QUANTIFICATION PROTOCOL FOR SOLAR ELECTRICITY GENERATION

ABRIDGED

Submitted to:

Alberta Environment

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Disclaimer

The following document presents an abridged version of the Solar Electricity Generation Protocol prepared for Alberta Environment which has completed an initial round of technical review. This document has been prepared as a means of supporting a broader stakeholder consultation process. As such, this document should not be used as a quantification protocol.

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1.0 Project and Methodology Scope and Description

This protocol is applicable to the quantification of reductions in greenhouse gas (GHG) emissions resulting from the implementation of facilities that convert the energy in solar radiation into electrical energy as the end product. These cover several technologies and will be referred to simply as "solar electric facilities". The protocol quantifies the emission reductions based on the generation of an equivalent quantity of electricity from fossil fuel based sources, either at grid-connected or off-grid facilities. This quantification protocol is written for the solar electric facility project operator or project proponent. Some familiarity with, or general understanding of, the operation of a solar electric facility, and associated practices, is expected.

Under the project condition, solar electric facilities energize either loads connected to the electrical utility grid or to off-grid loads. The baseline condition includes the generation of electricity by other facilities linked to the electrical loads to cover the net generation capacity of the solar electric facility.

FIGURE 1.1: Project Element Life Cycle Chart

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

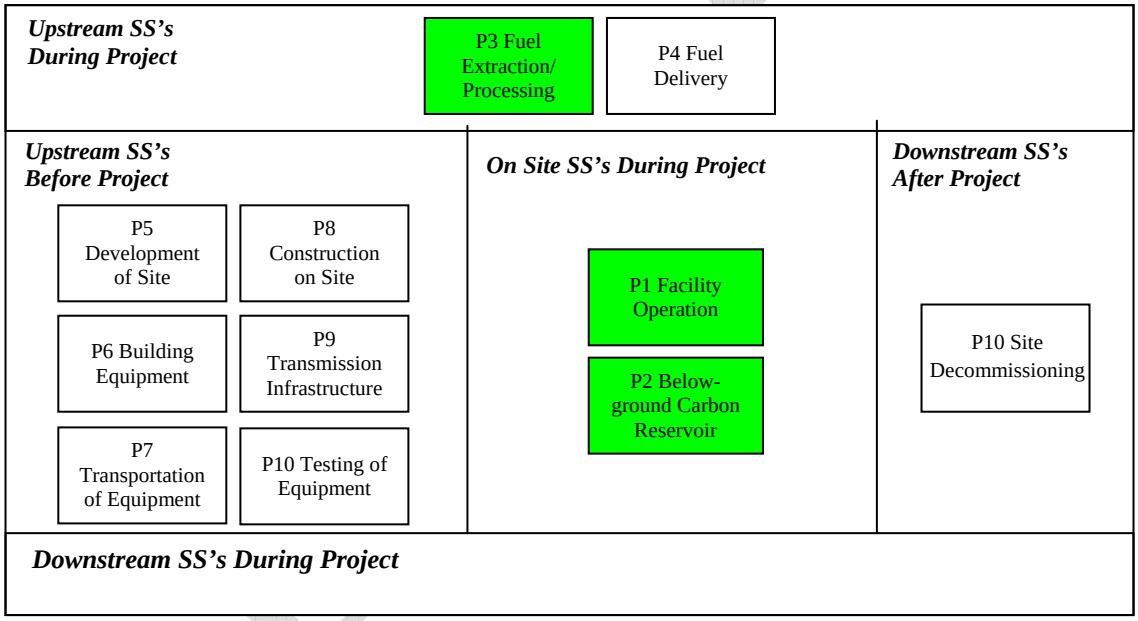
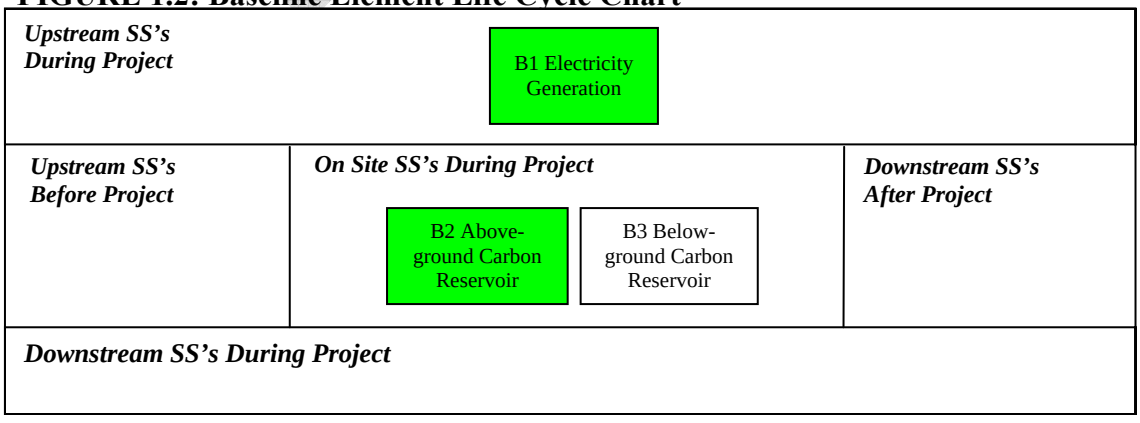


