



Greenhouse Gas Offset Credit System Regulations Comments

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May 5, 2021

Request for Comments

The proposed *Greenhouse Gas Offset Credit System Regulations (Canada)* were published in the March 6th version of *Canada Gazette, Part I, Volume 155, Number 10* [1]:

Understood from this is the Government of Canada is developing a federal GHG offset credit (pollution pricing) system under its GGPPA legislation to support achieving reduced GHG emissions. It consists of three main elements for ameliorating this national concern:

- *regulations made under the Act to implement the operational aspects of the system;*
- *federal offset protocols to establish the methods for quantifying GHG reductions for given project types; and*
- *a credit and tracking system to register offset projects, issue and track offset credits, and share key information through a public registry.*

Federal offset protocols would occur separately from the regulatory development process. ECCC has identified and prioritized the four project types described below for its initial protocol baseline, which it plans to begin in early 2021:

Initial Protocol Baseline Project Types	Estimated Baseline Emissions	Estimate Data Source
<i>Advanced refrigeration systems:</i>	~ 13 Mt CO ₂ e	Table ES-2, NIR 2021 Edition INDUSTRIAL PROCESSES HaloCarbons (2019)
<i>Landfill methane management:</i>	~ 18 Mt CO ₂ e	Table A-10-3, NIR 2020 Edition WASTE 2018
<i>Improved forest management:</i>	~ -13 Mt CO ₂ e	Table 2-3, NIR 2020 Edition LULUCF 2018
<i>Enhanced soil organic carbon:</i>	~ 25 Mt CO ₂ e	Table ES-2, NIR 2021 Edition AGRICULTURAL Soils (2018)

“Each federal offset protocol would define, or provide the methods for determining, a baseline for project activities, as well as the methods for quantifying GHG reductions that would be considered incremental to this baseline” (~ 729 Mt CO₂e per NIR 2020 Table2-3 Part1 and Table A10-3 Part3).

The project baseline should be measured in the business-as-usual scenario against which businesses would execute relevant project activities - from which federal offset credits could be generated and managed. It is understood a project activity must reduce or remove GHGs in relation to the project baseline for it to generate GHG reductions that would be considered incremental to the baseline. Each protocol would also contain requirements related to project planning and implementation activities, including monitoring, reporting, and risk assessment and management.

With respect to how to provide compensation for excess emissions one can pay the excess emissions charge (up to \$170/tonneCO₂e), or, one can use compliance units, which are (i) surplus credits that it has earned or purchased from another covered facility; (ii) provincial or territorial offset credits formally recognized by the Minister under the OBPSR as compliance units; and (iii) federal offset credits (and incentivizing activities) system.

Please submit comments in writing to ec.cfsncp.ec@canada.ca addressed to:

Carbon Markets Bureau
Environmental Protection Branch
Department of the Environment
Gatineau, QC K1A 0H3

Hydrofuel Comments

Acknowledged is the **2021 SCC 11** decision [2] regarding the GGPPA (*Greenhouse Gas Pollution Pricing Act, S.C. 2018, c. 12, s. 186*) [3]. The nexus between stringent regulatory charge (*pricing mechanism*) and national concern about GHG emissions impacting the climate for current/future Canadians will turn on the **achieving** of meaningful **GHG reduction** – by altering behaviours in **all** of Canada.

Heightened concerns regarding **lack** of fundamental mass-balancing of GHG emissions now exist. Respectfully, social science influences that ignore natural science practices to affect these proposed “*GHG offset credit*” objectives are worrisome. **Crucial** to the execution of any project is the formal **breakdown** (*a quantifiable scope of the similar, multiple tasks among project participants and respective jurisdictions and ecosystems*) **of work** required to achieve the sanctioned results intended.

