

# QUANTIFICATION PROTOCOL FOR DISTRIBUTED RENEWABLE ENERGY GENERATION

Version 1.0

March 2013

*Specified Gas Emitters Regulation*

**Government  
of Alberta** ■

*Alberta* ■

**Disclaimer:**

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

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

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

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

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Date of Publication: March 2013

ISBN No. 978-1-4601-0793-5 (Printed)  
ISBN No. 978-1-4601-0794-2 (On-line)

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**Alberta Environment and Sustainable Resource Development Related Publications**

Climate Change and Emissions Management Act  
Specified Gas Emitters Regulation  
Specified Gas Reporting Regulation

Alberta's 2008 Climate Change Strategy

Technical Guidance for Completing Annual Compliance Reports  
Technical Guidance for Completing Baseline Emissions Intensity Applications  
Technical Guidance for Landfill Operators

Technical Guidance for Offset Project Developers  
Technical Guidance for Offset Protocol Developers  
Quantification Protocols (<http://environment.alberta.ca/1238.html>)

Technical Seed Document for Distributed Renewable Energy Generation

Technical Guidance for Greenhouse Gas Verifications at Reasonable Level Assurance

## 1.0 Offset Project Description

Electricity generation in Alberta is primarily derived from coal and natural gas fired power plants. Thermal energy production in Alberta was responsible for approximately 52 per cent of Alberta's greenhouse gas emissions in 2006<sup>1</sup>, making fossil-fired electricity generation the single largest source of greenhouse gas emissions in Alberta.

Decentralized solar photovoltaic and small wind-driven electricity generators can be deployed in projects that have little to no greenhouse gas emissions. As such, the greenhouse gas savings from voluntary deployment of small, decentralized renewable electricity generation systems can result in reductions in provincial greenhouse gas emissions. Emissions reductions are achieved by displacing higher intensity electricity on the Alberta electricity transmission grid with these lower intensity sources. Additional emissions reductions are achieved by reducing or eliminating line losses at the distributed energy site.

This protocol specifically addresses grid connected wind and solar generating projects with a rated electrical capacity of less than 1 MW located at the consumer end of the electric distribution system. Individual projects will yield small volume emissions reductions that cannot be processed as stand-alone offset projects in the Alberta Offset System. The methodology provided in this protocol is for aggregated, distributed renewable electricity projects. Familiarity with and general understanding of distributed energy system operations is required.

### 1.1 Protocol Scope

The methodology provided in this protocol applies to the quantification of greenhouse gas emissions resulting from the installation of micro wind and solar photovoltaic systems at the consumer end of the electricity distribution system.

For the purposes of this protocol, **conventional, centralized generation** such as coal-fired facilities, are generators that are connected to the Alberta electric transmission system (referred to as a "transmission-connected generating plant", or "transmission generator"). **Decentralized electricity generators** such as solar photovoltaic systems and small wind generation systems are connected to the downstream portion of electricity distribution infrastructure (referred to as a "distribution-connected generation system").

The quantification methodology outlined below quantifies the difference in the greenhouse gas intensities of the two electricity sources. Additional emissions reductions are achieved through avoided line losses associated with transporting electricity to consumers via transmission lines and distribution grids.

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<sup>1</sup> [http://www.environment.alberta.ca/documents/2006\\_GHG\\_Report.pdf](http://www.environment.alberta.ca/documents/2006_GHG_Report.pdf)

**Eligible Project Conditions:**

Projects must meet the following conditions to be eligible under this protocol:

- Electricity is generated either by solar photo voltaic or small wind generation systems;
- The generating unit has a rated electrical power generating capacity of less than 1 MW;
- The generating unit is connected to the consumer end of a utility electric distribution system under AUC Rule 007 or Rule 024; and
- Ownership of environmental attributes must be explicitly stated in sale or lease agreements.

**Ineligible Project Conditions:**

The following project conditions are not eligible under this protocol:

- Off-grid renewable energy installations. Although there may be potential for greenhouse gas reductions by avoiding the construction of electricity distribution infrastructure, such project conditions are sufficiently different and are out of scope for this protocol;
- Project conditions reflecting renewable energy systems other than solar photovoltaic and small scale wind; and
- Projects that create and sell renewable energy credits (RECs and/or 'green tags') to capture and monetize the green attributes of renewable electricity.

Alberta Environment and Sustainable Resource Development (AESRD) has prescribed the baseline intensity for grid electricity for the purpose of calculating offset credits, which is published in the *Technical Guidance Document for Protocol Developers*<sup>2</sup>, and updated periodically. Project developers must ensure that the most current grid intensity factors available at the time of project implementation are used, and project documentation is up-dated periodically when these emission factors are revised.

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<sup>2</sup> See <http://environment.alberta.ca/02275.html>

## 1.2 Protocol Applicability

Greenhouse gas emissions reductions achieved at discreet consumer end points are required to be aggregated into a single larger aggregated project that meets Alberta Offset System requirements for aggregated projects. For the purposes of this protocol, the project developer will be the owner or aggregator of the decentralized wind or solar generator with ownership of the environmental attributes of its operation and access to appropriate tracking data. **Ownership and other requirements must be resolved between the project developer and the consumer through explicit contractual arrangement.**

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

- Sites are connected to the Alberta electricity grid for their electricity requirements;
- Sites are located in Alberta;
- Renewable energy systems may connect to the grid under Alberta Regulation 27/2008 (i.e. the Micro-Generation Regulation and AUC Rule 024) and/or AUC Rule 007 Part 4 (Small Power Plants under 1 MW);
- Projects must result from solar or wind-derived electricity generated on or after the date of approval of this protocol and commissioned January 2, 2012 or later; and
- Project must meet the eligibility criteria stated in Section 7 of the Specified Gas Emitters Regulation.

## 1.3 Protocol Flexibility

No alternative quantification opportunities exist for this activity. The approved quantification methodology prescribed in this protocol is available in Section 4.

## 1.4 Glossary of New Terms

Alberta Electricity Grid:	Is 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.
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Line losses:	Line loss represents the electric energy converted to heat and dissipated into the local environment in the process of transporting it over wires. Line losses can be separated into two categories: transmission system losses and distribution system losses.
Micro-Generation:	Generation of renewable energy that is less than 1 MW and is located at the consumer end of the Alberta electricity transmission grid.
Micro-Generation Unit:	Wind turbine or solar photovoltaic electricity generation unit located at the consumer end of the electricity transmission system that produces less than 1 MW of electricity.
Micro-wind:	Mechanical energy from wind that is collected by a wind turbine and transformed into electric energy.
Renewable Energy:	Is defined as energy that comes from naturally replenished sources including sun, wind, hydro, tidal, geothermal, and biomass sources.
Solar photovoltaic:	Solar photovoltaic (photovoltaic) technologies generate direct-current electricity from the energy in solar radiation using a semi-conductor electronic material.
Solar photovoltaic system:	Consists of an array of solar photovoltaic modules and a grid-dependent inverter. Each solar photovoltaic module consists of multiple solar cells in which the cell converts solar energy into DC electricity using the photovoltaic effect.
Wind turbine:	Is a rotary device on a vertical or horizontal axis to absorb the mechanical energy from the wind to create electricity.

