Electricity Emission Intensity Factor Methodology

1. Purpose and Applicability

A consistent, robust, and transparent way to calculate the greenhouse gas (GHG) emission intensity of electricity for the purposes of:

- Liquefied natural gas operations complying with *Greenhouse Gas Industrial Reporting and Control Act* requirements regarding use of grid electricity;
- Public sector organizations complying with carbon-neutral government requirements under the *Greenhouse Gas Emissions Targets Act*
- Local governments and communities in meeting their obligations under the Climate Action Charter;
- Offset projects as prescribed in relevant protocols;
- Other customers of BC Hydro and FortisBC who wish to calculate the GHG emissions associated with their electricity use.

2. Methodology

Electricity in BC, depending on geographical location (see maps in **Appendix A**), is supplied to customers either through the integrated grid, the Fort Nelson grid, or through community generating stations for isolated grid communities. Self-generated electricity for single family use as well as for industrial use is outside the scope of this document.

The Director must establish an emission intensity factor applicable to grid electricity for year Y ("Applicable EF^Y") for each calendar year, for the integrated grid and the Fort Nelson grid.

In year Y the most recent data available to the Director is from year Y-1, available in the fall of year Y. The Director can publish the Applicable EF^Y in late year Y. For example, in establishing the EF for year 2017, the most recent emission and generation data, available in the fall of 2017, is for year 2016.

In order to smooth out year-to-year variability in generated and imported electricity and associated emissions due to variability in water inflows and trading markets, a three-year running average based on the most recent three years of available data is calculated.

2.1 Integrated grid

Southern BC is covered by an electrical transmission grid with electricity supplied by BC Hydro and Fortis BC; it is connected to the Western United States and Alberta electrical grids. The integrated grid (also known as the "BC Hydro grid") has multiple generating sources of electricity, including imports, of varying emission intensity. Since it is not possible to identify GHG emissions associated with specific electrons, a grid-wide emission intensity factor, calculated and published by the Director, is used in calculating GHG emissions attributable to that electricity.

The general formula for calculating the integrated grid electricity emission intensity factor is as follows:

$$EF_{IntGrid} = \frac{GHG_{gen} + GHG_{imp}}{MWh_{gen} + MWh_{imp} - MWh_{TDLoss}} \quad (1.1)$$

Where

GHG_{gen} = the emissions, in tonnes of carbon dioxide equivalent (tCO_2e), attributable to electricity generation of electricity supplied to the integrated grid from facilities located in British Columbia[1];

GHG_{imp} = the emissions, in tCO2e, attributable to electricity generation of electricity imported into British Columbia and supplied to the integrated grid;

MWh_{gen} = the amount of electricity, in MWh, supplied to the integrated grid from facilities located in British Columbia;

MWh_{imp} = the amount of electricity, in MWh, imported into British Columbia and supplied to the integrated);

MWh_{TDLoss} = the amount of electricity, in MWh, lost in the course of transmission and distribution of electricity to customers on the integrated grid.

Transmission and distribution losses are estimated as:

$$MWh_{TDLoss} = r_{TDL} \times (MWh_{gen} + MWh_{imp}) \quad (1.2)$$

Where $r_{TDL} = 0.1$ is a BC-average transmission and distribution loss factor.

[1] Not including electricity generated for the facility's own use.

Note that:

$$GHG_{gen} = GHG_{BCH_{own}} + GHG_{IPP} + GHG_{FBC} + GHG_{CRT} - GHG_{SS} \quad (1.3)$$

Where

$GHG_{BCH_{own}}$ = the emissions attributable to electricity generation from BC Hydro-owned generation supplying electricity to the integrated grid;

GHG_{IPP} = the emissions attributable to electricity generation from several categories of independent power producers supplying electricity to the integrated grid;

GHG_{FBC} = the emissions attributable to electricity generation from FortisBC generation connected to the integrated grid;

GHG_{CRT} = the emissions attributable to electricity generation from the Columbia River Treaty entitlements (= 0).

GHG_{SS} = the emissions attributable to electricity generated for specified sales. A specified sale is a transaction for the export of electricity outside of British Columbia, in which that transaction must identify the electricity generating facility or sub-facility, located in British Columbia, as the source of the electricity.

Similarly,

$$MWh_{gen} = MWh_{BCH_{own}} + MWh_{IPP} + MWh_{FBC} + MWh_{CRT} - MWh_{SS} \quad (1.4)$$

Where

$MWh_{BCH_{own}}$ = the amount of electricity supplied to the integrated grid from BC Hydro's owned generation;

MWh_{IPP} = the amount of electricity supplied to the integrated grid from several categories of independent power producers supplying electricity to the integrated grid;

MWh_{FBC} = the amount of electricity supplied from FortisBC generation connected to the integrated grid;

MWh_{CRT} = the amount of electricity supplied to the integrated grid from the Columbia River Treaty entitlements.

