SITE C CLEAN ENERGY PROJECT

RESPONSE TO WORKING GROUP AND PUBLIC COMMENTS ON THE SITE C CLEAN ENERGY PROJECT ENVIRONMENTAL IMPACT STATEMENT

Technical Memo

GREENHOUSE GAS EMISSION MERITS OF THE PROJECT

MAY 8, 2013

Subject: Greenhouse Gas Emission Merits of the Project

Purpose and Key Findings

This memorandum explains the merits of the Site C Clean Energy Project (Project) for the generation of electricity as this relates to greenhouse gas (GHG) emissions during all phases of the Project.

Carbon emission intensity measures the average emissions based on the amount of electricity produced. Carbon intensity is an appropriate way to compare the greenhouse gas emissions of different electricity generating technologies, including fossil fuel electricity generation (e.g. coal, natural gas) and renewable electricity generation (e.g. hydroelectric, wind and solar).

The carbon intensity over the life of the Project, is predicted to be low compared with that of fossil fueled electrical power generation. It is similar in magnitude to those reported for wind turbine facilities. The GHG emissions associated with the Project would be small when compared to provincial, national and global emissions, and on average over the life of the Project are considered low in the context of CEA Agency guidance.

Background on Hydroelectric GHG Emissions

In the context of increasing global energy demand and global climate change, evaluating generating facilities by their emissions (g CO_2e) per unit of energy generated (kWh) is an important relative measure when evaluating the potential contribution of a project to climate change.

With respect to electricity generating facilities, absolute emissions should not be directly compared among facilities because the output, or electricity production of each facility is different; some plants produce large amounts of electricity per year, and some plants produce much less. Therefore the most appropriate way to compare electricity generating facilities is to compare the relative emissions per unit energy produced (g CO_2e/kWh).

Hydroelectric development has been criticized[1,2,3,4] as a potentially important net source of GHGs. These concerns may be justified in some circumstances, primarily in tropical environments where there is evidence that some hydroelectric reservoirs are large sources of methane (CH_4) emissions. However, these concerns are not applicable to all hydroelectric facilities. Evidence has shown that hydroelectric reservoirs in northern (i.e., temperate and boreal) environments emit lower quantities of GHG (i.e., g CO_2e/m^2/yr) emissions than tropical reservoirs[4].

Furthermore, the physical characteristics of the area impounded by the reservoir influences the potential net emissions, and therefore the emission intensity of a hydroelectric facility. First, reservoirs that occupy relatively small areas in relation to their generating output typically emit fewer GHGs than

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1 St. Louis, V.L., Kelly, C.A., Duchemin, E., Rudd, J.W., and Rosenberg, D.M. 2000. Reservoir surfaces as sources of greenhouse gases to the atmosphere: A global estimate. BioScience Vol. 50(9), pp. 66-775.

2 Fernside, P.M. 2004. Greenhouse gas emissions from hydroelectric dams: controversies provide a springboard for rethinking a supposedly ‘clean’ energy source. An editorial comment. Climatic Change, ol. 66, pp. 1-8.

3 International Rivers Network (IRN). 2006. Fizzy Science. Loosening the Hydro Industry’s Grip on Reservoir Greenhouse Gas Emissions Research. 24 pp. Accessed October 2008 from www.irn.org.

4 Li, S. and Lu., X. X. 2012. Uncertainties of carbon emission from hydroelectric reservoirs. Nat. Hazards, Vol. 62, pp. 1343-1343, doi: 10.1007/s11069-012-0127-3.

those that flood relatively large areas. Further, cold, deep and well oxygenated systems, such as is the case for the reservoir area for the Project, typically emit carbon primarily in the form of CO_2 rather than CH_4. [5] The ratio of these gases is approximately 100:1 for boreal reservoirs, whereas it may be closer to 20:1 for tropical reservoirs[4].

Estimate of Project GHG Emissions

Construction phase GHG emissions were estimated by accounting for emissions from fuel combustion and electricity consumption associated with construction activities, and emissions associated with materials that would be used in the construction of the Project, for example, concrete, steel, stainless steel, aluminum and copper, also known as life cycle emissions.

Operating phase GHG emissions were estimated by accounting for emissions from vegetation removed for the reservoir and land clearing activities, and for net emissions from the reservoir area over a 100-year period. Following methods described by the Intergovernmental Panel on Climate Change (IPCC, 2003) a detailed carbon model was developed to account for the substantive carbon stocks, processes and fluxes relevant to the Project, for both current and Project conditions. Two Project scenarios were modeled, reflecting a conservative and likely scenario for the emissions associated with the removed vegetation.