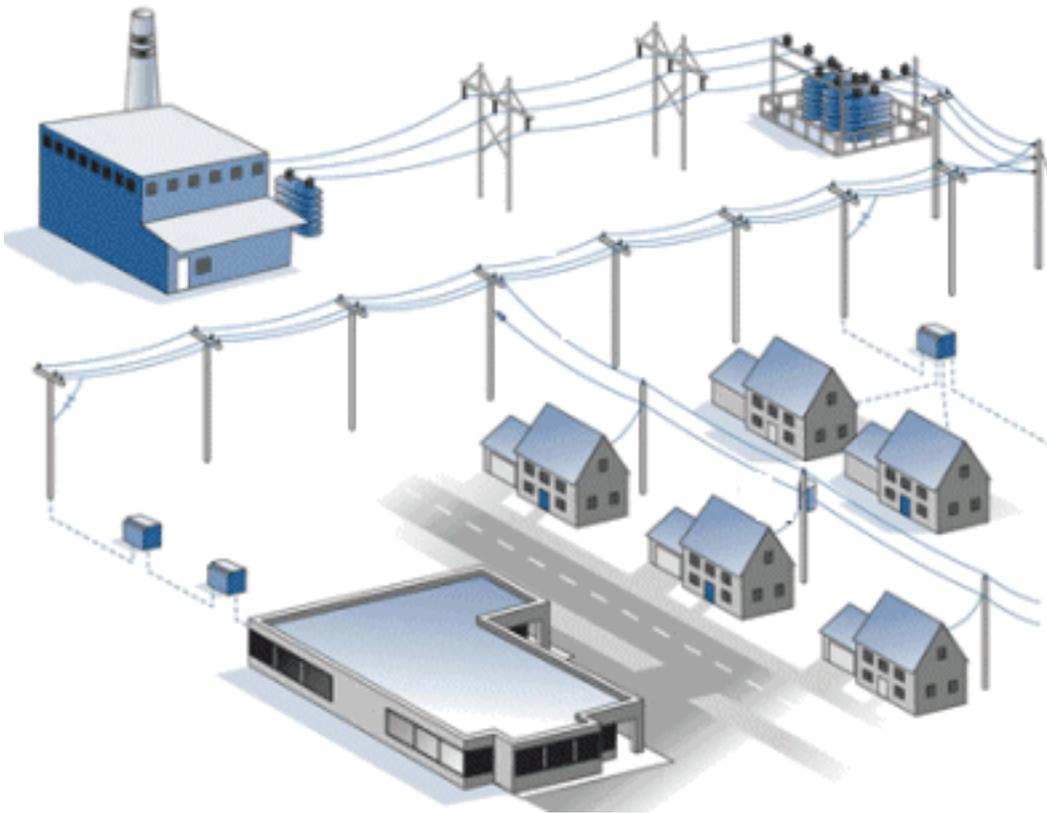
## 2.0 Baseline Condition

The baseline condition is the consumption of Alberta grid electricity comprised primarily of fossil-fuel-fired generation. Coal and to a lesser extent, natural gas, are used for base load. Natural gas provides most of the peaking capacity along with smaller amounts of wind, hydro and negligible amounts of solar electricity.

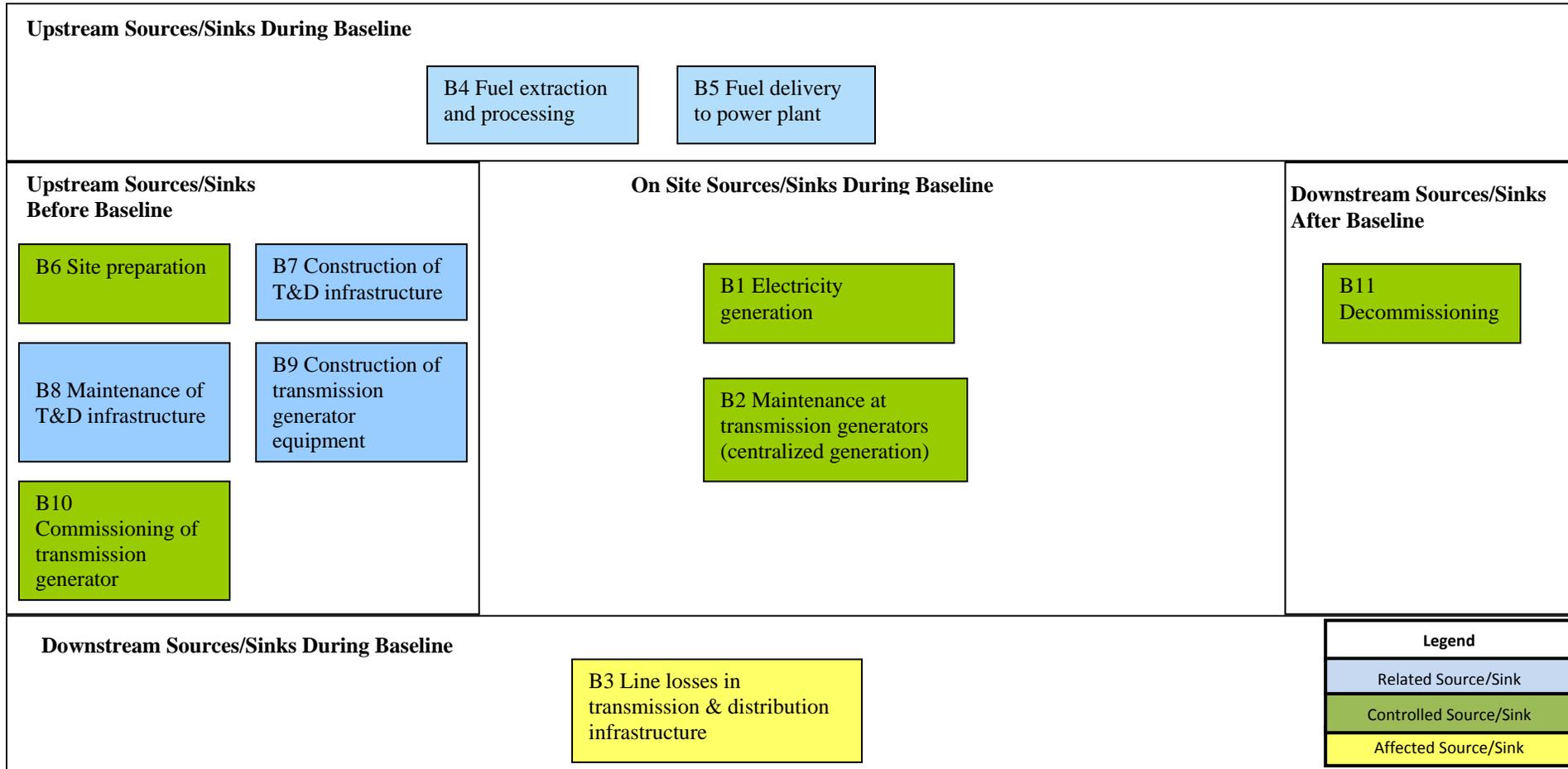
The Alberta grid intensity factor provides a conservative estimate for greenhouse gas emissions resulting from power production in the province. This value reflects a combination of operating margin, grid average, and build margin for new electricity generation. This baseline value is set by AESRD for all renewable energy based greenhouse gas reduction projects and is published in the *Technical Guidance Document for Protocol Developers*.