MWh_{SS} = the amount of electricity generated for specified sales. A specified sale is a transaction for the export of electricity outside of British Columbia, in which that transaction must identify the electricity generating facility or sub-facility, located in British Columbia, as the source of the electricity.

For year Y, the applicable $EF^{Y}_{IntGrid}$ as a three-year running average based on the most recent three years of available data is:

$$\text{Applicable } EF^{Y}_{IntGrid} = \sum_{n=Y-3}^{Y-1} \left\{GHG^{n}_{BCH_{own}} + GHG^{n}_{IPP} + GHG^{n}_{FBC} + GHG^{n}_{imp} + GHG^{n}_{CRT} - GHG^{n}_{SS}\right\} \Big/ \sum_{n=Y-3}^{Y-1} \left\{MWh^{n}_{BCH_{own}} + MWh^{n}_{IPP} + MWh^{n}_{FBC} + MWh^{n}_{imp} + MWh^{n}_{CRT} - MWh^{n}_{SS} - MWh_{TDLoss}\right\} \quad (1.5)$$

2.2 Fort Nelson grid

Northeast BC has its own grid which is connected to Alberta's electricity grid. It is not connected to the integrated grid. The region's electricity is supplied by the Fort Nelson generating station and imports from the Alberta grid (denoted below with the "*impAB*" subscript).

The general formula for calculating the Fort Nelson grid electricity emission intensity factor is as follows:

$$EF_{FNgrid} = \frac{GHG_{genFN} + GHG_{impAB}}{MWh_{genFN} + MWh_{impAB} - MWh_{TDLoss}} \quad (2.1)$$

Where

GHG_{genFN} = the emissions, in tonnes of carbon dioxide equivalent (tCO_2e), attributable to electricity generation of electricity supplied to the Fort Nelson grid by the Fort Nelson generating station[2];

GHG_{impAB} = the emissions, in tCO2e, attributable to electricity generation of electricity imported into British Columbia from the Alberta grid and supplied to the Fort Nelson grid;

MWh_{genFN} = the amount of electricity, in MWh, supplied to the Fort Nelson by the Fort Nelson generating station;

MWh_{impAB} = the amount of electricity, in MWh, imported into British Columbia from Alberta and supplied to the Fort Nelson grid;

$MWh_{TDLossFN}$ = the amount of electricity, in MWh, lost in the course of transmission and distribution of electricity to customers on the Fort Nelson grid.

Transmission and distribution losses are estimated as:

$$MWh_{TDLossFN} = r_{TDL} \times (MWh_{genFN} + MWh_{impAB}) \quad (1.2)$$

Where $r_{TDL} = 0.1$ is a BC-average transmission and distribution loss factor.

[2] Not including electricity generated for the facility's own use.

For year Y, the applicable EF^{Y}_{FNgrid} as a three-year running average based on the most recent three years of available data is:

$$\text{Applicable } EF^{Y}_{FNgrid} =$$

$$= \sum_{n=Y-3}^{Y-1} \left\{GHG^{n}_{genFN} + GHG^{n}_{impAB}\right\} \Big/ \sum_{n=Y-3}^{Y-1} \left\{MWh^{n}_{genFN} + MWh^{n}_{impAB} - MWh_{TDLossFN}\right\} \quad (2.2)$$

2.3 Isolated grids

Localized/community electricity generation which is not connected to either the integrated grid or the Fort Nelson grid is typically diesel-fired. Electricity EF must be calculated for each local generator following the methodology for general stationary combustion by fuel in WCI.20. Typically this would mean using default HHV or default fuel EF, values of which listed by fuel in Tables 20-1, 20-1a, 20-1a, 20-2, 20-3, 20-5, or 20-7, as applicable.

For example, from WCI 23 for CO_2 emissions:

(a) Calculation Methodology 1. Calculate the annual CO_2 mass emissions for each type of fuel by substituting a fuel-specific default CO_2 emission factor, a default high heat value, and the annual fuel consumption into Equation 20-1 or 20-1a:

$$CO_2 = Fuel \times HHV \times EF \times 0.001 \qquad \textbf{Equation 20-1}$$

$$CO_2 = Fuel \times EF_c \times 0.001 \qquad \textbf{Equation 20-1a}$$

Where:

CO_2	=	Annual CO_2 mass emissions for the specific fuel type (tonnes).
Fuel	=	Mass or volume of fuel combusted per year (express mass in tonnes for solid fuel, volume in standard cubic meters for gaseous fuel, or volume in kilolitres for liquid fuel).
HHV	=	Default high heat value of the fuel, from Table 20-1 and 20-1a (GJ per tonne for solid fuel, GJ per kilolitre for liquid fuel, or GJ per cubic meter for gaseous fuel).
EF	=	Fuel-specific default CO_2 emission factor, from Tables 20-1a, 20-2, 20-3, 20-5, or 20-7, as applicable (kg CO_2/GJ).
EFc	=	Fuel-specific default CO_2 emission factor, from Tables 20-2 or 20-5 (kg CO_2 per tonne for solid fuel, kg CO_2 per kilolitre for liquid fuel, or kg CO_2 per cubic meter for gaseous fuel)
0.001	=	Conversion factor from kilograms to tonnes.