- 1) The *drafters of Canada Gazette, Part I, Volume 155, Number 10: Greenhouse Gas Offset Credit System Regulations* appear reliant on very problematic usage/reporting of data for quantifying “GHG baseline measurements” to achieve the national CO_{2e} emissions reduction goal.
- 2) Hydrofuel’s submission to ECCC [4] regarding Clean Fuel Standards challenged the baseline CO_{2e} measurement of Canada’s (**729 Mt**) GHG emissions. Hydrofuel’s estimate was derived from CER end-use demand, and was not adjusted to account for (~162 Mt) CO_{2e} emissions from NO₂ or CH₄ gases.
- 3) Now, an apparent total (~960 Mt CO_{2e}) must be adjusted downward to reflect the real impact of sequestered CO_{2e} **in all** of Canada’s 347 million hectares of forest and **in all** its wood products. CH₄ escaping from Canada’s fast melting Arctic methane hydrates (aka methane clathrates) will likely be 25 times more impactful than CO_{2e} emissions. Completeness in GHG baseline measurement is vital for Canada. (See Appendix 1,2,3)
- 4) Canadians merit the respect of having IPCC - GHG emissions reports correlated for them in familiar, meaningful “*Business-As-Usual*” terms/principles with data structures like those in (page 41 or 61) NRCan “Energy Facts 2020-2021” [5]. Respective project (economic business sector) participants, in each provinces/territory, could then more simply evaluate, or broaden, CO_{2e} emissions data (by gas, energy consumption, etc.), in terms of mitigation opportunities.
- 5) GHG CO_{2e} emissions by gas as presented at Table 7 (pg 31/112) in *Canada’s 2018 Greenhouse Gas and Air Pollutant Emissions Projections* [6] are now available. Table ES-2 in *NIR 1990–2019: GREENHOUSE GAS SOURCES AND SINKS IN CANADA* [7] of MtCO_{2e} equivalent information does not coincide with inferable **CO₂** emissions from *Canada’s Energy Future 2016: Update, Reference, End-Use Demand, 2016* data [8] (11,548 PJ), or with Table 2 and Table 3 for 2016 (En1-78E-PDF at page 27/112 [6]).

- 6) Moreover, tables 2 and 3 obfuscate the information provided. Agriculture emissions by IPCC sector is less in the economic sector; transport emissions by IPCC sector are greater than in the economic sector. StatsCan reports about **482,000** commercial or institutional buildings [9], about **193,492** farms with at least one farm building [10], and Treasury Board reports it has **37,087** buildings [11]. (*How many buildings are in Canada and contributing to 81 Mt CO₂e emissions?*)
- 7) The CCME Pan-Canadian Greenhouse Gas Offsets Framework [12] expects that “**programs should incorporate best practices for quantification and monitoring GHG emissions to ... support Canada’s action under the Paris Agreement**”. NIR reports must be substantially improved to support credible GHG reduction needs-planning by Canadian emitters, and accordingly build confidence in GHG offset credits program.
- 8) Canada’s many **NIR** quantification variances (*evidenced by different values for same line item for same year in a different NIR Edition year*) are exacerbated by questionable interpretation. For example, how does a **2018 value**, in a *2020 NRCAN Annual Forest Report* [13] (pg 39) of **243.2 Mt CO₂e** of Net GHG emissions [14] **become** either 129 Mt in a 2020 or 141 Mt CO₂e value in a 2021 Edition NIR report. (How does a vague footnote (*Table ES-2, footnote a*) [7] abet reliable information for Canadians?)
- 9) The *2020 NIR (table A10-3) report* [15] ignored *2020 Annual Forest Report*: a 347 million ha forest carbon sink (of which 65% -226 million ha is managed and only 0.3% was harvested to produce 21 million tonnes of forest products) [13]. The NIR reported 1.2 Mt of CO₂e emitted (implying 500 million litres of fuel consumption) for transportation of all forest resources; yet for pulp & paper, the NIR separately reported 1.2 Mt of CO₂e as being emitted (again implying 500 million liters of fuel consumption) for transportation purposes which the forest report said 17 of the harvested 21 million tonnes had involved pulp feedstock [16] ... *what caused this apparent discrepancy??*
- 10) According to *StatsCan Table 32-10-0136-01* [17], total operating expenses grew from \$58.8 billion in 2015 to \$65.5 billion in 2019, for some 26 million tonnes of fertilizers, 115 PJ of farm fuel, and 8500 GWh of electricity - about 9% of CER reported end-use energy consumption in Canada.
- 11) StatsCan reports 200,000 tonnes/year of aquaculture product [18] was produced in the 2015-19 period. 250 kilotonnes of algae were required to feed these 200 kilo-tonnes of fish. *Carbon capture of CO₂e from 1.0 GJ of diesel fuel could render about 33 kg of needed fish-feed.*
- 12) Sadly, aquaculture was not recognized as an economic sector in Canada’s NIR reports. Asphalt was also ignored; half of the agricultural CO₂e from energy for buildings was ignored on 20,000 farms (*housing poultry, eggs, dairy, swine, mink, etc*); and, also, omitted were commercial fisheries that employed 45,907 and contributed \$3.7 billion to Canada’s economy.
- 13) Canadians are aware [19] that its household food waste approximates 2,938,321 tonnes/year, and results in more tonnage placed in landfills [20], which then increases consequential GHG

emissions. StatsCan reported 9.3 million tonnes [21] were diverted in 2016 from 25 million tonnes of waste for disposal [22]; but Canada reported (Table 1) 41 Mt CO₂e in (reduced) waste emissions in 2016 [23].