Figure 1 below is a schematic of the baseline condition (the Alberta electricity grid). Figure 2 below shows baseline sources and sinks associated with the Alberta electricity grid.

**Figure 1: Process Flow Diagram for the Project Baseline**



**Figure 2: Baseline Sources and Sinks**



## 2.1 Identification of Baseline Sources and Sinks

Sources and sinks for an activity are assessed based on guidance provided by Environment Canada and are classified as follows:

- Controlled: The behavior or operation of a controlled source and/or sink is under the direction and influence of a project developer through financial, policy, management, or other instruments.
- Related: A related source and/or 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 and/or sink is influenced by the project activity through changes in market demand or supply for projects or services associated with the project.

Baseline sources and sinks were identified by reviewing the relevant process flow diagrams, consulting with technical experts, national greenhouse gas inventory scientists, and reviewing good practice guidance. This iterative process confirmed the sources and sinks in the process flow diagrams covered the full scope of eligible project activities under this protocol.

Based on the process flow diagram provided above, the baseline sources and sinks were organized into life cycle categories in Figure 2. Descriptions of each of the sources and/or sinks and their classification as controlled, related or affected are provided in Table 1.

**Table 1: Baseline Sources and Sinks**

Sources/Sinks	Description	Controlled, Affected, Related
<b>Upstream Sources and Sinks Before Baseline</b>		
B6 Site preparation	Land clearing and ancillary utility service construction are required to prepare the site of the transmission generator, which involve removal of biomass and combustion of fossil fuels by heavy machinery. Emissions from these activities results from the combustion of transportation fuels.	Related
B7 Construction of transmission and distribution infrastructure	Construction of high tension transmission lines, transformer stations and distribution wires involves inputs of primary and/or secondary energy sources (e.g., coal or coke; and electricity, respectively), which cause greenhouse gas emissions through combustion of fossil hydrocarbons.	Related
B8 Maintenance of transmission and distribution infrastructure	Ongoing maintenance of transmission and distribution infrastructure is a source of greenhouse gas emissions, including the spark-suppressing gas sulphur hexafluoride (SF <sub>6</sub> ), a high potency greenhouse gas used in high voltage switches and relays, which can escape during maintenance. Travel of crews to sites also releases greenhouse gases through the combustion of hydrocarbon fuels.	Related
B9 Construction of equipment for the transmission generator	Construction and manufacturing of boilers, steam turbines, piping, pumps, controls, housing, mines, energy processing and storage facilities consumes energy, the production of which releases greenhouse gases at various intensities, depending on the source.	Related
B10 Commissioning of transmission generator	Transportation of equipment to site causes release of greenhouse gases from rail, marine and road transport. Equipment installation and commissioning may involve consumption of energy in the form of welding, transportation, and other activities that release greenhouse gases.	Related
<b>Upstream Sources and Sinks During Baseline</b>		
B4 Fuel extraction and processing	Upstream mining and upgrading of coal and natural gas for use in electricity generation equipment involve combustion of primary and secondary forms of energy (liquid fuel and electricity), which release greenhouse gases.	Related
B5 Fuel delivery to power plant	Shipping of process fuel to transmission generator involves combustion of hydrocarbons, releasing greenhouse gases.	Related
<b>Onsite Sources and Sinks During Baseline</b>		
B1 Electricity generation	Electricity generated at the transmission generator involves combustion of hydrocarbons releasing greenhouse gases.	Controlled
B2 Maintenance at remotely-located	Ongoing maintenance and periodic retrofits of turbines, etc. involve transportation (combustion of	Controlled

transmission generators	hydrocarbon fuels) and energy inputs in the form of electricity for welding, etc.	
<b>Downstream Sources and Sinks During Baseline</b>		
B3 Line losses in electricity transmission and distribution	Transmission and distribution losses are an indirect, but significant source of greenhouse gas emissions. Since large-scale coal plants are located at a distance from electrical loads, a significant amount of energy is lost in transferring and distributing the energy to customers. This energy is lost as heat due to resistance in wires. These losses are classified as transmissions line losses and distribution line losses.	Related
<b>Downstream Sources and Sinks After Baseline</b>		
B11 Decommissioning	Dismantling and disposal of transmission generator involves transportation and demolition, which involve combustion of hydrocarbon fuels and consumption of electricity, both of which release greenhouse gases.	Related

### 3.0 Project Condition

The project condition consists of installing and operating distributed solar photovoltaic system or a micro-wind turbine with a grid connection to the Alberta electricity grid. The distributed micro-generation must be primarily for local electricity consumption for the end user (household). Excess generation is transported to the other nearby grid-connected households located on the downstream portion of the electrical distribution grid.

The project reduces greenhouse gas emissions generated in Alberta through the following processes:

- Displacing electricity on the grid with lower greenhouse gas intensity electricity generating sources; and
- Reducing line losses through the nearby connection between the electricity generation source and the consumption site;

Additional greenhouse gas emission reductions are achieved through avoided line losses resulting from the proximity of generation to the consumption site. Most or all of the energy from micro wind or photovoltaic electricity generation is consumed at or within relatively short distances of the project site resulting in negligible amounts of energy loss in the electrical transmission lines.

