile is considered to be a fine feedstock.	Must not be held for more than 90 days prior to combustion.
Medium particle size feedstock- If particle size is between 30 and 70mm in diameter, the pile is considered to be a medium feedstock.	Must not be held for more than six months prior to combustion.
Large particle size feedstock - If the particles size is greater than 70mm in diameter, the pile is considered to be a large feedstock.	Must not be held for more than one year.
If in a non-homogenous pile, more than 25 per cent of particles are considered to be of a smaller feedstock, the pile is considered to be of the smaller feedstock. For example, if more than 25 per cent of particles are less than 30mm in diameter, the pile is considered to be a fine feedstock.	
Manure Biomass	
Feedstock Dry Matter Content	*Acceptable Storage Limits*
Manure with dry matter content less than 20%	Can be held up to 45 days between removal from barns and combustion however storage over 24 hours requires emissions to be quantified and included in project emissions.
Manure with dry matter content greater than 20%	Should not be stored longer than one year.
Other Biomass	
Waste	*Acceptable Storage Limits*
Putrescible waste (wastes that will become putrid)	Must be used within 72 hours to avoid anaerobic conditions.
Highly degradable waste types (wastes with a C:N ratio of less than 16:1)	Must be used within 24 hours or covered with a layer of high carbon materials within 24 hours and used within 72 hours or be placed in a building under negative air pressure with exhaust gas vented through a functional bio-filter.

[6] As measured by screen testing.

APPENDIX B: Quantification for Non-Biogenic CO_2 from Municipal Solid Waste

Emission Factors for Municipal Solid Waste (MSW)

Biogenic CO_2 Emission Factor for Municipal Solid Waste (MSW)

The biogenic CO_2 emission from thermal destruction of MSW is not included in the quantification of emissions offsets because biogenic CO_2 emissions are considered to be carbon neutral and excluded from emission reduction calculations. Biogenic emissions are reported as an included GHG source (P/B20) but not included in the calculation of offsets. Methods for quantification and reporting of biogenic emissions should follow the standard set for the industry and be compliant with regulatory standards for facilities combusting similar biomass types.

Non-Biogenic CO_2 Emission Factor for Municipal Solid Waste (MSW)

The non-biogenic CO_2 emission factor for thermal destruction of MSW is interpreted from the U.S. Environmental Protection Agency (EPA) technical report Voluntary Reporting of Greenhouse Gases Program of 1997. This report estimates the CO_2 emission factor for the non-organic portion of the MSW, primarily the plastics, is 2.8795 tonnes CO_2/tonne plastic waste. Using this information an emission factor for non-biogenic emissions from MSW can be estimated by multiplying the EPA value by the proportion of plastic waste to overall waste at the site as:

EF MSW Non-biogenic CO_2 = 2.8795 (tonnes CO_2/tonnes plastic waste) * % Plastics Content of Waste

Where: EF MSW Non-biogenic CO_2 = CO_2 emissions (tonnes CO_2/tonnes waste)

% Plastics Content of Waste = Plastics component of the waste stream (tonnes plastics / tonnes waste)

A site-specific non-biogenic CO_2 emission factor can be calculated as outlined in the flexibility mechanism by performing a mass balance as follows:

EF MSW Non-biogenic CO_2 = C * Plastics * 44/12

Where: EF MSW Non-biogenic CO_2 = CO_2 emissions (tonnes CO_2/tonnes waste)

C = Concentration of carbon in plastics fraction (%)

Plastics = % Plastics component of the waste stream (tonnes plastics/tonnes waste)