- 14) Economic sectors are the work product of Canadians. Work is measured in joules, not the monetary values social science prefers to utilize. Deficiency in (meaningfully) reporting energy consumption bi-product (CO₂e => **another form of energy**) equates to negating economic growth, and, in turn, ensuring the **not** instilling of confidence in the (GHG offset credit) system.
- 15) Canada's 2030 emissions commitments (achievement of ~211 Mt /30% CO₂ reduction) and 2050 (achievement of net-zero CO₂ emission) commitments **are not ambiguous**. One (1) gigajoule of energy (**work**) from a carbonaceous fuel energy or from a Canadian is the "same". Managers of good work output (cement, office-work, etc) know that (work) effort has a **CO₂e** bi-product. Work **baseline** measurements omitting/ignoring known facts cause unintended problems.
- 16) Absenting quantified (carbon, nitrous oxide, or methane) GHG emissions from any (proposed) action (work), or GHG (**NIR**) reports, impedes facilitating comparisons of all **CO₂e** quantities across potential alternatives or mitigation opportunities; it does not foster the aims of the **Impact Assessment Act** (S.C. 2019, c. 28).
- 17) The most direct form of achieving CO₂ emissions reduction is by switching from solid to liquid fossil fuel or by switching from liquid fossil fuel to gaseous fossil fuel. "Liquid petroleum" fossil fuels produce 30% more carbon dioxide per gigajoule than "natural gaseous" fossil fuels, and liquid petroleum produces 30% less carbon dioxide per gigajoule than "solid" fossil fuels.
- 18) The document summarizing emissions factors [24] used to estimate greenhouse gas (GHG) emissions in **Canada's official national GHG inventory should be amended to reflect **complete consistency**** with the IPCC protocol (*SI mass unit per SI unit of energy*). Its *Tables A6.1–1 thru Tables A6.1–7* are an embarrassment; liters and cubic meters are not SI units of energy.
- 19) Hydrofuel strongly disagrees with "deeming" ethanol and biodiesel as renewable fuels - and not subject to GHG emission accounting; this is because **CO₂e** is emitted during the manufacture or combustion of these fuels. (*One is either pregnant or one is not.*)
- 20) Respectfully, these proposed Regulations seem to supplant a performance-based policy tool that respects the natural CI of fossil fuels harvested, processed, refined and imported in Canada; they must ensure harmony with global consumption emissions quantification practices, and be consistent with established management of upstream, midstream, and downstream activities.
- 21) These proposed regulations are (*as made clear in paragraph 219 of the 2021 SCC 11 decision*) intended for advancing and accomplishing achievement of national interest goals (the reduction of GHG emissions; not the generation of revenue), by altering behaviour – of **all** project participants (including government departments). [2]

- 22) The required nexus of these “offset credits” is to regulatory purpose – **achieving** reduction of GHG emissions. Absenting a clear demonstrative linkage between the GHG regulation and imputable contribution to achievement of the national GHG interest goals (as confirmed by the SCC) will imperil the legislated intent.
- 23) Regarding the (average 1.0 Mt **CO₂e**) emissions released by refrigerants: is this demonstrating awareness that there are upwards of 130 million cooling apparatuses of varying size/capacity? Albeit, a monthly 1% count factor recognizing 13 million tonnes emissions annually is a not unreasonable allocation identifier in the needed baseline for offset credits.
- 24) Likewise, recognition of 45,000 farms [25] with animal crops on 47.8 million pasture acreage and 63,628 farms with 93.4 million acres in land with crops involving ~ 25 Mt CO₂e enhanced-soil organic-carbon is also a not unreasonable concern. And once 150 million tonnes of manure from the animal crops are spread over all these acres, it, too, will add credibility to the “offset credit” **baseline** needed for these proposed regulations.
- 25) Agreeably, fugitive methane escapes are of concern. With northern Canada visibly advanced in a thaw, more methane hydrates will be released as “permafrost” and “bogs” continue warming. LIDAR technology [26] may need to be utilized in locating these leaks - given that methane has a 25x greater warming potential than carbon dioxide. Flaring could become a need - 1.0 GJ of CH₄ weighs about 18 kg, and when combusted, it only emits about 56 kg of CO₂.
- 26) Executing/achieving a GHG reduction plan across Canada’s 13 ecosystems’ goals necessitates “**mass-balanced**” management configuration that respects the idiosyncrasies of each ecosystem within the whole of the national achievement goal. A “**mass-balance**” approach facilitates the optimizing of positive environmental affects, the mitigating of negative environmental effects within each ecosystem, and, more easily exposing goal achievement (**hindrance or help**) likelihood.
- 27) Just as deployment of “*energy hub-microgrid*” thinking is *the epitome of the laws of energy*, when “offset credit” baselines include GHG reduction perspectives, foreseeable impacts and (*horse before the cart*) response needs can be more readily detected by a project proponent – thereby enhancing achievement of national (GHG reduction) concern, and resiliency.
- 28) These draft regulations fail to convey demonstrable achievement (attainment) measures of meaningful GHG reduction that contribute to ultimate overall net-zero emissions. Globally, it is estimated that 1800 billion tonnes of CO₂ have now (2020) been emitted by anthropogenic activity since 1960; **mass-balance** principles imply the need to also replace much more than those 1300 billion tonnes of oxygen already taken from the atmosphere.
- 29) Hydrofuel foresees ~960 MtCO₂e as the apparent gross emissions in Canada, calculated from CER end-use (**11,877 PJ**) consumption data to which was applied international CO₂e/GJ emission rates that inferred 675 Mt CO₂e to which was added 162 CO₂e Mt (extrapolated from Table 7 in En1-78E-PDF) adjustment for CH₄ and N₂O => **837 Mt CO₂e**. Agriculture and Waste