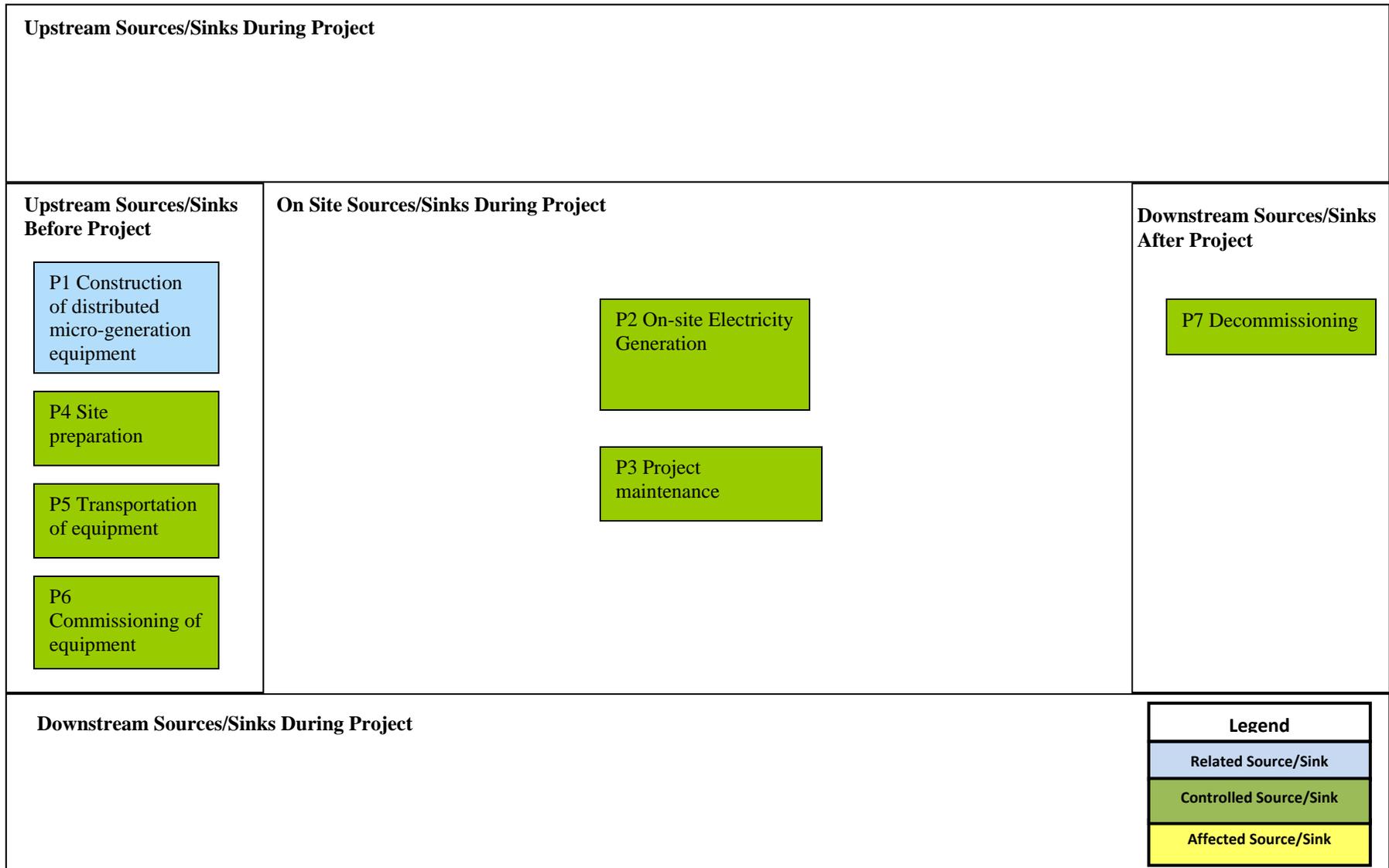
Line losses are conservatively assessed at 7.7 per cent. Justification for the establishment of this factor is provided in Appendix A and in the Technical Seed Document.

Figure 3 below provides an example schematic of a distributed generation site that includes both solar photovoltaic and micro-wind generation. It is expected that most distributed energy sites will include one or the other, but not both. Figure 4 provides a process flow diagram sources and sinks in the project condition.

**Figure 3: Process Flow Diagram for the Project Condition**



**Figure 4: Project Sources and Sinks**



### **3.1 Identification of Project Sources and Sinks**

Sources and sinks for the distributed micro-generation projects were identified based on scientific peer review. The technical working group confirmed that sources and sinks in the process flow diagram (Figure 5) covered the full scope of eligible project activities under this protocol.

These sources and sinks have been listed according to the life cycle categories identified in Figure 5 above and classified as controlled, related, or affected as described in Table 2 below.

**Table 2: Project Condition Sources and Sinks**

Sources/Sinks	Description	Controlled, Affected, Related
<b>Upstream Sources and Sinks Before Project</b>		
P1 Construction of distributed micro-generation equipment	Manufacturing of micro wind and photovoltaic electricity generation equipment and ancillary materials, including supportive racking, supports, wiring, inverters and foundation materials each involve energy inputs in the form of electricity.	Related
P4 Site preparation	Installation of micro wind and photovoltaic electricity generation systems may involve driving to the site, which releases greenhouse gases through the combustion of fossil transportation fuels. Installing foundation for wind turbines may require the use of machines which also combust fossil fuels. Installing photovoltaic systems may require the use of electrical hand tools, which cause upstream emissions from fossil-fired conventional electricity generation facilities.	Controlled
P5 Transportation of equipment	Moving material and equipments from ware houses to the project sites involves combustion of fossil fuels which releases greenhouse gases.	Controlled
P6 Commissioning of equipment	Testing and commissioning systems to ensure proper performance of components, including quality assurance checks, may involve transportation to sites, involving combustion of fossil fuels and releasing greenhouse gases.	Controlled
<b>Onsite Sources and Sinks During Project</b>		
P2 On-site Electricity Generation	Renewable electricity generation from the systems does not release greenhouse gases	Controlled
P3 Project maintenance	As required, may include visual inspection, performance testing, and cleaning. This may require a site visit, requiring combustion of transportation fuels which releases greenhouse gases.	Controlled
<b>Downstream Sources and Sinks After Project</b>		
P7 Decommissioning	At the end of operational life or project life these systems will be removed from the site, which may involve removing the equipments and support structure, and driving to the site to remove equipment. This transportation involve combustion of fossil fuels, which release greenhouse gases.	Controlled

## 4.0 Quantification

Each source and sink compared between the baseline and project condition. Sources were either included or excluded depending on how they were impacted by the project condition. Sources that are not expected to change between the baseline and project condition are excluded from the project quantification. It is assumed that excluded activities will occur at the same magnitude and emissions rate during the baseline and project, and so will not be impacted by the project.

Emissions that increase or decrease as a result of the project must be included and associated greenhouse gas emissions must be quantified as part of the project condition.

All sources and sinks identified in Tables 1 and 2 above are listed in Table 3 below. Justification for inclusion or exclusion is provided.

