Technical Appendix - Canada:

Methods for estimating community-scale sectoral data from national and regional statistics for the purpose greenhouse gas accounting and climate action planning

Varsha Suresh, Tom Cyrs, and Kevin Kurkul– World Resources Institute

Buildings and Stationary Energy Sector

This document details the calculation approaches and data sources for producing community-level activity data and emission factors for the buildings and stationary energy sector. This sector contains the following subsectors:

Buildings and Stationary Energy Sector	
Residential buildings	Estimated
Commercial buildings	Estimated
Municipal buildings	Not Estimated
Industrial Buildings	Estimated
Agriculture, forestry and fisheries	Estimated
Fugitive emissions	Not Estimated

Residential Buildings

Subsector Summary

The residential buildings subsector encompasses all GHG emitting activities from energy use in households, including heating, cooking, and lighting. The two primary categories of GHG emitting activities within the subsector are: scope 1) emissions from fuel combustion associated with residential buildings within the community boundary and scope 2) emissions from consumption of grid-supplied electricity (which may be generated outside the community boundary).

Inclusions:

For the Canada, based on data availability and country-specific relevance, estimates for the following activity data points are produced:

- **Natural gas**, **residual fuel oil**, and **kerosene/stove oil** consumption by households, based on annual fuel sales to residential customers in each Canadian Province/Territory.
- **Grid-supplied electricity** consumption by households, based on annual electricity sales to residential customers in each Canadian Province/Territory.

Exclusions:

Due to lack of data availability and country-specific relevance, estimates for the following activity data points are not produced:

- **Off-highway motor gasoline** consumption, e.g. for use in lawn and gardening equipment
- **District heating, cooling,** or other non-electricity grid-supplied energy

Activity Data Coverage:

The specific data points and energy sources covered by the methodology are outlined in the table below.

Fuels/Energy Source	GHGDP Definition	Units	Scope
Natural Gas	Natural gas consumption within community boundary for a single year for all households.	MJ	Scope 1
Residual Fuel Oil	Residual fuel oil consumption within community boundary for a single year for all households.	MJ	
Kerosene/Stove oil	Kerosene/stove oil consumption within community boundary for a single year for all households.	MJ	
Grid Electricity	Grid-supplied electricity consumption within community boundary for a single year for all commercial buildings	MJ	Scope 2

Calculation Methodologies:
Scope 1: Natural Gas

Methodology Notes

Residential building natural gas consumption is calculated using Canadian province/territory-level natural gas consumption totals for the residential end-use sector—available through Statistics Canada's *Supply and demand of primary and secondary energy* data table—as initial input data. This input data is combined with computed ratios representing:

- the **proportion of households** in each community relative to province/territory totals, by type
- the **proportion** of total residential natural gas consumption

Household data is sourced from the Canadian Census "Population and Dwelling Count Highlight Tables, 2016 Census" estimates at the town/village level (Statistics Canada, 2016).

Household natural gas consumption is then allocated to the community not simply by number of household units, but also by a **weighted average household intensity**, which takes into consideration the relative natural gas intensity of different household types averaged into one community-wide proportion relative to the province average.

Household intensity weights are calculated using Statistics Canada data on Household energy consumption, by type of dwelling, in Canadian provinces, in combination with the above-mentioned Census housing estimates. derived average natural gas consumption intensity estimates (in MJ/household type) are paired with Census estimates of the number of each corresponding household type (e.g. single-family, multi-unit) within each community to generate average household intensity figures. Final weights thus represent the average natural gas consumption of a household (across all types) within the community boundary, based on the community's estimated household type mix. This is done so that estimates are reflective of the housing context within individual communities, avoiding a simple per-household intensity across all communities and making the data more useful for comparison.