emissions Mt CO₂e forecasts (*from column “2020 Ref 18” Table 5 in En1-78E-PDF*) are then added (74+43=) **117 Mt CO₂e**. Hence, a foreseeable (837-117=) ~960 MtCO₂e as the **apparent gross emissions baseline** for Canada.

Forestry, given paragraphs 8 & 9 above, is of significant carbon **sequestration value** [14] which must be offset by foreseeable methane hydrate releases from Canada’s Arctic regions.

Consistency

Canada’s governments know the covid-19 pandemic has demonstrated **national consistency** between jurisdictions or public/private entities. Government should also mimic the natural **laws of energy which have induced** the GHG phenomenon, just as has the IPCC has done. GHGs are a function (bi-product) of energy consumed that are measured in grams per joules. (*see paragraph 18 above*)

Energy end-use consumption records can easily impute corresponding GHG emissions in point-of-sale transaction data. All governments apply a levy on fossil fuel consumption and are aware of amounts of fuel exempt from their levy; it is an accurate means for **mass-balancing** all manner of accurate, GHG emissions reporting to the IPCC. It will also reduce confusion for Canadians.

Nothing on planet Earth happens **without energy**; energy must be respected as the common denominator measure it is. Canadians accustomed to natural science work-environments easily comprehend that energy is work effort, work effort becomes work product, and work product (measured in joules) generates economy – subsequently equilibrated to monetary values.

The government is deemed to know that GHG emissions are larger than reported - planting billions more trees to increase photosynthesis; growing more seaweed (*algae*) will help too. *Canada’s emissions are almost 1000 Mt of CO₂e, potentially offset by a large land/aquatic carbon sink needing to be enlarged.*

Canada’s north is thawing. Its 3 ocean boundaries are under threat – from rising sea levels, hypoxia, and acidification. Biogenic methane escape is now seen as a larger problem due to finding more subsea emissions; locating and measuring these GHG sources is an immediate imperative.

Science vs Expediency

The **chemistry (not convenience)** of an “end-use” fossil fuel product is what **determines GHG emission factors** (and legal consequences).

The LCA modelling mechanism, the clean fuel standard, the December 12-2020 climate plan, and other like regulatory analyses all clearly demonstrate, a) lack of collaboration within the relevant Canadian ministries; b), incompetence or carelessness; and c), apparent contempt for Canada’s formal commitments to the world. *The modelling appears to very much mirror “cart-before-the-horse” thinking in the LCA report.*

The **evidenced lack of mass balancing** apparent in charts/tables (in Canada’s latest climate plan) mirrors profound bureaucratic weakness that must be ameliorated – immediately.

Just as Canada has a Chief Medical Officer overseeing the pathway of its national health needs, it also needs a Chief Science Officer to oversee the pathway to reducing deleterious GHG emissions.