**Table 3: Comparison of Sources and Sinks**

Identified Sources and Sinks	Baseline	Project	Include or Exclude from Quantification	Justification for Inclusion/Exclusion
<b>Upstream Sources/Sinks</b>				
B4 Fuel extraction and processing	Related	N/A	Exclude	Fuel extraction and processing are critical to availability of primary energy source to fire electricity generation, but are excluded from offset calculations because they are covered in the prescribed baseline carbon intensity of Alberta grid electricity.
B5 Fuel delivery to power plant	Related	N/A	Exclude	Fuel delivery is needed to bring primary energy source to conventional electricity generation site, but emissions from fuel transportation are excluded from offset calculations because they are covered in the prescribed baseline carbon intensity of Alberta grid electricity.
B6 Site preparation	Controlled	N/A	Exclude	Site preparation may require earthworks, but are excluded from offset calculations because they are covered in the prescribed baseline carbon intensity of Alberta grid electricity.
B7 Construction of T&D infrastructure	Related	N/A	Exclude	Construction of transmission and distribution infrastructure is upstream of project condition. These emissions are excluded from offset calculations because they are covered in the prescribed baseline carbon intensity of Alberta grid electricity.
B8 Maintenance of T&D infrastructure	Related	N/A	Exclude	Maintenance of transmission and distribution infrastructure is upstream of project condition are excluded from offset calculations because they are covered in the prescribed baseline carbon intensity of Alberta grid electricity.
B9 Construction of transmission generation equipment	Controlled	N/A	Exclude	Emissions from production of centralized electricity generation equipment including turbines, coal combustion equipment, etc are excluded from offset calculations because they are covered in the prescribed baseline carbon intensity of Alberta grid electricity.
B10 Commissioning of transmission generation	Controlled	N/A	Exclude	Emissions from commissioning of centralized electricity generation are excluded as they are relatively small in comparison to greenhouse gas emissions from operation, but are excluded from offset calculations because they are covered in the prescribed baseline carbon intensity of Alberta grid electricity.
P1 Construction of distributed micro-generation equipment	N/A	Related	Exclude	Emissions from production of modules, inverters, wire and racking, nacelles and poles are expected to be similar or lower to baseline electricity generation emissions, and are therefore excluded.
P4 Site preparation	N/A	Controlled	Exclude	Emissions from site preparation are expected to be lower than in the baseline condition and are therefore excluded.

Identified Sources and Sinks	Baseline	Project	Include or Exclude from Quantification	Justification for Inclusion/Exclusion
P5 Transportation of equipment	N/A	Related	Exclude	Emissions from transportation of equipment are expected to be similar or lower than in the baseline condition and are therefore excluded.
P6 Commissioning of equipment	N/A	Controlled	Exclude	Emissions from testing and commissioning of renewable electricity generation equipment are expected to be lower than in the baseline condition. They are therefore excluded.
<b>Onsite Sources/Sinks</b>				
B1 Electricity Generation	Controlled	N/A	<b>Include</b>	The baseline reflects electricity generation from centralized fossil fuel-fired generation systems. The carbon intensity of grid power in Alberta for calculating offsets is prescribed by Alberta Environment and Sustainable Resource Development in the Technical Guidance Document for Offset Project Developers. These emissions are included.
B2 Maintenance	Controlled	N/A	Exclude	Emissions from maintenance are covered in the prescribed baseline carbon intensity of Alberta grid electricity.
P2 On-site Electricity Generation	N/A	Controlled	Exclude	The project activity involves generation of electricity from renewable sources that do not emit greenhouse gases from the project site. This activity is included in calculation of emissions for offset purposes.
P3 Project maintenance	N/A	Controlled	Exclude	Emissions from maintenance are extremely small as outlined in the appendix and technical seed document. This source is excluded on the basis that the project level emissions are negligible as shown by sample calculations.
<b>Downstream Sources/Sinks</b>				
B3 Line losses from electricity transmission and distribution (T&D)	Related	N/A	<b>Include</b>	A percentage of energy is lost as heat during transmission and distribution. Since the proposed renewable systems will replace grid electricity, they eliminate these line losses. An average loss factor for all of Alberta can be used to adjust the electricity production to account for these losses.
B11 Decommissioning	Related	N/A	Exclude	The emissions from decommissioning are not anticipated to be different from the project condition on a normalized basis and are therefore excluded.
P7 Decommissioning	N/A	Related	Exclude	The emissions from decommissioning are not anticipated to be different from the baseline condition on a normalized basis and are therefore excluded.

## 4.1 Quantification Methodology

Quantification of the reductions, removals and reversals of relevant sources/sinks for each of the greenhouse gases must be completed using the methodologies outlined in Table 4, below. A listing of relevant emission factors are provided in Appendix A and Appendix B. These calculation methodologies serve to complete the following three equations for calculating the emission reductions from the comparison of the baseline and project conditions.

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

$$\text{Emissions}_{\text{Baseline}} = \text{Emissions}_{\text{Electricity Generation}} + \text{Emissions}_{\text{Line Loss}}$$

$$\text{Emissions}_{\text{Project}} = \text{No incremental emissions present}$$

Where:

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

$\text{Emissions}_{\text{Electricity Generation}}$  = emissions under SS B1 Electricity generation

$\text{Emissions}_{\text{Line Loss}}$  = emissions under SS B3 Line losses from electricity transmission and distribution (T&D)

Note, Consumers must be connected to the Alberta electricity distribution system.

### Standardized Quantification Approach

Distributed micro-generation sites yield small annual reductions that are not feasible to quantify as stand-alone offset projects. As such, distributed micro-generation projects will be aggregated projects that pool a number of discrete micro-generation sites together into a single offset project that is capable of supporting offset project quantification, verification, and transaction costs.

Each discrete site in the project must be quantified using the same methodology as prescribed below. Each micro-generation site included in the project must be tracked for the entire project crediting period. Project quantification is based on the type of equipment (solar photovoltaic or micro-wind turbine) and the amount of electricity (in MWh) produced at the consumer end of a distribution system to determine the total electricity produced during that period. This total is then used to calculate the amount of greenhouse gas emissions that would have been generated by fossil fuel power using the Alberta electricity grid displacement factor.

Each distributed micro-generation site must be metered or use an energy tracking system to quantify the amount of electricity produced. Meters must be accurate within 95 per cent, measured at an assumed 100 per cent power factor<sup>3</sup>. All tracking data must be collected and maintained in an auditable manner to preserve the ability to review electricity generation tallies.

Tracking systems must track and store data to support reductions claimed. Aggregated production data must be auditable for any given month in the reporting period as requested by an auditor. If third party hosted solutions (e.g., online tracking systems) are used, reports of annual system production must be available directly from the service provider as annual summaries, which include individual site tallies of electricity generation. If tallies of multiple sites' annual production are possible in a single report, the full dataset of daily production values must remain available for audit purposes either online or as a downloaded database or similar digital file.

Table 4 below provides quantification requirements for distributed micro-generation projects.

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<sup>3</sup> Photovoltaic and wind generators by definition export electricity at 100 per cent power factor.

