APPENDIX



# METHODOLOGY FOR CALCULATING GHG INTENSITIES

## Introduction

Many different methodologies could be used to calculate emissions intensity. This appendix details how the intensities could be calculated to fairly show differences in corporate choices and environmental social governance (ESG). The methodologies are not the same as would be used by governments to assess compliance under climate legislation against their own emissions intensity benchmarks.

The work uses only publically available datasets, or datasets that can be requested under the Freedom of Information and Protection of Privacy Act (FOIP). It is the goal of this work to use datasets that anyone could access to evaluate emissions intensities. Whenever possible, consideration is given to both Scope 1 emissions (generated at a facility location) as well as Scope 2 emissions (emissions associated with imported quantities of electricity or heat).

For oil sands operations and offshore oil production, individual facility data was used to generate intensities. To obtain a sector average, the production weighting of facility intensities was used.

For conventional oil and natural gas operations, a top-down approach is taken whereby the sector is evaluated as a whole rather than evaluating individual facility intensities. The reasons for this approach are discussed in section 5.

Issues and data gaps in public data are to be expected. When data issues are encountered, CAPP will take reasonable efforts to notify appropriate parties. CAPP takes no responsibility for reported data.

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## I. Introduction

There are many different methodologies that could be used to calculate greenhouse gas (GHG) emissions intensity. This document details how the intensities could be calculated to fairly show differences in corporate choices and environmental social governance (ESG). The methodologies are not the same as would be used by governments to assess compliance under climate legislation against their own GHG intensity benchmarks.

The work uses only publically available datasets, or datasets that can be requested under the Freedom of Information and Protection of Privacy Act (FOIP). It is the goal of this work to use datasets that anyone could access to evaluate GHG intensities. Whenever possible, consideration is given to both Scope 1 emissions (generated at a facility location) as well as Scope 2 emissions (emissions associated with imported quantities of electricity or heat).

For oil sands operations and offshore oil production, individual facility data was used to generate intensities. To obtain a sector average, the production weighting of facility intensities was used.

For conventional oil and natural gas operations, a top-down approach is taken whereby the sector is evaluated as a whole rather than evaluating individual facility intensities. The reasons for this approach being chosen are discussed in Section V.

It is expected that there will be issues and data gaps when using the public data. When data issues are encountered, CAPP will take reasonable efforts to notify appropriate parties. CAPP takes no responsibility for reported data.

## II. In-Situ Oil Sands

When calculating GHG intensity, three potential facility configurations must be considered and the formula for GHG intensity adjusted for each scenario:

a) Facility importing electricity from the Alberta electricity grid
b) Facility with integrated cogeneration
c) Facility importing electricity from a third-party cogeneration facility

### a. Facility Importing Electricity from the Alberta Electricity Grid

A number of facilities import electricity from the Alberta electricity grid. The GHG emissions associated with this electricity are higher than with self-produced electricity and should be accounted for accordingly when comparing facilities by GHG intensity. Therefore it is recommended that the annual consumption grid intensity be used. In 2019, this value for Alberta was 0.680 t/MWh according to Canada's National Inventory Report Part 3. The following formula is recommended for calculating GHG intensity:

$$GHG_{intensity} = \left(\frac{TDE + E_{consumed} * EF_{grid}}{Production_{Bitumen}}\right)$$

Where,

*TDE–Total direct facility emissions ($tCO_2e$)including cogeneration*
*$E_{consumed}$ – Electricity consumed for bitumen production in MWh*
*$EF_{grid}$ – Grid electricity emission factor*

### b. Facility with Integrated Cogeneration

Many in situ oil sands facilities employ onsite cogeneration for electricity and heat needs as well as for electricity export to the Alberta electricity grid. Emissions associated with electricity export should not be included when calculating GHG intensity of the in situ operation.