Professional Engineers vs Chartered Professional Accountants

ECCC’s *METHOD FOR VALIDATION, VERIFICATION AND CERTIFICATION CLEAN FUEL REGULATIONS* (see pages 20,21,22 of 93) [27] appears to over-ride constitutionally protected provincial jurisdiction regarding professional engineering laws, and over-ride established common practice of professional engineering services as understood by Canadians **the SCC reinforces this understanding** in short, CPAs are **not** PEngs *professional engineering credentials are established by provincial jurisdiction, and established law – not by what the ECCC wants.*

The **SCC**, in its GGPPA decision at paragraphs 391 and 392 **infers** the utilization of professional engineering services to achieve the expectation set forth in the draft of these credit regulations:

” A project activity must reduce or remove GHGs in relation to the project baseline for it to generate GHG reductions that would be considered incremental to the baseline.” [1]

Hydrofuel would like to direct ECCC attention to provincial legislation, e.g., Professional Engineers Ontario **PEO**, that *if an act a) involves designing, evaluating and/or reporting; b) involves the public interest; and c) and requires the application of engineering principles, the activity qualifies as practice of professional engineering.*

A **professional engineer is** who makes the determination, via engineering principles, whether or not a GHG will remove or reduce the gross emissions to the desired NET amounts of GHG reduction. Neither CPAs nor other professionals are legally sanctioned in Canada to perform professional engineering services, other than via provincial jurisdiction.

Accordingly, GHG project proposals with a professional engineer’s seal should ensure the technical viability of a GHG reduction project. The practical benefit the attention and expertise demanded by the engineer’s seal would add credibility to the GHG offset credits projects/protocols being “demonstratively” linked to achievement of GHG reduction.

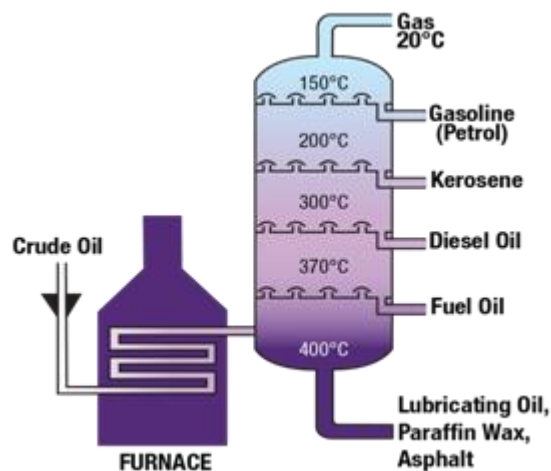
This would also reduce potential federal or provincial (jurisdictional) conflict concerns raised by the SCC in its decision

Ethanol and Other Renewables

The Clean Fuel Standard focused on fossil fuels but then exempted ethanol and biofuels from their "life cycle analyses" (e.g., land use). In addition, it classified these renewables as low carbon and thereby can increase the minimum blend-mandate from 5-10% to 15% basically by stealth. The EU no longer classifies these as “green fuels” effective 2021, and has proposed rules to reduce these levels to 3.8 percent in 2030 and 7 percent in 2021.

Why was Asphalt Ignored?

Asphalt [28] is a key output in refinery operations, then later subjected to further “preparation” operations that are already subject to ECCC regulations (*Asphalt Code of Practice* [29]). Asphalt also appears to left out of the NIR, CFS, etc.



See Petroleum Products Facts, Note: outputs + capacity (2020-10-06 update) [30]

Intentions vs Actions

“Carbon Credit Compliance” infers prioritizing the mitigation pathways to achieving GHG reduction. In the vernacular, our concern is that the horse must be provided with sufficient strength/vision to get the cart to arrive at the agreed upon destination.

Our view is that the “carbon increase” corresponds to the amount of “oxygen decrease” –chemistry cannot be simpler. 1700 billion tonnes of CO₂ emissions were made from 1200 billion tonnes of atmospheric oxygen; this is the imbalance induced by anthropogenic activity. Each hectare of Canada’s forest absorbs 100 tonnes of CO₂ and replaces about 100 tonnes of oxygen in our five-mile-thick atmosphere.

Unless an atmosphere like that of Mars is wanted, either more trees and more algae need to be planted, or more carbon-free fuels need to be deployed

Recommendations

The four project types identified and prioritized by ECCC for its initial protocol baseline would seem to be among the least effective means of reducing Canadian GHG emissions based upon the Pareto Principal: 80% of the benefit should come from doing 20% of the work.

The majority of GHG emissions are systemic in nature, which means the entire system should be considered rather than piecemeal approach of tackling individual carbon emissions of individual fuel components of the systems’ processes. Otherwise, we are just making a token effort amounting to window dressing and the whole exercise is just a bureaucratic show to convince the rest of the world that we are not climate change laggards.

These draft regulations should be in complete alignment with the SCC decision understanding of the regulatory purpose and the meaningful abetting of the participation of project participants wanting to reduce GHGs in Canada.

Summary

Critical to “offset GHG credit” integrity is credible, imputable contribution to achievement of GHG emissions reduction in Canada - where anyone can emit GHGs provided they pay the established minimum national price which is structured to alter behaviour of emitters.