The rules listed in WCI.23 including WCI.23(e) "Use of the Four CO2 Calculation Methodologies" and in WCI.24 "Calculation of CH4 and N2O Emissions" must be followed.

Appendix A: BC Electrical transmission system

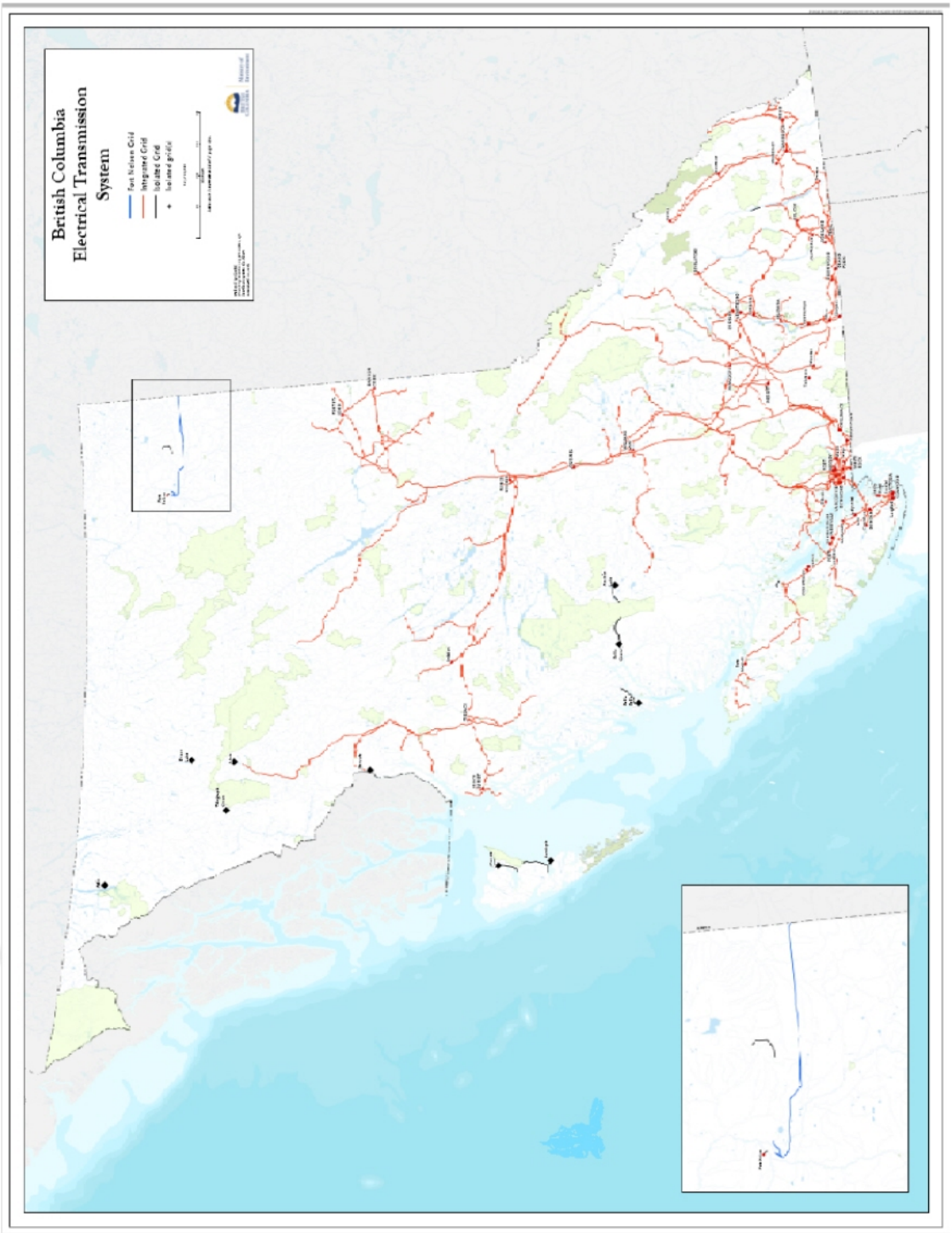

Figure 1: BC-wide map showing the integrated grid, the Fort Nelson grid and some isolated grid communities.

Figure 2: The general FortisBC portion of the integrated grid in southeast BC.