The following formula is recommended for calculating GHG intensity for facilities with integrated cogeneration that are net exporters of electricity:

$$GHG_{intensity} = \left(\frac{TDE + (E_{consumed} - E_{gen}) * EF_E}{Production_{Bitumen}}\right)$$

Where,

*TDE – Total direct facility emissions ($tCO_2e$)including cogeneration*
*$E_{consumed}$ – Electricity consumed for bitumen production in MWh*
*$E_{gen}$ – Electricity generated on site in MWh*
*$EF_E$ – Electricity emission factor calculated as:*

$$EF_E = \left(\frac{GHG_{cogen} - H_{cogen} * EF_H}{E_{gen}}\right)$$

Where,

*$GHG_{cogen}$ – Tonnes of GHG from cogeneration*
*$H_{cogen}$ – Heat in GJ produced by cogeneration*
*$EF_H$ – Heat emission factor-recommend 0.06299 $tCO_2e/GJ$*

The following formula is recommended for calculating GHG intensity for facilities with integrated cogeneration that are net exporters of electricity:

$$GHG_{intensity} = \left(\frac{TDE + (E_{consumed} - E_{gen}) * EF_{grid}}{Production_{Bitumen}}\right)$$

### c. Facility Importing Electricity from a Third-party Cogeneration Facilit

Some facilities import electricity and heat from a third-party cogeneration facility. In this circumstance, the cogeneration facility and the in situ facility should be treated as a single integrated site for the purposes of calculating GHG intensity. Currently, only one in-situ facility is importing heat and electricity from a third-party cogeneration facility – Suncor MacKay River. The cogeneration facility associated with this facility is the ATCO MacKay River Cogeneration facility. The same equation is recommended for an integrated cogeneration facility applies, however, in this case, TDE includes both the in situ direct emissions and the cogeneration emissions.

$$GHG_{intensity} = \left(\frac{TDE + (E_{consumed} - E_{gen}) * EF_E}{Production_{Bitumen}}\right)$$

### d. Data Sources

| | Data Source | Data Source |
|---|---|---|
| Total Emissions TDE ($tCO_2e$), Cogen Emissions ($tCO_2e$), Cogen Heat (GJ), Cogen Elec. Generated (MWh) | https://open.alberta.ca/opendata/alberta-oil-sands-greenhouse-gas-emission-intensity-analysis | Posted on AEP website for 2011-2019. |
| Bitumen Production | https://www.aer.ca/providing-information/data-and-reports/statistical-reports/st53.html | Updated monthly |
| Electricity Consumption (MWh), Net Electricity Import (MWh) | By request through Alberta Environment and Parks | Publicly available, but requires request. CAPP requests annually. |
| AB grid electricity consumption intensity (t/MWh) | https://unfccc.int/documents/271493 | NIR 2021 Part 3 Annex 13, Table A13-10 |

## III. Oil Sands Mining

Currently there are six oil sands mining operations. Of these six operations, three are stand-alone and three are integrated with upgraders. Suncor's Fort Hills mine is the newest stand-alone mine having started commercial operation in 2017.

### a. Stand-alone Mine

Calculating GHG intensity at stand-alone mines is straightforward but different considering whether the facility has onsite cogeneration supplying heat and electricity needs or is importing from the grid. The formulas used to calculate GHG intensity are basically the same as in Section II with one distinction: some facilities produce additional electricity with steam turbines and this additional electricity must be included in the $E_{gen}$ term but not in the $E_{genCogen}$ term. For a facility with onsite cogeneration that produces more electricity than it consumes (i.e. net exporter of electricity):

$$GHG_{intensity} = \left(\frac{TDE + (E_{consumed} - E_{gen}) * EF_E}{Production_{Bitumen}}\right)$$

Where,

*TDE – Total direct facility emissions ($tCO_2e$)including cogeneration*
*$H_{consumed}$ – Electricity consumed for bitumen production in MWh*
*$E_{gen}$ – is the total on site electricity generated (including electricity from steam turbines)*

$$EF_E = \left(\frac{GHG_{cogen} - H_{cogen} * EF_H}{E_{genCogen}}\right)$$

*$E_{genCogen}$ – is the electricity generated by gas turbines only*
*$GHG_{cogen}$ – are the emissions due to cogeneration only*
*$H_{cogen}$ is the heat associated with cogeneration only*

It is important that the first equation contains total electricity generated and the calculation of the electricity emission factor should include only the cogeneration electricity. The result is that the emissions associated with the net export of electricity is subtracted at the rate of $EF_E$.

For a facility with onsite cogeneration that produces less electricity than it consumes (i.e. net importer of electricity – note that an example of this scenario is Imperial Oil's Kearl in 2019), $EF_E$ should be replaced with $EF_{grid}$.

$$GHG_{intensity} = \left(\frac{TDE + (E_{consumed} - E_{gen}) * EF_{Grid}}{Production_{Bitumen}}\right)$$

For a facility importing heat and electricity from a third-party cogeneration facility (such as CNRL Albian 2019), the cogeneration emissions should be added to the TDE and the facility should be evaluated as in the above equations.