44/12 = The molecular weight conversion factor from C to CO_2

CH_4 and N_2O Emission Factors for Derived Gases

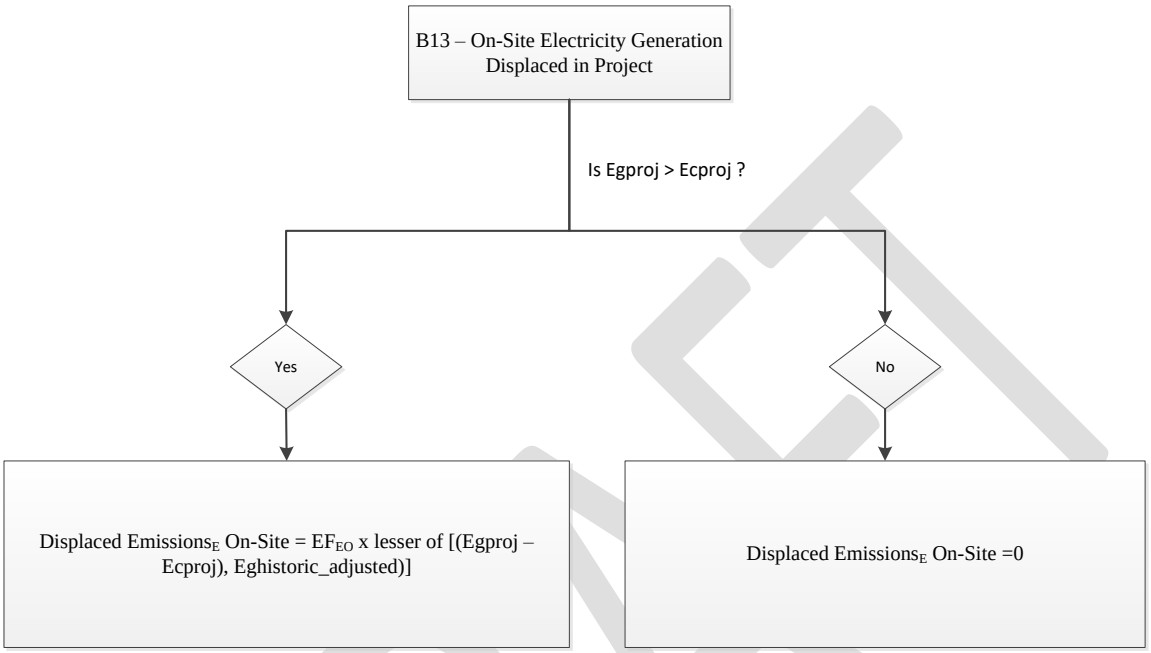
Based on its composition, the biofuel may reasonably be considered as analogous to a derived gas stream. As per Table 2.2 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, the coefficients for CH_4 and N_2O emission factors for derived gases are 0.001 tonnes of CH_4 per TJ of biofuel and 0.0001 tonnes N_2O per TJ of biofuel, respectfully, regardless of the source, type or usage.

APPENDIX C: Sample Calculations – Electricity and Heat

Example for B13 – On-Site Electricity Generation Displaced in Project

Applies to on-site electricity displaced in project or increased usage. New facilities do not qualify for on-site displacement but do qualify for off-site displacement. Figure 6 provides a decision tree for assessing project electricity emissions quantification.

FIGURE 6: B13 EMISSIONS ASSESSMENT



If the electricity consumption is greater than project electricity generation, there is no emissions from electricity generation displaced on site:

$$Displaced\ Emissions_E\ On\text{-}Site = 0$$

Increased use of grid/on-site electricity will be quantified under the appropriate project sources.

If the electricity consumption is less than the project electricity generation, the following equation is used:

$$\text{Displaced Emissions}_E\ \text{On-Site} = EF_{EO} \times \text{lesser of } [(Egproj - Ecproj), Eghistoric_{adjusted})]$$

Existing facilities that are displacing on-site electricity generation cannot have on-site displacement that is greater than Eghistoric. If there is no historic on-site generation, this does not apply

Example for B6 –Off-Site Electricity Generation Displaced in Project

Applies to off-site electricity generation displaced in project. If the project generates electricity from biomass that is greater than the historic on-site generation, off-site displacement may be claimed as follows:

$$Displaced\ Emissions_E\ Off\text{-}Site = EF_{EG} \times max\ of\ (Egproj - Ecproj - Eghistoric_{adjusted},\ 0)$$