Equation 1: Household NG Consumption

The below equation represents the calculation method utilized to estimate household natural gas consumption.

$$\text{Community-scale household consumption} = \text{aggregate province sales}_{\text{residential}} \times \left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{province}}} \right) \times \left(\frac{\text{avg. household intensity}_{\text{community}}}{\text{avg. household intensity}_{\text{province}}} \right)$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale household consumption	Natural gas consumption within community boundary for a single year for all households.	Equation 1	MJ
Aggregate province sales	Amount of fuel distributed to residential customers within entire province	Statistics Canada 2018	MJ
$\left(\dfrac{\text{total households}_{\text{community}}}{\text{total households}_{\text{province}}}\right)$	Ratio representing the number of households within the community over the number of households within the entire province	Canada Census 2016	households
$\left(\dfrac{\text{avg. household intensity}_{\text{community}}}{\text{avg. household intensity}_{\text{province}}}\right)$	Calculated ratio representing the average household natural gas consumption intensity in the community over the average household natural gas consumption intensity for the province	Calculated ratio	MJ/ household

Methodology Assumptions

General assumptions

- Number of households correlates positively with amount of natural gas consumed (i.e. regional natural gas consumption increases or decreases with number of households)
- Housing units are assumed to have an occupancy rate of 100%
- Household types are assumed to have the same average energy consumption, regardless of size of the household (in terms of number of household members)
- Within a province boundary, factors of climate and individual housing infrastructure that may otherwise impact relative fuel consumption – e.g. relative mix of natural gas or fuel oil used for heating – are not accounted for in the method.
- Province fuel totals from Statistics Canada are assumed to encompass the vast majority of natural gas sales within an entire province.

Scope 1: Residual Fuel Oil

Household residual fuel oil[1] consumption is calculated using Canadian province/territory-residual fuel oil consumption totals for the residential end-use sector—available through Statistics Canada's *Supply and demand of primary and secondary energy* data table—as initial input data. This input data is combined with computed ratios representing:

- the **proportion of households** in each community relative to province/territory totals, by type
- the **proportion** of total residential residual fuel oil consumption). This sales data is combined with computed ratios representing:

Household data is sourced from the Canadian Census "Population and Dwelling Count Highlight Tables, 2016 Census" estimates at the town/village level (Statistics Canada, 2016).

Equation 2: Household RFO Consumption

The below equation represents the calculation method utilized to estimate household distillate fuel oil consumption.

$$\text{Community-scale household consumption} = \text{aggregate province sales}_{\text{residential}} \times \left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{province}}}\right)$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale household consumption	Distillate fuel oil consumption within community boundary for a single year for all households.	Equation 2	MJ
Aggregate province sales	Amount of fuel distributed to residential customers within entire province	Statistics Canada 2018	MJ
$\left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{province}}}\right)$	Ratio representing the number of households within the community over the number of households within the entire province	Canada Census 2016	households

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[1] The EIA defines distillate fuel oil as a general classification for one of the petroleum fractions produced in conventional distillation operations. The category includes diesel fuels and fuel oils. Products known as No. 1, No. 2, and No. 4 diesel fuel are used in on-highway diesel engines, such as those in trucks and automobiles, as well as off-highway engines, such as those in railroad locomotives and agricultural machinery. Products known as No. 1, No. 2, and No. 4 fuel oils are used primarily for space heating and electric power generation.

Methodology Assumptions

General assumptions

- Number of households correlates positively with amount of fuel consumed (i.e. regional fuel consumption increases or decreases with number of households)
- Housing units are assumed to have an occupancy rate of 100%
- Household types are assumed to have the same average energy consumption, regardless of size of the household (in terms of number of household members)
- Within a province boundary, factors of climate and individual housing infrastructure that may otherwise impact relative fuel consumption – e.g. relative mix of natural gas or fuel oil used for heating – are not accounted for in the method.
- Province fuel totals from Statistics Canada are assumed to encompass the vast majority of Residual Fuel Oil sales within an entire province.