INTEGRATED GRID	GHG Emissions (t CO2e) 2014	2015	2016	2017	Electricity Generation (GWh) 2014	2015	2016	2017	
BCHydro own	22,197	16,056	11,550	714	s.17				(includes T&D losses)
FortisBC own	-	-	-	-					
IPPs (BCH + FBC)	s.17								
Imports (BCH+FBC)	2,148,845	752,029	1,018,537	1,180,580					
CRT	-	-	-	-					
Specified Sales	s.17								Subtracting these from the above
T&D Losses									
Grand TOTAL excluding T&D losses	2,831,336	1,435,897	1,678,707	1,773,158					
			5,945,940	4,887,762					

	2017	2018
Director's Electricity EF for Integrated Grid:	31.7	25.3

each year:	47.1	22.6	26.4
w/o imports:	12.5	11.3	11.1

FORT NELSON GRID	2014	2015	2016	2017	2014	2015	2016	2017	
BCH own (FNGen)	119,630	114,277	67,068	24,912	s.17				(includes T&D losses)
Imports from Alberta	s.17								
T&D Losses									Subtracting from the above
Grand TOTAL excluding T&D losses	128,082	124,507	109,759	105,169					
			362,348	339,436					

	2017	2018
Director's Electricity EF for Fort Nelson Grid:	559	572

Type	GHG Emissions (t CO_2e)				Net Electricity Generation (GWh) (including transmission losses)			
	2014	2015	2016	**2017**	2014	2015	2016	**2017**
Specified Sales	s.17							
Specified Sources								
Unspecified Sources (not incl. AB->FN)								
Columbia River Treaty								
Imports from AB to Fort Nelson grid (unspecified sources)								

Company	Type_of_Operation	Facility_Name	Report_Number	Process_Name	Specified Source Emission	Specified Emission Quantity	Unspecified Source Emiss	Unspecified Emission Quantit	EIO Total E	EIO Total Emissions	FACILITY_ID	REPORT_ID	ACTIVE_IND	REPORTING_YEAR
FortisBC Inc.	EIO	Warfield Control Centre	2825	ElectricityImportOperation	Emissions from specified s	s.17	Emissions from unspecifie	s.17	EIO Total E	88,428	58	26831	Y	2013
FortisBC Inc.	EIO	Warfield Control Centre	4139	ElectricityImportOperation	Emissions from specified s		Emissions from unspecifie		EIO Total E	72,946	58	27073	Y	2012
FortisBC Inc.	EIO	Warfield Control Centre	5616	ElectricityImportOperation	Emissions from specified s		Emissions from unspecifie		EIO Total E	48,967	58	30054	Y	2014
Powerex Corp.	EIO	Powerex EIO	4248	ElectricityImportOperation	Emissions from specified s		Emissions from unspecifie		EIO Total E	1,253,491	697	27182	Y	2013
Powerex Corp.	EIO	Powerex EIO	2260	ElectricityImportOperation	Emissions from specified s		Emissions from unspecifie		EIO Total E	1,084,554	697	26323	Y	2012
Powerex Corp.	EIO	Powerex EIO	8535	ElectricityImportOperation	Emissions from specified s		Emissions from unspecifie		EIO Total E	2,099,878	697	30147	Y	2014

FortisBC EIO Emissions (tonnes)

Company	Year	SSE	UnSE	Total Emissions	GWh Imported
FortisBC	2011	s.17		59,184	s.17
FortisBC	2012			72,946	
FortisBC	2013			88,428	
FortisBC	2014			48,967	
FortisBC	2015			30,507	
FortisBC	2016			42,217	
	2017			59,411	

Columbia Criver Treaty (CRT)	Fortis EIO 2016 MWh
Canadian Entitlement Agreement (CEA)	s.17
Libby Coordination Agreement (*LCA*)	

2017

s.17

Powerex EIO Emissions (tonnes) - Integrated Grid only

Company	Year	SSE	UnSE	Total	GWh Imported
Powerex	2011	s.17		1,877,145	s.17
Powerex	2012			1,084,554	
Powerex	2013			1,253,491	
Powerex	2014			2,099,878	
Powerex	2015			721,522	
Powerex	2016			976,320	

	CRT (GWh)	CEA	LCA
2011	s.17		
2012			
2013			
2014			
2015			
2016			

Provincial EIO Emissions (tonnes) - Integrated Grid only

Year	SSE	UnSE	Total tCO2e	GWh Imported
2011	s.17		1,936,329	s.17
2012			1,157,500	
2013			1,341,919	
2014			2,148,845	
2015			752,029	
2016			1,018,537	
			7,336,621	
			4,242,793	

Year	
2011	
2012	
2013	
2014	
2015	
2016	
	2011-2016 average
	2013-2015 (3-yr) average