Results

To calculate emission intensity the average annual GHG emissions (averaged over the 108-year construction and operation phase) is divided by the average annual electricity produced by the Project. As shown in Table 15.11, Section 15 in the EIS (table below), using the results of two Project model scenarios and including embedded carbon, the Project would produce between 10.5 and 14.3 grams of CO_2e per kilowatt hour of electricity produced. Approximately 20% of total emissions would be associated with construction activities, and the remaining emissions would be associated with the operating phase emissions, including all land clearing. These emissions are low when compared to emission estimates for various fossil fuel generating options, such as modern coal plants (1,000 g CO2e/kWh), diesel (717 g CO2e/kWh), or natural gas combined cycle (545 g CO2e/kWh). Further, these values are also at the low end of the range for other Canadian boreal hydroelectric stations.

As shown in Figure 10.2, Volume 2, Appendix S in the EIS (figure below), annual operating phase emissions would be highest in the early years, and would return to near current conditions within 20 years. High early year emissions are due to the emissions from land clearing, and the initial flux of GHG from the reservoir itself. On an annual basis, values would range from 212g CO2e/kWh (year 1) in the conservative scenario, to 2g CO2e/kWh (years 35 to 100) in both the conservative and the likely scenario.

[5] Tremblay, A., Bastien, J. Bonneville M., del Giorgio, P., Demarty, M., Garneau, M., Hélie, J., Pelltier, L., Prairie Y., Roulet, N., Stachan, I., and Teodoru, C. 2010. Émissions nettes de gaz à effet de serre au réservoir Eastmain 1 Québec, Canada. In: Congrès Mondial de l'Énergie, Montréal, Québec, September 12-16, 2010.

Table 1 Emissions Intensity – Project Compared with Other Generation

Generating Facility Type	Range (g CO_2e/kWh)	Average (g CO_2e/kWh)
Tropical Hydroelectric	1,750 – 2,700	2,150
Modern Coal	959 – 1,042	1,000
IGCC (coal)	763 – 833	798
Diesel	555 – 880	717
NGCC (Natural Gas)	469 – 622	545
Photovoltaic	13 – 104	58
Canada Boreal Hydroelectric	8 – 60	36
Wind Turbines	7 – 22	14
BC Hydro Site C (construction plus conservative operations estimate)	—	14.3 [a]
BC Hydro Site C (conservative operations estimate)	2 – 212 (annual range) [b]	11.4 [c]
BC Hydro Site C (construction plus likely operations estimate)	—	10.5 [a]
BC Hydro Site C (likely operations estimate)	2 – 146 (annual range)	8.5 [c]

NOTES:

[a] Average emission intensity over 8 year construction and 100 year operating period.

[b] Figure 1 shows annual operating phase emissions would be highest at the outset and decline to low annual emission rate within 20 years