Scope 1: Kerosene

Methodology Notes

Residential building kerosene consumption is calculated using Canadian province/territory-level kerosene consumption totals for the residential end-use sector—available through Statistics Canada's *Supply and demand of primary and secondary energy* data table—as initial input data. This input data is combined with computed ratios representing:

- the **proportion of households** in each community relative to province/territory totals, by type
- the **proportion** of total residential kerosene consumption

Household data is sourced from the Canadian Census "Population and Dwelling Count Highlight Tables, 2016 Census" estimates at the town/village level (Statistics Canada, 2016).

Equation 3: Household Kerosene Consumption

The below equation represents the calculation method utilized to estimate household kerosene consumption.

$$\text{Community-scale household consumption} = \text{aggregate province sales}_{residential} \times \left(\frac{\text{total households}_{community}}{\text{total households}_{province}} \right)$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale household consumption	Kerosene consumption within community boundary for a single year for all households	Equation 3	MJ
Aggregate province sales	Amount of fuel distributed to residential customers within entire province	Statistics Canada 2018	MJ
$\left(\dfrac{\text{total households}_{\text{community}}}{\text{total households}_{\text{province}}}\right)$	Ratio representing the number of households within the community over the number of households within the entire province	Canada Census 2016	households

Methodology Assumptions

General assumptions

- Number of households correlates positively with amount of fuel consumed (i.e. regional fuel consumption increases or decreases with number of households)
- Housing units are assumed to have an occupancy rate of 100%
- Household types are assumed to have the same average energy consumption, regardless of size of the household (in terms of number of household members)
- Within a province boundary, factors of climate and individual housing infrastructure that may otherwise impact relative fuel consumption – e.g. relative mix of natural gas or fuel oil used for heating – are not accounted for in the method.
- Province fuel totals from Statistics Canada are assumed to encompass the vast majority of kerosene sales within an entire province.

Scope 2: Electricity

Methodology Notes

Residential building electricity consumption is calculated using Canadian province/territory-level electricity consumption totals for the residential end-use sector—available through Statistics Canada's *Supply and demand of primary and secondary energy* data table—as initial input data. This input data is combined with computed ratios representing:

- the **proportion of households** in each community relative to province/territory totals, by type
- the **proportion** of total residential electricity consumption

Household data is sourced from the Canadian Census "Population and Dwelling Count Highlight Tables, 2016 Census" estimates at the town/village level (Statistics Canada, 2016).

Household electricity consumption is then allocated to the community not simply by number of household units, but also by a **weighted average household intensity**, which takes into consideration the relative electricity intensity of different household types averaged into one community-wide proportion relative to the province average.

Household intensity weights are calculated using Statistics Canada data on Household energy consumption, by type of dwelling, in Canadian provinces, in combination with the above-mentioned Census housing estimates. derived average electricity consumption intensity estimates (in MJ/household type) are paired with Census estimates of the number of each corresponding household type (e.g. single-family, multi-unit) within each community to generate average household intensity figures. Final weights thus represent the average electricity consumption of a household (across all types) within the community boundary, based on the community's estimated household type mix. This is done so that estimates are reflective of the housing context within individual communities, avoiding a simple per-household intensity across all communities and making the data more useful for comparison.

Equation 4: Household Electricity Consumption

The below equation represents the calculation method utilized to estimate household electricity consumption.

$$\text{Community-scale household consumption} = \text{aggregate province sales}_{\text{residential}} \times \left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{province}}}\right) \times \left(\frac{\text{avg. household intensity}_{\text{community}}}{\text{avg. household intensity}_{\text{province}}}\right)$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale household consumption	Electricity consumption within community boundary for a single year for all residential buildings	Equation 4	MJ
Aggregate province sales	Amount of electricity distributed to residential customers within entire province	Statistics Canada 2018	MJ
$\left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{province}}}\right)$	Ratio representing the number of households within the community over the number of households within the entire province	Canada Census 2016	households

$\left(\dfrac{\text{avg. household intensity}_{\text{community}}}{\text{avg. household intensity}_{\text{province}}}\right)$	Calculated ratio representing the average household electricity consumption intensity in the community over the average household consumption intensity for the province	Calculated ratio	MJ/ household