Only a mass-balanced baseline GHG quantification will be beyond reproach for those who want to participate in ameliorating Canada’s national concern.

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(Trademarks Reg. in Canada, USA & EU)

Background Notes

- 1) Global warming potentials <https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/quantification-guidance/global-warming-potentials.html> as of 2019-02-18, CO₂ = 1; methane => 25 x CO₂; & NO₂=> 298 x CO₂
- 2) CANADA'S GHG AND AIR POLLUTANT EMISSIONS PROJECTIONS see Table 7 @ pg 31/112 http://publications.gc.ca/collections/collection_2018/eccc/En1-78-2018-eng.pdf
- 3) NATIONAL INVENTORY REPORT 1990–2019 - Exec Summary see page 10 / 15 http://publications.gc.ca/collections/collection_2021/eccc/En81-4-1-2019-eng.pdf
- 4) Between 2009 and 2019, the number of forest fires each year was highly variable, with no clear trend. In these 11 years , 69000 fires burned 30 million hectares of forest (4 times the total area harvested in the same time frame) <https://www.nrcan.gc.ca/our-natural-resources/forests-forestry/state-canadas-forests-report/how-does-disturbance-shape-canad/indicator-forest-fires/16392>
- 5) 2020 NIR Part 3 http://publications.gc.ca/collections/collection_2020/eccc/En81-4-2018-3-eng.pdf
- 6) 2020 NIR Part 2 http://publications.gc.ca/collections/collection_2020/eccc/En81-4-2018-2-eng.pdf
- 7) 2020 NIR Part 1 http://publications.gc.ca/collections/collection_2020/eccc/En81-4-2018-1-eng.pdf
- 8) Canada to United Nations 2020 National Inventory Report (NIR) <https://unfccc.int/documents/224829>
- 9) NRCan Forestry Data <https://cfs.nrcan.gc.ca/statsprofile/production-and-investment>
Forest carbon emissions and removals <https://www.nrcan.gc.ca/our-natural-resources/forests-forestry/state-canadas-forests-report/how-does-disturbance-shape-canad/indicator-carbon-emissions-removals/16552>
- 10) Annual Deforestation Canada <https://www.nrcan.gc.ca/our-natural-resources/forests-forestry/state-canadas-forests-report/how-much-forest-does-canada-have/indicator-deforestation-afforestation/16546>
- 11) Carbon per tonne of wood estimates https://www.canadianbiomassmagazine.ca/images/stories/c02_whitepaper.pdf

- 12) CER energy futures link <https://apps.cer-rec.gc.ca/ftppndc4/dflt.aspx?GoCTemplateCulture=en-CA>
- 13) CANADA'S GREENHOUSE GAS QUANTIFICATION REQUIREMENTS 15A (149/153) API 2009 http://publications.gc.ca/collections/collection_2021/eccc/En81-28-2020-eng.pdf
- 14) API - COMPENDIUM OF GREENHOUSE GAS EMISSIONS METHODOLOGIES FOR THE OIL AND NATURAL GAS INDUSTRY Table 7-4 at page 396 & Table 7-5 at page 398/807 https://www.api.org/~media/Files/EHS/climate-change/2009_GHG_COMPENDIUM.pdf
- 15) Canada Measurement accuracy requirements <https://www.canada.ca/en/services/business/permits/federallyregulatedbusinessactivities/measurementaccuracy.html>
- 16) NRCan Energy Fact Book 2020-2021 https://www.nrcan.gc.ca/sites/nrcan/files/energy/energy_fact/energy-factbook-2020-2021-English.pdf
- 17) Canadian Council of Ministers of the Environment, "PAN-CANADIAN GREENHOUSE GAS OFFSETSFRAMEWORK," 2019. <https://ccme.ca/en/res/pan-canadianghoffsetsframeworken1.0secured.pdf>
- 18) Carbon pollution pricing: options for a Federal GHG Offset System <https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/pricing-pollution/pricing-pollutionProtocol-Development-GHG-Offset-System-v6.pdf>

Appendix 1

Table 26
Exports and imports of merchandise, 2019

	Exports	Imports	Trade balance
	millions of dollars		
Total, all merchandise	595,263	613,706	-18,443
Farm, fishing and intermediate food products	37,989	21,227	19,400
Energy products	114,065	37,420	76,645
Metal ores and non-metallic minerals	20,865	14,175	6,689
Metal and non-metallic mineral products	65,296	39,576	25,721
Basic and industrial chemical, plastic and rubber products	34,212	44,972	-10,760
Forestry products and building and packaging materials	42,377	26,894	15,482
Industrial machinery, equipment and parts	41,309	69,388	-28,079
Electronic and electrical equipment and parts	30,011	72,155	-42,144
Motor vehicles and parts	93,130	115,046	-21,915
Aircraft and other transportation equipment and parts	28,043	26,417	2,068
Consumer goods	70,705	125,424	-54,719
Special transaction trade	3,827	9,170	-4,893
Other balance of payments adjustments	13,436	11,842	1,593
Note: Balance of payments basis.			
Source: Statistics Canada, table 12-10-0121-01 .			