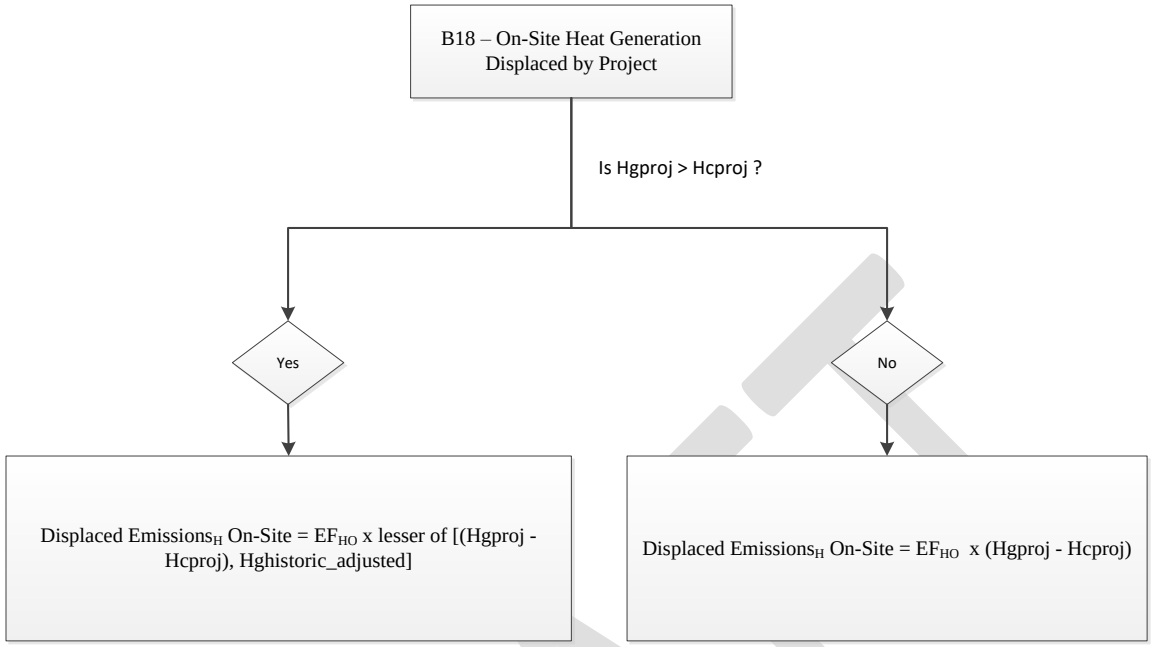
Applies to new and existing facilities that displace off-site electricity production.

Displaced off-site emissions apply only to emissions that are beyond what is being displaced on-site. There is no overlap.

Example for B18 – On-Site Heat (Thermal Energy) Generation Displaced in Project

Applies to on-site thermal energy generation displaced by project. Figure 7 provides a decision tree for assessing emissions from heat generation in the project.

FIGURE 7: B18 EMISSIONS ASSESSMENT



If the thermal energy consumed is greater than the thermal energy generated in the project, the following equation is used:

$$Displaced\ Emissions_H\ On\text{-}Site = EF_{HO} \times (Hgproj - Hcproj)$$

This value is negative representing an increase in project period thermal energy use

If the thermal energy consumed is less than the thermal energy generated in the project, the following equation is used:

$$Displaced\ Emissions_H\ On\text{-}Site = EF_{HO} \times lesser\ of\ [(Hgproj - Hcproj), Hghistoric_{adjusted})]$$

On-site heat displacement cannot be greater that historic heat generation.

<u>Example for B16 – Off-Site Heat Generation Displaced in Project</u>

Applies to off-site thermal energy generation displaced by project.

If the thermal energy generated from biomass is greater than the thermal energy displaced on-site and the excess thermal energy is exported for use, the following equation is used:

$$Displaced\ Emissions_H\ Off\text{-}Site = EF_{HE} \times max\ [(Hgproj - Hcproj - Hghistoric_{adjusted}), 0]$$

No offset credits can be generated for excess thermal energy generation that is vented to the atmosphere.