Methodology Assumptions

General assumptions

- Number of households correlates positively with amount of electricity consumed (i.e. regional electricity consumption increases or decreases with number of households)
- Housing units are assumed to have an occupancy rate of 100%
- Household types are assumed to have the same average energy consumption, regardless of size of the household (in terms of number of household members)
- Within a province boundary, factors of climate and individual housing infrastructure that may otherwise impact relative fuel consumption – e.g. relative mix of natural gas or fuel oil used for heating – are not accounted for in the method.
- Province electricity sales from Statistics Canada are assumed to encompass the vast majority of electricity sales within an entire province

Emission Factors:

The following table provides IPCC 2006 emission factor values for the list of fuels used in the buildings and stationary sector methodology for Canada.

Emission Factor Data Elements

Fuel type	Carbon Dioxide (CO2) kg/GJ	Methane (CH4) kg/GJ	Nitrous Oxide (N2O) kg/GJ	Heating Value Mass GJ/ton	Heating Value Liquid Volume GJ/liter	Heating Value Gaseous Volume GJ/m3
Fossil						
Coal	96.1	0.01	0.0015			
Natural Gas	56.1	0.005	0.0001			0.03360
Oil	73.3	0.01	0.0006		0.03384	
Residual Fuel Oil	77.4	0.01	0.0006		0.03798	
Distillate Fuel Oil	74.1	0.01	0.0006		0.03612	
Kerosene	71.9	0.01	0.0006		0.03504	

Liquified Natural Gas (LNG)						
Liquified Petroleum Gas (LPG)	63.1	0.005	0.0001	47.3	0.02554	0.03360
Compressed Natural Gas (CNG)						
Diesel	74.1	0.01	0.0006		0.03612	
Gasoline	69.3	0.01	0.0006		0.03278	
Jet Fuel						
Non-fossil						
Solid biomass						
Liquid Biofuel (Stationary)						
Biogas	54.6	0.005	0.0001			0.03360
Biodiesel	70.8	0.01	0.0006		0.03570	
Ethanol	64.8	0.001	0.0001		0.02343	

The following table provides province-specific electricity grid emission factors, provided by the National Inventory Report 1990-2016.

Province	kg CO_2/MWh	kg CH_4/MWh	kg N_2O/MWh
Newfoundland and Labrador	32	0.0005	0.001
Prince Edward Island	20	0.0008	0.0003
Nova Scotia	600	0.02	0.01
New Brunswick	280	0.02	0.005
Quebec	1.1	0	0.0001
Ontario	40	0.01	0.001
Manitoba	3.3	0.0003	0.0001
Sasketchewan	660	0.04	0.02
Alberta	790	0.04	0.02
British Columbia	12.6	0.003	0.0007
Yukon	39	0.002	0.006
Northwest Territories	370	0.02	0.05
Nunavut	720	0	0

References:

Statistics Canada. 2017. Population and Dwelling Count Highlight Tables. 2016 Census.
https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/hlt-fst/pd-pl/comprehensive.cfm

Statistics Canada. 2018. Supply and demand of primary and secondary energy in terajoules, annual (terajoules)
https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2510002901

Environment and Climate Change Canada. 2018. Electricity in Canada: Summary and Intensity Tables
https://unfccc.int/documents/65715

IPCC. 2006. IPCC Guidelines for National Greenhouse Gas Inventories. Volume 2: Energy.   The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change
https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html

Commercial Buildings

Subsector Summary

The commercial buildings subsector encompasses all GHG emitting activities from energy use in commercial buildings, including heating, cooling, and lighting. The two primary categories of GHG emitting activities within the subsector are: scope 1 emissions from fuel combustion associated with commercial buildings within the community boundary and scope 2 emissions from consumption of grid-supplied electricity.