**b. Mine Integrated with Upgrader**

For a mine integrated with an upgrader, in order to compare on a bitumen production basis with other mines, there is a need to apply a methodology to separate mine and upgrading emissions and then compare all mines to each other (integrated and standalone).

CAPP members have supported this approach for the following reasons:

- Comparing facilities on a synthetic crude oil (SCO) production basis is not fair due to differences in processing at these facilities: primarily in sweet versus sour SCO. CAPP recommends that upgrading be compared on a complexity weighted barrel (CWB) basis.
- Evaluating complete facility intensity does not take into account third-party bitumen processed at upgraders, resulting in unfair treatment.
- Comparing on a barrel of bitumen basis allows all six surface mining operations to be compared and an industry average for surface mining calculated.
- Separation of mining and upgrading emissions needs to be done for annual GHG compliance reporting to Alberta TIER if these operations would like to be compared to the high performance benchmarks anyway.

Past data collection work has resulted in an overall split of mining emissions to upgrading emissions of approximately 45-55%. Therefore, for simplicity, the total emissions be calculated for the integrated site, adjusted for Scope 2 emissions and then a ratio of 45% be assumed mining emissions.

In 2019, both Syncrude and Suncor were net exporters of electricity while CNRL Horizon was a net importer. The following formulas apply:

Net electricity exporting facilities (Syncrude and Suncor):

$$GHG_{intensity} = \left(\frac{TDE + (E_{consumed} - E_{gen}) * EF_E}{Production_{Bitumen}}\right) * 0.45$$

Net electricity importing facilities (CNRL Horizon):

$$GHG_{intensity} = \left(\frac{TDE + (E_{consumed} - E_{gen}) * EF_{grid}}{Production_{Bitumen}}\right) * 0.45$$

Where all emissions, imports and exports apply to the integrated facility as a whole (i.e. mine + upgrader).

### c. Data Sources

| Data Needed | Source | Details |
|---|---|---|
| Total Emissions TDE ($tCO_2e$), Cogen Emissions ($tCO_2e$), Cogen Heat (GJ), Cogen Elec. Generated (MWh) | https://open.alberta.ca/opendata/alberta-oil-sands-greenhouse-gas-emission-intensity-analysis | Posted on AEP website for 2011-2019. |
| Bitumen Production | https://www.aer.ca/providing-information/data-and-reports/statistical-reports/st53.html | Updated monthly |
| Electricity Consumption (MWh), Net Electricity Import (MWh), Electricity generation (MWh) | https://www.aer.ca/providing-information/data-and-reports/statistical-reports/st39.html | Updated monthly |

## IV. Offshore Oil

### a. Methodology

Emissions data is accessed from ECCC GHG reporting data. Production data is accessed from Canada – Newfoundland and Labrador Offshore Petroleum Board. It is important to match data for the same year. The most recent data from ECCC is 2019 so the 2019 oil production from C-NLOPB should also be used to calculate the GHG intensity. Assume gas production is consumed on site and does not contribute to saleable product. No Scope 2 emissions are applicable as offshore facilities do not import or export any heat or power.

$$GHG_{intensity} = \left(\frac{TDE}{Production_{oil}}\right)$$

### b. Data Sources

| Data Needed | Source | Details |
|---|---|---|
| Total Emissions TDE ($tCO_2e$) | https://open.canada.ca/data/en/dataset/a8ba14b7-7f23-462a-bdbb-83b0ef629823 | Released April 2021 |
| Oil Production | https://www.cnlopb.ca/information/statistics/#rm | Updated monthly |

## V. Conventional Natural Gas, Natural Gas Liquids and Condensate

For conventional natural gas, natural gas liquids and condensate operations, facility specific data is not available for every operation. Currently the most recent ECCC GHG dataset (2019) includes facilities emitting 10 kt $CO_2e$ and above. Scope 2 emissions are not available on a facility basis

Scope 2 emissions were estimated for the sector utilizing *ECCC data from 2015-Data by Fuel* to determine the average electricity used on $m^3OE$ or bbl OE basis for the sector. The factor was 0.0128 MWh/bbl OE or 0.0805 MWh/ $m^3OE$. Using the grid intensity factors from the NIR Part 3 Annex 13 that were available by province, the production volumes were utilized to estimate the emissions associated with the electricity used for production weighted by province to establish the GHG emissions associated with the electricity usage.