**Table 4: Quantification Methodology**

Source/Sink	Parameter / Variable	Unit	Measured/ Estimated	Method	Frequency	Justify measurement or estimation and frequency
<b>Baseline Condition</b>						
B1 Electricity Generation	Emissions <sub>Electricity Generation</sub> = Electricity Generation * EF <sub>Elec</sub>					
	Emissions <sub>Electricity</sub>	Tonne of CO2e	N/A	N/A	N/A	Quantity being calculated.
	Electricity Generation, is the renewable generation that is displacing grid generation	MWh	Measured	Direct metering.	Annual	Summed annually from continuous monitoring by energy management devices, integrated tracking in inverters or electricity meters. This is the renewable electricity that is being generated in the project condition.  Data must be available for aggregate and daily MWh of grid electricity offset for the span of the reporting period.
	Emissions Factor for Electricity / EF <sub>Elec</sub>	Tonnes of CO2e per MWh	Estimated	From Alberta Environment reference documents.	Annual	Alberta Environment and Sustainable Resource Development prescribes the carbon intensity of Alberta grid electricity for the purpose of offsets and publishes the prescribed value in Technical Guidance Documents for Protocol Developers. This value covers carbon dioxide (CO <sub>2</sub> ) and the carbon dioxide equivalent global warming potential from emissions of other greenhouse gases including methane (CH <sub>4</sub> ), nitrous oxide (N <sub>2</sub> O), sulphur hexafluoride (SF <sub>6</sub> ) and others as defined in the <i>Specified Gas Emitters Regulation</i> .
B3 Line losses from electricity transmission and distribution (T&D)	Emissions <sub>Line Loss</sub> = Electricity Consumed * EF <sub>Elec</sub> * EF <sub>Line Loss</sub>					
	Emissions <sub>Electricity</sub>	Tonne of CO2e	N/A	N/A	N/A	Quantity being calculated.
	Electricity Consumed, is the on-site renewable generation that is consumed, therefore avoiding line loss from grid sourced generation	MWh	Measured	Direct metering.	Annual	Summed annually from continuous monitoring by energy management devices, integrated tracking in inverters or electricity meters.  Data must be available for aggregate and daily MWh of grid electricity offset for the span of the reporting period.

	Emissions Factor for Electricity / EF <sub>Elec</sub>	Tonnes of CO2e per MWh	Estimated	From Alberta Environment reference documents.	Annual	Alberta Environment and Sustainable Resource Development prescribes the carbon intensity of Alberta grid electricity for the purpose of offsets and publishes the prescribed value in Technical Guidance Documents for Protocol Developers. This value covers carbon dioxide (CO <sub>2</sub> ) and the carbon dioxide equivalent global warming potential from emissions of other greenhouse gases including methane (CH <sub>4</sub> ), nitrous oxide (N <sub>2</sub> O), sulphur hexafluoride (SF <sub>6</sub> ) and others as defined in the <i>Specified Gas Emitters Regulation</i> .
	Emission factor for line loss, EF <sub>Line Loss</sub>	MWh of electricity lost per MWh consumed	Estimated	Calculated based on per cent line loss. Weighted average of provincial transmission and distribution losses was last provided in CASA, 2004 (Jem Energy consulting report, p. 41).	Annual	Alberta Electric System Operator publishes transmission and distribution losses for each distribution area annually. These figures should not change significantly enough from year to year to justify updating annually; a new provincial calculation will be performed in consultation with Alberta Environment and Sustainable Resource Development when this protocol is reviewed (i.e. every 5 years).  Line loss factor is outlined in Appendix A.

## 5.0 Data Management

Data quality management must be of sufficient quality to fulfill the quantification requirements and be substantiated by actual records for the purpose of verification.

A project developer shall establish and apply quality management procedures to manage data and information. Written procedures must be established for each measurement task outlining responsibility, timing and record location requirements. The greater the rigor of the management system for the data, the more easily verification will be to conduct for the project.

The data management plan should produce complete, reliable and accurate data for processing and analysis purposes. Aggregators should develop a QA/QC plan for ensuring a successful data management process.

Similarly, an easy to understand and easily replicable quantification methodology must be employed to estimate greenhouse gas reductions. In the absence of complete and accurate information, conservative estimates should be used to minimize the risk of overestimation.

## 5.1 Project Documentation

### Project Eligibility Documentation

To be eligible a project must be located in Alberta and be operating in accordance with the Alberta Electric Utilities Act as enforced by the Alberta Utilities Commission's Rule 007 or Rule 024, and use solar or wind as its renewable energy source for electricity production.

### Baseline Condition Documentation

The baseline condition for all eligible products assumes a grid connected customer within the Province of Alberta. The default carbon intensity is set by Alberta Environment and Sustainable Resource Development in the *Technical Guidance for Offset Protocol Developers*. The line loss factor is provided in Appendix A.

### Project Quantification Documentation

The project developer must, at a minimum, have specific site information for each location to be included in the project. This includes:

1. Legal land description;
2. Unique site ID (utility customer ID number);

3. Type of renewable energy system;
4. Rated generating capacity of the generator portion of the renewable energy system;
5. Activation date of the renewable energy system;
6. Date of decommissioning for the renewable energy system (if applicable); and
7. Data measurement system (i.e. brand and model of electricity generation tracking equipment) in place for all project sites.

To avoid any duplication of greenhouse gas reduction claims, the greenhouse gas offsets will be tied to the unique site ID. Equipment moved to a new site must maintain the same site ID, which will eliminate the possibility of any undesirable leakage due to relocation of the systems from one project site to another.

Ownership of offset credits must be established through contractual agreement between the consumer and the project aggregator.

## **5.2 Record Keeping**

Alberta Environment and Sustainable Resource Development requires that project developers maintain appropriate supporting information for the project, including all raw data for the project for a period of 7 years **after** the end of the project crediting period. Where the project developer is different from the person implementing the activity, as in the case of an aggregated project, the individual projects and the aggregator, must both maintain sufficient records to support the offset project. The project developer (project implementer and aggregator) must keep the information listed below (in addition to others that will support the project) and disclose all information to the verifier and/or government auditor upon request.

### **Record Keeping Requirements:**

- Site location, unique identifier, renewable energy type, system generator capacity, commissioning date, and if, available, decommissioning date;
- Electricity production for project period;
- Energy measurement equipment specifications (model number and manufacturer's calibration procedures);
- All calculations of greenhouse gas emissions/reductions and emission factors;
- Energy measurement equipment maintenance activity logs; and
- Initial and annual verification records and audit results.

In order to support the third party verification and the potential supplemental government audit, the project developer must put in place a system that meets the following criteria:

- All records must be kept in areas that are easily located;
- All records must be legible, dated and revised as needed;
- All records must be maintained in an orderly manner;
- All documents must be retained for 7 years after the project crediting period;
- Electronic and paper documentation are both satisfactory; and
- Copies of records should be stored in two locations to reduce the likelihood of data loss.