FIGURE 1.2: Baseline Element Life Cycle Chart



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

1. The metering of net electricity production must be made at a point downstream of both generation and any storage system, typically to where generated electricity is connected to its loads.
2. The solar electric project must meet the eligibility requirements for solar electric projects as set forth under the Environmental Choice program. Proof of compliance may be indicated by an attestation of project developer or confirmation by the EcoLogo program or with an audit/verification report prepared by a third party. Compliance with the certification criteria needs only be proven once through the life of the project; and
3. The quantification of reductions achieved by the project is based on actual measurement and monitoring (except where indicated in this protocol) as indicated by the proper application of this protocol.

It is important to understand that GHG emission reductions are one of many environmental benefits associated with renewable low-impact electricity generation. The aggregation of the environmental benefits of one megawatt-hour of renewable electricity generation are commonly referred to as 'green tags' and traded as Renewable Energy Certificates (RECs). To avoid the 'double counting' of the environmental benefits bundled in RECs and emission offsets, the electricity generation to which any traded RECs are associated with should not be included in the quantification of GHG offsets from an eligible project.

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

1. For off-grid projects, where the solar electric facility is connected by a dedicated line to its loads, site specific electricity generation emission factors, reflecting the source of generation displaced under the project condition, may be substituted for the generic electrical grid emission factors indicated in this protocol document. The methodology for generation of these emission factors must be sufficiently robust as to ensure reasonable accuracy; and
2. For projects where the land area cleared to make way for electrical energy generation is less than 1 hectare, onsite sink B2. Above-ground Carbon Reservoir can be excluded because of the negligible amount of canopy cleared.

If flexibility provisions have been applied, the proponent must describe the provisions used, and justify their application through a detailed methodology, calculations, and all supporting documentation.

2.0 Quantification of Identified Sources, Sinks and Reservoirs

These calculation methodologies serve to complete the following three equations for calculating the emission reductions from the comparison of the baseline and project conditions.

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

$$\text{Emissions}_{\text{Baseline}} = \text{Emissions}_{\text{Electricity Generation}} + \text{Sequestration}_{\text{Above-ground Carbon Reservoir}}{}^{1} * \text{Assurance Factor}$$

$$\text{Emissions}_{\text{Project}} = \text{Emissions}_{\text{Facility Operation}} + \text{Emissions}_{\text{Fuel Extraction and Processing}}$$

Where:

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

$\text{Emissions}_{\text{Electricity Generation}}$ = emissions under SS B1 Electricity Generation
$\text{Sequestration}_{\text{Above-ground Carbon Reservoir}}$ = Sequestration under SS B2 Above ground Carbon Reservoir
Assurance Factor = Factor which accounts for potential future reversal of sequestered carbon. Relevant assurance factors are provided in Appendix B.

$\text{Emissions}_{\text{Project}}$ = sum of the emissions under the project condition.
$\text{Emissions}_{\text{Facility Operation}}$ = emissions under SS P1 Facility Operations
$\text{Emissions}_{\text{Fuel Extraction and Processing}}$ = emissions under SS P4 Fuel Extraction and Processing

Note 1: Above-ground Carbon Reservoir may be excluded in the case described in the mechanisms outlined in Section 1. This calculation is only necessary for the first year of the project.