### a. Methodology

Given the aforementioned challenges, a top down approach, whereby the sector is evaluated holistically, is used. The GHG emissions data is obtained from Canada's National Inventory Report (NIR) Part 3 while the production data is obtained from the Canada Energy Regulator (CER). The NIR breaks down emissions per economic sector and per province. The relevant economic sectors considered in this analysis is the Natural gas production and processing.

To evaluate GHG intensity natural gas, natural gas liquids and condensates are added together in the units of $m^3$ of oil equivalent ($m^3OE$). The following conversion factors are used *(Standard for Developing Benchmarks, Technology Innovation and Emissions Reduction Regulation version 1, Oct 2019):*

- Natural gas $e^3m^3$ * 0.971 $m^3OE/e^3m^3$
- NGLs $m^3$ * 0.71 $m^3OE/m^3$
- Condensates $m^3$ * 0.86 $m^3OE/m^3$

$$GHG_{intensityNG,NGLs,Cond} = \left( \frac{Emissions\ natural\ gas \frac{production}{processing} + SCOPE\ 2\ Emissions)}{\sum_{NG,NGLs,Cond} Production} \right)$$

Where,
Scope 2 Emission are

$$\sum_{NG,NGLs,Cond} Production * EU * Canada\ Grid\ Factor$$

Production = Total Annual Production
EU = 0.0805 MWh/ $m^3OE$ based on 2015 usage and production data.
Canada Grid Factor = Annual Weighted Grid factors using AB, SK, BC Grid Factors from NIR Annex 13. See table 1.

**Table 1** –
Electricity Consumption Assumptions for NG, NGLs, Cond

Adapted From NIR Part 3 Annex 13

| Year | AB Grid Intensity of Consumption ($gCO_2eq$/ kWh) | BC Grid Intensity of Consumption ($gCO_2eq$/ kWh) | SK Grid Intensity of Consumption ($gCO_2eq$/ kWh) | NG,NGLs,Cond Grid Intensity when weighted for production ($gCO_2eq$/kWh) | Grid Intensity (tonne/ MWh) |
|---|---|---|---|---|---|
| 2010 | 1100 | 26 | 860 | 877 | 0.88 |
| 2011 | 1000 | 15 | 850 | 765 | 0.77 |
| 2012 | 930 | 9.4 | 880 | 704 | 0.70 |
| 2013 | 880 | 12 | 780 | 653 | 0.65 |
| 2014 | 820 | 12 | 900 | 608 | 0.61 |
| 2015 | 890 | 9.9 | 740 | 650 | 0.65 |
| 2016 | 830 | 13 | 690 | 601 | 0.60 |
| 2017 | 790 | 10.2 | 720 | 578 | 0.58 |
| 2018 | 690 | 12.8 | 750 | 491 | 0.49 |
| 2019 | 670 | 19.7 | 710 | 479 | 0.48 |

## b. Data Sources

| Data Needed | Source | Details |
|---|---|---|
| GHG emissions | https://unfccc.int/documents/65715<br>https://unfccc.int/documents/224829<br>https://unfccc.int/documents/271493 | NIR 2018, NIR 2020, NIR 2021 Part 3 Annex 12 |
| Natural gas production | https://www.cer-rec.gc.ca/en/data-analysis/energy-commodities/natural-gas/statistics/marketable-natural-gas-production-in-canada.html | |
| Natural gas liquids production | http://www.cer-rec.gc.ca/nrg/ntgrtd/ftr/2019ntrlgslqds/index-eng.html<br><br>https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/provincial-territorial-energy-profiles/provincial-territorial-energy-profiles-alberta.html | From the excel data sheet, gather ethane/propane/butane from those tabs for "production from gas processing". This is the total for Canada so apply the ratio from 2018 of 76%AB, 22%BC, and 2% SK (from the CER website provincial summaries). |
| Condensate and Pentanes plus production | https://www.cer-rec.gc.ca/en/data-analysis/energy-commodities/crude-oil-petroleum-products/statistics/estimated-production-canadian-crude-oil-equivalent.html | |
| Electricity Usage | https://unfccc.int/documents/271493<br>https://unfccc.int/documents/224829<br>https://unfccc.int/documents/65715 | NIR 2019,2018, Part 3 Annex 13 |