**Table 5: Data and Record Keeping Requirements**

Data Requirement	Examples of Acceptable Records	Why it is Required
Proof of distributed micro-generation system location	Copies of wires owner interconnection agreement, Alberta Electricity System Operator (AESO) registration or contractor site assessment form (used for municipal permitting application).	This is needed to establish the legal address and utility customer site ID number, installation date and renewable energy system type.
Proof of ownership of environmental attributes of distributed micro-generation system	Copies of paid invoices for equipment and records of installation in the case of direct ownership of renewable energy systems.  For lease arrangements, copy of signed Lease Agreement between lesser of renewable energy equipment and lessee clearly defining ownership or assignment of environmental attributes of distributed micro-generation system.	This is needed to confirm ownership and rights to transact on offset credits.
Proof of system operation and summary of electricity generation	Detailed summary from automated tracking system or periodic meter readings  Data must be verifiable against primary data source (i.e. non-modifiable hardware matching time/date periods to energy generation, or 3 <sup>rd</sup> party service)	This is needed to confirm that the system is producing electricity, and to quantify the amount of electricity produced.

Greenhouse gas reduction calculations	Copies of calculations, methodologies and results	This is needed to be able to verify mathematical procedures, emissions factors used and other issues affecting validity of quantification claims.
Tracking system accuracy and calibration information	Equipment manufacturer's operating guidelines or product literature describing tracking accuracy and frequency and process for calibration (if required).	This is needed to verify that tracking equipment is appropriate and in good operating order throughout the crediting period.
Initial and annual verification records and audit results	Copies of audit reports and annual data summaries	These are required to confirm that calculation and accounting methods remain consistent over time (or are properly noted for auditors).

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*Note: Attestations will not be considered sufficient proof that an activity took place and will not to meet verification requirements.*

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### 5.3 Quality Assurance/Quality Control

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

- Protecting measuring and monitoring equipment (sealed meters and data loggers);
- Protecting records of measured data (hard copy and electronic storage);
- Checking data integrity on a regular and periodic basis (manual assessment, comparing redundant metered data, and detection of outstanding data/records);
- Comparing current estimates with previous estimates as a 'reality check';
- Provide sufficient training to operators to perform maintenance and calibration of measurement devices;
- Establish minimum experience and requirements for operators in charge of project and monitoring; and
- Performing re-calculations to make sure no mathematical errors have been made.

**Table 6: Quality Control Requirements**

<b>Data Requirement</b>	<b>Examples of Acceptable Records</b>	<b>Why it is Required</b>
Proof of data pedigree and significant digits	<p>Data from individual sites must be measured to the nearest kWh and maintain two significant digits for intermediary calculations (accuracy of electricity grid displacement factor, or EGDF) to avoid material rounding errors.</p> <p>Where data storage of monitoring system is limited, date stamped hard copy print-offs or photographic records may be stored as backup evidence of energy generated. Where tallies of multiple readings are required, supporting evidence of each data point is required for full audit continuity. Notes must accompany records such that an auditor may trace generation at a granularity of at least kWh per month.</p>	This is needed to establish the origin and validity of each data point.

## **5.4 Liability**

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

Notwithstanding any agreement between a third party carbon management system provider, and the project developer and/or the buyer of the offset credits, the third party management system provider shall not and cannot pass on any regulatory liability for errors in the design of their carbon data management system.

## **5.5 Registration and Claim of Offset Credits**

All emission reductions and removals used for regulatory compliance must be tracked through the Alberta Emissions Offset Registry. Reductions are specific to an activity and must be traceable to an action (installation of a distributed micro-generation system) at a specific location.

Specific information related to project location is collected by the registry and used as a mechanism to check for double counting. An example of the required fields for filing with the registry is provided in Table 7 below.

**Table 7: Data Fields**

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Emission Reduction Claim	kWh Produced	Year	Bldg Name/ AESO #	Bldg #	Street Name	City/ Town	Postal Code	Name	Legal Land Location if applicable	Total Energy Savings for Project Period	System Specs
X tonnes	X kWh	2012	###-ABC	123	123 Ave.	Edmonton	A1A2B2	Smith Family		X kWh	X kW 6 panel...

## 6.0 References

Alberta Environment Report on 2006 Greenhouse Gas Emissions

[http://www.environment.alberta.ca/documents/2006\\_GHG\\_Report.pdf](http://www.environment.alberta.ca/documents/2006_GHG_Report.pdf)

Alberta Micro-Generation Regulation

[http://www.auc.ab.ca/rule-development/micro-generation/Documents/Micro\\_Generation/Microgen\\_Regulation.pdf](http://www.auc.ab.ca/rule-development/micro-generation/Documents/Micro_Generation/Microgen_Regulation.pdf)

Alberta Utilities Commission Micro-Generation Reporting

[http://www.auc.ab.ca/rule-development/micro-generation/Documents/Micro\\_Generation/Micro-Generation\\_Reporting\\_2011\\_May.pdf](http://www.auc.ab.ca/rule-development/micro-generation/Documents/Micro_Generation/Micro-Generation_Reporting_2011_May.pdf)

Alberta Utilities Commission Micro-Generator Application Guidelines

[http://www.auc.ab.ca/rule-development/micro-generation/Documents/Micro\\_Generation/Micro-Generator\\_Application\\_Guidelines.pdf](http://www.auc.ab.ca/rule-development/micro-generation/Documents/Micro_Generation/Micro-Generator_Application_Guidelines.pdf)

Alberta Utilities Commission Rule 007. URL: <http://www.auc.ab.ca/acts-regulations-and-auc-rules/rules/Documents/Rule007.pdf>

Alberta Utilities Commission Rule 024. URL: <http://www.auc.ab.ca/acts-regulations-and-auc-rules/rules/Documents/Rule024.pdf>

Alberta Quantification Protocol for Solar Electricity Generation

<http://environment.gov.ab.ca/info/library/7960.pdf>

Alberta Quantification Protocol for Low-Retention Water-Powered Electricity Generation as Run-of-River or on an Existing Reservoir

<http://environment.gov.ab.ca/info/library/7957.pdf>

Alberta Quantification Protocol for Wind-Powered Electricity Generation

<http://environment.gov.ab.ca/info/library/7933.pdf>

Clean Air Strategic Alliance, 2004. A Study on the Efficiency of Alberta's Electrical Supply System. Linked via:

<http://www.assembly.ab.ca/lao/library/egovdocs/ca6/casa/2004/146660.pdf>

Climate Change Emissions Management Act

[http://www.qp.alberta.ca/574.cfm?page=C16P7.cfm&leg\\_type=Acts&isbncln=9780779740956](http://www.qp.alberta.ca/574.cfm?page=C16P7.cfm&leg_type=Acts&isbncln=9780779740956)

National Inventory Report 1990-2009: Greenhouse Gas Sources and Sinks in Canada.

URL:

[http://unfccc.int/national\\_reports/annex\\_i\\_ghg\\_inventories/national\\_inventories\\_submissions/items/5888.php](http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5888.php)

Specified Gas Emitters Regulation

<http://environment.gov.ab.ca/info/library/7811.pdf>

Technical Guidance for Offset Project Developers

<http://environment.gov.ab.ca/info/library/7915.pdf>

Technical Guidance for Offset Protocol Developers

<http://environment.gov.ab.ca/info/library/8331.pdf>

UNFCCC CDM General Guidelines for Sampling and Surveys for Small-Scale CDM Project Activities URL: [http://cdm.unfccc.int/EB/050/eb50\\_repan30.pdf](http://cdm.unfccc.int/EB/050/eb50_repan30.pdf).