TABLE 1.1: Quantification Procedures

1.0 Project / Baseline SS	2. Parameter / Variable	3. Unit
Project SS's		
P1 Facility Operation	**Emissions $_{\text{Facility Operation}}$ = ∑ (Vol. Fuel $_{i}$ * EF Fuel $_{i\ CO2}$) ; ∑ (Vol. Fuel $_{i}$ * EF Fuel $_{i\ CH4}$) ; ∑ (Vol. Fuel $_{i}$ * EF Fuel $_{i\ N2O}$); ∑ (Mass HFC $_{i}$ / HCFC $_{i}$ * EF $_{HFC\ i}$)**	
	Emissions $_{\text{Facility Operation}}$	kg of CO_2 ; CH_4 ; N_2O
	Volume of Each Type of Fuel / Vol Fuel $_{i}$	L, m^3 or other
	CO_2 Emissions Factor for Each Type of Fuel / EF Fuel $_{i\ CO2}$	kg CO_2 per L, m^3 or other
	CH_4 Emissions Factor for Each Type of Fuel / EF Fuel $_{i\ CH4}$	kg CH_4 per L, m^3 or other
	N_2O Emissions Factor for Each Type of Fuel / EF Fuel $_{i\ N2O}$	kg N2O per L, m^3 or other
	Mass of Each Type of Refrigerant / Mass or HFCs and HCFCs	kg HFC_i and/or kg of HCFCi
	Global Warming Potential for Each Type of HFC and/or HCFC / EF $_{HFC\ i}$	kg CO_{2e} per kg HFC_i and/or $HCFC_i$ consumed
P4 Fuel Extraction and Processing	**Emissions $_{\text{Fuel Extraction / Processing}}$ = ∑ (Vol. Fuel $_{i}$ * EF Fuel $_{i\ CO2}$) ; ∑ (Vol. Fuel $_{i}$ * EF Fuel $_{i\ CH4}$) ; ∑ (Vol. Fuel $_{i}$ * EF Fuel $_{i\ N2O}$)**	
	Emissions $_{\text{Fuel Extraction / Processing}}$	kg of CO2e
	Volume of Each Type of Fuel Combusted for P1 and P2 / Vol $_{\text{Fuel i}}$	m^3
	Including CO_2 Emissions Factor for Fuel Production and Processing / EF Fuel $_{i\ CO2}$	kg CO_2 per m^3
	CH_4 Emissions Factor for Each Fuel Including Production and Processing / EF Fuel $_{i\ CH4}$	kg CH_4 per m^3
	N_2O Emissions Factor for Each Fuel Including Production and Processing / EF Fuel $_{i\ N2O}$	kg N2O per m^3
Baseline SS's		
B1 Electricity Generation	**Emissions $_{\text{Electricity Generation}}$ = Electricity * EF $_{\text{Elec}}$**	
	Emissions $_{\text{Electricity}}$	kg of CO2e
	Incremental Electricity Exported from the Project Site / Electricity	kWh
	Emissions Factor for Electricity / EF $_{\text{Elec}}$	kg of CO2e per kWh
B2 Above-ground Carbon Reservoir [1]	**Sequestration $_{\text{Above-ground Carbon Reservoir}}$ = Vol. $_{\text{Biomass Harvested}}$* Expansion Factor $_{\text{Biomass}}$ * Conversion Factor $_{\text{C-CO2}}$**	
	Sequestration $_{\text{Above-ground Carbon Reservoir}}$	kg of CO_{2e}
	Volume of Above Ground Biomass Harvested / Vol. $_{\text{Biomass Harvested}}$	m^3
	Biomass Expansion Factor / Expansion Factor $_{\text{Biomass}}$	kg of Carbon per m^3
	Conversion factor for Carbon to Carbon Dioxide / Conversion Factor $_{\text{C-CO2}}$	-

Note 1: Above-ground Carbon Reservoir may be excluded in the case described in the mechanisms outlined in Section 1. This calculation is only necessary for the first year of the project.

APPENDIX A: Glossary of New Terms

Above-ground Carbon Reservoir:

Is the total amount of carbon held above ground in the terrestrial biosphere, which was transferred from the atmospheric carbon reservoir through photosynthesis. For example, all parts of a tree seen above ground (canopy, trunk) are considered part of the above-ground carbon reservoir.

Below-ground Carbon Reservoir:

Is the total amount of carbon held below ground in the terrestrial biosphere, which was transferred from atmospheric carbon reservoir through photosynthesis. For example, the root system of a tree and compacted detritus would be considered part of the below-ground carbon reservoir.

Electricity Grid: Infrastructure that transports electrical energy from generating plants to the end users through long-distance high-voltage transmission systems between the generators and distribution systems, and lower-voltage distribution systems that transport the energy to nearby individual customers.

Solar Electric Facility: A facility consisting of all solar electrical energy generating, conversion, storage, and management equipment, sub-systems, and their connections up to the point where the generating system connects to its AC or DC loads or to the electricity grid. Solar photovoltaic (PV) facilities can include the solar PV array, any optical concentrating, tracking and mounting equipment, Direct Current (DC) to DC charge controllers, batteries of electrochemical or other energy storage cells, disconnecting means, current management means, wiring, DC to Alternating Current (AC) conversion devices, and AC to DC conversion devices. Solar thermal-electric facilities can include any optical concentrating, tracking and mounting equipment, heat collecting towers, heat transfer, pumping and storage sub-systems, steam generators, steam or air turbines, rotating electricity generators, system controls and converters, and staff operating buildings