Business As Usual => All products traded by Canada should be measured in work effort (PJ) and in work value (\$). Statscan (Table 12-10-0121-01) reports a trade negative balance averaging \$ 260 million monthly in 2018 and \$210 million monthly in 2019 for refined petroleum **energy products**. Knowing the total PJ amount of energy involved would facilitate calculation of imported or exported amounts of GHG emissions.

Appendix 2

Business As Usual => measuring **input** work effort against accomplished **output** work effort

Canada's Energy Future 2018: Update

<https://epps.cen-rec.gc.ca/fr/produit/offr.aspx?GoCTemplateCulture=ren-CA>

TOTAL End-Use Sector - Petajoules

	2018	CO2e kg/GJ	Mt CO2e	CH4 kg/GJ *	Mt CO2e	N2O kg/GJ *	Mt CO2e	GHG Mt
Total End-Use DEMAND	11,876.64							836
Electric	1,999.11	16	32		6		2	40
Natural Gas	4,150.32	56	238		41		16	285
RFP	4,828.99	72	347		60		23	430
Biofuels & Emerging Energy	642.23	72	46		8		3	57
Other	167.99	72	12		2		1	15
Residential Sector - Petajoules	1,499.16							
Total End-Use	1,499.16							
Electric	546.63							
Natural Gas	698.45							
RFP	81.27							
Biofuels & Emerging Energy	172.2							
Other	0.61							
Commercial Sector - Petajoules	1,491.02							
Total End-Use	1,491.02							
Electric	572.11							
Natural Gas	677.36							
RFP	238.78							
Biofuels & Emerging Energy	0.77							
Other	2							
Industrial Sector - Petajoules	6,227.34							
Total End-Use	6,227.34							
Electricity	870.02							
LPG & Petroleum Feedstocks	701.41							
Natural Gas	2,864.97							
RFP	709.93							
Solar and Geothermal	0							
Still Gas & Petroleum Coke	542.02							
Biomass	374.02							
Coal, Coke & Coke Oven Gas	130.03							
Other	14.94							
Transportation Sector - Petajoules	2,689.09							
Total End-Use	2,689.09							
Electric	4.34							
LPG	7.09							
Natural Gas	9.54							
Biofuels	93.24							
Aviation Fuel	275.17							
Diesel	842.61							
Heavy Fuel Oil	54.92							
Lubricants	1.26							
Motor Gasoline	1,368.92							

* From Data in Table 7 (pg 22/22) in ECCC No : En1-78F

CANADA Actual Work Output in tonnes per year by Industry Group is a need-to-know

2012 NAICS Canada structure

NAICS Canada 2012 consists of 28 sectors, 182 subsectors, 323 industry groups, 711 industries and 922 Canadian industries, and replaces NAICS Canada 2007. The following summary table shows the counts of subsectors, industry groups, industries, and Canadian industries for each of the NAICS sectors.

Sector code	Sector name	Sub-sectors	Industry groups	Industries	Canadian industries	Total
11	Agriculture, forestry, fishing and hunting	5	19	41	50	115
21	Mining, quarrying, and oil and gas extraction	3	5	10	29	47
22	Utilities	1	3	6	10	28
23	Construction	3	10	28	29	78
31-33	Manufacturing	21	86	181	251	539
41	Wholesale trade	9	26	72	72	179
44-45	Retail trade	12	27	58	74	171
48-49	Transportation and warehousing	11	29	42	58	140
51	Information and cultural industries	6	12	27	30	75
52	Finance and insurance	5	11	28	52	96
53	Real estate and rental and leasing	3	8	19	22	52
54	Professional, scientific and technical services	1	9	35	41	86
55	Management of companies and enterprises	1	1	1	2	5
56	Administrative and support, waste management and remediation services	2	11	29	34	76
61	Educational services	1	7	12	12	32
62	Health care and social assistance	4	18	30	37	89
71	Arts, entertainment and recreation	3	9	23	34	68
72	Accommodation and food services	2	6	10	18	36
81	Other services (except public administration)	4	14	30	38	86
91	Public administration	5	12	29	29	75
Total		182	323	711	922	2,858

Missing Sectors ?? More at: <https://www150.statcan.gc.ca/n1/pub/71-607-x/71-607-x-202008-eng.htm>
 Upstream Energy - Harvest Process
 Midstream Energy - FIT/forUSE Logistics
 Downstream Energy - USEFUL WASTE
 Forestry Sector
 Food Sector
 Institutional Sector
 ExtraPlanetary

End-Use Energy Consumption by Sectors

End-Use Energy Emissions - see Top Line

Industrial Classifications Structure => Canada's energy expenditure

CO2e is a work bi-product and a feedstock for plant life.