## Appendix A: Line Loss in Alberta Electricity System

Line loss quantification is discussed in more detail in the Technical Seed Document for Distributed Micro-Generation projects. Relevant information for project quantification is summarized below.

### Line losses

Distributed micro-generators cause a direct reduction on the line losses incurred by those customers that choose to use a distributed generation technology. Distributed generation does not incur the line loss, as the consumer does not use the transmission system and only use a very small portion of the distribution system in the consumption and export of the electricity generated on-site. The avoidance of these losses means less transmission-connected electricity is generated and less greenhouse gas produced in the delivery of that energy to the household.

The *Transmission Regulation*, 2004 (updated in 2007) requires transmission connected generators, Industrial Systems Designations, Demand Opportunity Service, Import and Export Service to pay for losses. Since the transmission lines are made of metallic conductors, *loss* of electrical energy occurs in the *line*. These Transmission *losses* can be significant and are determined by the AESO based on the following principles.

Based on the line loss methodology ([http://www.aeso.ca/downloads/Loss\\_Factors\\_-\\_High\\_Level\\_Process\\_Review.pdf](http://www.aeso.ca/downloads/Loss_Factors_-_High_Level_Process_Review.pdf)), AESO determines the transmission (STS) line loss factors for each transmission-connected generator in the province. Generators who locate near major load centers receive an incentive whereas generators that are more remote from the load centers are charged for line loss.

2011 Line loss factors have been determined based on the location to load. The large transmission generators such as Keephills or Genesee are subject to a line loss cost of about 6% where as the generators such as the Northern Prairie Power project are located near load and receive a line loss payment of - 4.5% from the AESO for reducing line loss (see MP ID NPP1 in Appendix B of the technical seed document).

Distributed generation is not eligible for a line loss payment because of the energy-generating scale at these sites. Regardless of this line loss payment tariff, the use of distributed generation achieves the same reduction in actual delivered energy as does the Northern Prairie Power Plant. In absolute terms the average transmission system loss as determined by the AESO for 2011 is 4.13 %.

## **Distribution losses**

Distribution generator sites provide the best system support with respect to line loss since they are located at or near the end of the distribution system. For distribution line loss the calculation of the additional associated factors is done by the franchise wires companies like ATCO, Fortis, ENMAX, EPCOR or the REA's. Each wires company calculates the line loss for their service territory and applies it in their tariff. Those line loss factors are avoided by distributed generation as they remove some of the need for additional energy for system support.

Service territories like ENMAX Power Corp. or the Southern Alberta REA are examples of the significant range in line losses as a factor of population density and total length of wires. In the ENMAX service territory the 2010 line loss calculation was determined to be 3.3% as part of the 2010 ENMAX Power Corp. tariff application (Source: EPC, FBR compliance filing, Appendix 5). Conversely the Southern Alberta REA has calculated their distribution losses at 13% and applied it in their 2010 tariff.

## **Total Line Loss**

The total avoided line loss for both transmission and distribution wires can be shown to have a wide range. A study by Jem Energy for the Clean Air Strategic Alliance in 2004 provides a weighted average line loss calculation for transmission and distribution in Alberta as 7.7%<sup>4</sup>.

Since these grid line losses are avoided by the use of distributed generation, 1.083 units of electricity from transmission-connected generators are offset by each unit of electricity generated at distributed generation sites, the general factor for which is calculated as  $1/(1-\text{loss})$ , or 1.083. Since the line loss calculation is separated out, the factor to be used in this protocol is 0.083 MWh line loss per MWh consumed.

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<sup>4</sup> CASA, 2004. URL: <http://www.assembly.ab.ca/lao/library/egovdocs/ca6/casa/2004/146660.pdf> page 41.

## Appendix B: Specified Gases Covered under SGER

Specified Gas	Formula	100-year GWP
Carbon dioxide	CO <sub>2</sub>	1
Methane	CH <sub>4</sub>	21
Nitrous Oxide	N <sub>2</sub> O	310
Sulphur Hexafluoride	SF <sub>6</sub>	23900
Perfluorocarbons (PFC)		
Perfluoromethane	CF <sub>4</sub>	6500
Perfluoroethane	C <sub>2</sub> F <sub>6</sub>	9200
Perfluoropropane	C <sub>3</sub> F <sub>8</sub>	7000
Perfluorobutane	C <sub>4</sub> F <sub>10</sub>	7000
Perfluorocyclobutane	c-C <sub>4</sub> F <sub>8</sub>	8700
Perfluoropentane	C <sub>5</sub> F <sub>12</sub>	7500
Perfluorohexane	C <sub>6</sub> F <sub>14</sub>	7400
Hydrofluorocarbons (HFC)		
HFC-23	CHF <sub>3</sub>	11700
HFC-32	CH <sub>2</sub> F <sub>2</sub>	650
HFC-41	CH <sub>3</sub> F	150
HFC-43-10mee	C <sub>5</sub> H <sub>2</sub> F <sub>10</sub> (structure: CF <sub>3</sub> CHFCHFCF <sub>2</sub> CF <sub>3</sub> )	1300
HFC-125	C <sub>2</sub> HF <sub>5</sub>	2800
HFC-134	C <sub>2</sub> H <sub>2</sub> F <sub>4</sub> (structure: CHF <sub>2</sub> CHF <sub>2</sub> )	1000
HFC-134a	C <sub>2</sub> H <sub>2</sub> F <sub>4</sub> (structure: CH <sub>2</sub> FCF <sub>3</sub> )	1300
HFC-143	C <sub>2</sub> H <sub>3</sub> F <sub>3</sub> (structure: CHF <sub>2</sub> CH <sub>2</sub> F)	300
HFC-143a	C <sub>2</sub> H <sub>3</sub> F <sub>3</sub> (structure: CF <sub>3</sub> CH <sub>3</sub> )	3800
HFC-152a	C <sub>2</sub> H <sub>4</sub> F <sub>2</sub> (structure: CH <sub>3</sub> CHF <sub>2</sub> )	140
HFC-227ea	C <sub>3</sub> HF <sub>7</sub> (structure: CF <sub>3</sub> CHFCF <sub>3</sub> )	2900
HFC-236fa	C <sub>3</sub> H <sub>2</sub> F <sub>6</sub> (structure: CF <sub>3</sub> CH <sub>2</sub> CF <sub>3</sub> )	6300
HFC-245ca	C <sub>3</sub> H <sub>3</sub> F <sub>5</sub> (structure: CH <sub>2</sub> FCF <sub>2</sub> CHF <sub>2</sub> )	560

Technical Guidance for Offset Protocol Developers can be downloaded from <http://environment.alberta.ca/03322.html>.