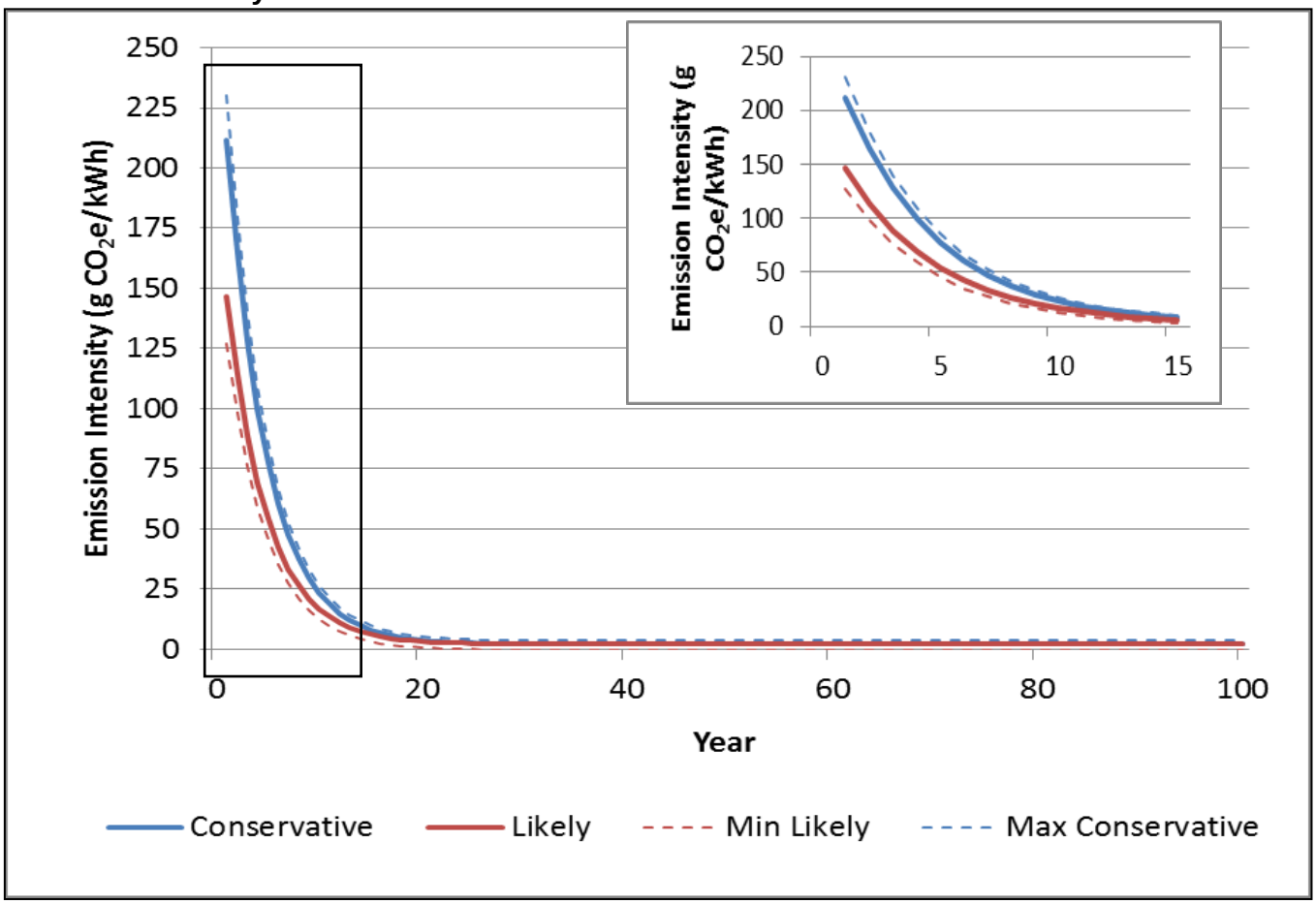
[c] Average emission intensity over 100 year operating period.

Intensities for Modern Coal, IGCC (coal), Diesel, NGCC (Natural Gas), Photovoltaic, and Wind Turbines include life cycle emissions. See IRN 2006. Intensities for Boreal and Tropical Hydroelectric facilities include only reservoir emissions.

— not available, however operating year 1 – 100 would be as shown for operations estimates

Source: IRN 2006

Figure 1 Emissions Intensity, Conservative and Likely Model Scenarios with Sensitivity Analysis



Significance of Project Emissions

Overall, the Project will result in a net benefit from a GHG perspective, producing electricity with substantially lower GHG emissions compared to other forms of firm electricity generation, and by supporting the integration of other low emission, renewable intermittent resources into the BC Hydro system. GHG emissions from construction and operation of the Project would not be considered significant, as they would represent about 0.2% and 0.01% of provincial and national annual GHG emissions respectively. Furthermore, when compared to other electricity generation sources, Project emissions per unit of energy are as low as wind or solar electricity generation and are less than 2% of emissions from gas or diesel generation, and less than 1% of emissions from coal generation.

While the construction and operation of the Site C reservoir and generating stations would result in a net increase in GHG emissions within the Project area itself, these would be considered “low” under the scoping considerations of the Canadian Environmental Assessment Agency Guidance[6].

[6] Canadian Environmental Assessment Agency. 2003. Incorporating climate change considerations in environmental assessment: general guidance for practitioners. Accessed December 2008 from http://www.ceaa.gc.ca/012/014/index_e.htm .

Cumulative Significance of Project Emissions in the Context of Global Emissions

Cumulative effects associated with releases of GHG emissons to the atmosphere are not limited to provincial or national borders, therefore it is appropriate to consider the Project emissions in combination with global emissions when assessing cumulative effects.

The Project's net GHG emission would be a tiny fraction of global GHG emissions, however the scientific community considers the existing and expected future global GHG emissions associated with other activities to already be significant. Therefore the cumulative effects of GHG emissions, because of global emissions, are considered significant. This rating reflects the existing emission context, globally, even in the absence of the Project.

Related Comments / Information Requests:

This technical memo provides information related to the following Information Requests:

pub_0202-001	pub_0203-001	pub_0577-001	pub_0706-001	pub_0714-001
pub_0855-001	pub_0856-001	pub_0892-001	pub_0897-001	pub_0922-001
pub_0985-001	ab_0007-003	ab_0007-004		