Appendix 3

The Pan Canadian Framework wants pathway identification that is easy to understand; current NIR reporting does not satisfy this basic need.

Table A10-3 Relationship between Canadian Econ

	Economic Category Total
National Inventory Total^{a,b}	729
OIL AND GAS	193
Upstream Oil and Gas	173
Natural Gas Production and Processing	50
Conventional Oil Production	29
Conventional Light Oil Production	16
Conventional Heavy Oil Production	11
Frontier Oil Production	2
Oil Sands (Mining, In-situ, Upgrading) ^c	84
Mining and Extraction	18
In-situ	41
Upgrading	24
Oil, Natural Gas and CO ₂ Transmission	11
Downstream Oil and Gas	21
Petroleum Refining	19
Natural Gas Distribution	1
ELECTRICITY	64
TRANSPORTATION^d	186
Passenger Transport	99
Cars, Light Trucks and Motorcycles	90
Bus, Rail and Domestic Aviation	9
Freight Transport	78
Heavy Duty Trucks, Rail	73
Domestic Aviation and Marine	5
Other: Recreational, Commercial and Residential	9
HEAVY INDUSTRY	78
Mining	8
Smelting and Refining (Non Ferrous Metals)	10
Pulp and Paper	8
Iron and Steel	16
Cement	11
Lime & Gypsum	2
Chemicals & Fertilizers	24
BUILDINGS	92
Service Industry	46
Residential	47
AGRICULTURE	73
On Farm Fuel Use ^e	14
Crop Production	24
Animal Production	36
WASTE	18
Solid Waste ^f	16
Wastewater	1
Waste Incineration	0
COAL PRODUCTION	3
LIGHT MANUFACTURING, CONSTRUCTION & FOREST RESOURCES	22
Light Manufacturing	14
Construction	6
Forest Resources	1

ECONOMIC CATEGORY

OIL & GAS

Gas-

Operation Type

Oil-

Exploration
Separation
Production
Gathering
Aux-Utility ??

Tar-

Camps
Logistics
Storage
Tailings
FIT for Sale

Min-

Ref-

Mfg-

Bio-

Ser-

Be it O&G, Min&Met, etc, heavy industry generically follows a similar approach that is "energy" intensive yet defines work product to work effort for:

- getting into business
- doing its business
- getting out of business

ECONOMIC sectors of main **work product** are typically measured in "units" or tonnes - for example (globally):

Ammonia Manufacture (2019)
175 million tonnes produced
avg >> 38 GJ/te effort
350 million tonnes CO₂e

Steel Production (2019)
1870 million tonnes produced
avg >> 20 GJ/te effort
2805 million tonnes CO₂e

Plastics Production (2019)
360 million tonnes produced
avg >> 20-27 GJ/te effort
2340 million tonnes CO₂e

N^o of Cars / Trucks / Buses
Tonnes of Food, Waste, etc
GWh of Electricity, etc

CO₂e is a bi-product common in **each/all Economic work sectors**

Appendix 4 – Acronyms & Abbreviations

CH₄ – Methane

CO₂ – Carbon Dioxide

CO₂e – Carbon Dioxide equivalent

NH₃ – Ammonia

NO_x – Nitrogen Oxides, especially Nitric Oxide (NO) and Nitrogen Dioxide (NO₂)

CCME – Canadian Council of Ministers of the Environment

CER – Canada Energy Regulator

CFS – Clean Fuel Standard

CI – carbon intensity

ECCC – Environment and Climate Change Canada

EU – European Union

GHG – Greenhouse Gas

GGPPA – Greenhouse Gas Pollution Pricing Act, S.C. 2018, c. 12, s. 186

IPCC – Intergovernmental Panel on Climate Change

LCA – Life Cycle Analyses

LULUCF – Land Use, Land-Use Change and Forestry

NIR – National Inventory Reports – 2020 Edition

NRCan – Natural Resources Canada

SCC – Supreme Court of Canada

StatsCan – Statistics Canada

US EPA – United States Environmental Protection Agency

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