Inclusions

For Canada, based on data availability and occurrence in-country, estimates for the following activity data points are produced:

- **Natural gas**, **distillate fuel oil**, **residual fuel oil** and **kerosene** used by commercial buildings, based on annual fuel consumption by customers in each Canadian Province/Territory
- **Grid-supplied electricity** used by commercial businesses, based on annual electricity consumed by commercial customers in each Canadian Province/Territory

Exclusions

Due to lack of data availability or occurrence in-country, estimates for the following activity data points are not produced:

- **Off-highway motor gasoline** consumption, e.g. for use in landscaping equipment
- **District heating, cooling,** or other non-electricity grid-supplied energy

Activity Data Coverage

The specific data points and energy sources covered by the methodology are outlined in the table below.

Fuels/Energy Source	Definition	Units	Scope
Natural Gas	Natural gas consumption within community boundary for a single year for all commercial buildings	MJ	Scope 1
Distillate Fuel Oil	Distillate fuel oil consumption within community boundary for a single year for all commercial buildings	MJ	Scope 1
Residual Fuel Oil	Residual Fuel Oil consumption within community boundary for a single year for all commercial buildings	MJ	Scope 1
Kerosene	Kerosene consumption within community boundary for a single year for all commercial buildings	MJ	Scope 1

Grid Electricity	Grid-supplied electricity consumption within community boundary for a single year for all commercial buildings	MJ	Scope 2

Calculation Methodologies

Scope 1: Natural Gas (NG)

Methodology Notes

Commercial building natural gas consumption is calculated using Canadian province/territory-level natural gas consumption totals for the commercial end-use sector—available through Statistics Canada's *Supply and demand of primary and secondary energy* data table—as initial input data. This initial input data is allocated to communities based on the **proportion of employees** in the community relative to the province totals.

Total counts of employees, by community, was obtained upon request from Statistics Canada's business and employee counts data for 2017. This data is not publicly available.

The following equation is utilized to estimate commercial sector natural gas consumption.

Equation 5:Commercial Natural Gas consumption

$$\text{Community-scale commercial consumption} = \text{aggregate province sales}_{\text{commercial}} \times \left(\frac{\text{sector employees}_{\text{community}}}{\text{sector employees}_{\text{province}}} \right)$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale commercial consumption	Natural gas consumption within community boundary for a single year for all commercial buildings	Equation 5	MJ
Province level fuel consumption commercial sector	Amount of fuel consumed by commercial customers within entire province in 2018	Statistics Canada 2018	MJ
Commercial employees - community	Estimated number of commercial sector employees for the community	Statistics Canada 2017	Employees

Commercial employees - province	Estimated number of commercial sector employees within province	Statistics Canada 2017	Employees

Methodology Assumptions

General assumptions

- Number of households correlates positively with amount of natural gas consumed (i.e. regional natural gas consumption increases or decreases with number of households)
- Housing units are assumed to have an occupancy rate of 100%
- Household types are assumed to have the same average energy consumption, regardless of size of the household (in terms of number of household members)
- Within a province boundary, factors of climate and individual housing infrastructure that may otherwise impact relative fuel consumption – e.g. relative mix of natural gas or fuel oil used for heating – are not accounted for in the method.
- Province Fuel Totals from Statistics Canada are assumed to encompass the vast majority of natural gas sales within an entire province.

Scope 1: Distillate Fuel Oil

Methodology Notes

Commercial building distillate fuel oil consumption is calculated using Canadian province/territory-level distillate fuel oil consumption totals for the commercial end-use sector—available through Statistics Canada's *Supply and demand of primary and secondary energy* data table—as initial input data. This initial input data is allocated to communities based on the **proportion of employees** in the community relative to the province totals.

Total counts of employees, by community, was obtained upon request from Statistics Canada's business and employee counts data for 2017. This data is not publicly available.

The following equation is utilized to estimate commercial distillate fuel oil consumption.

Equation 1:Commercial DFO consumption

$$\text{Community-scale commercial consumption} = \text{aggregate province sales}_{commercial} \times \left(\frac{\text{sector employees}_{community}}{\text{sector employees}_{province}} \right)$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale commercial consumption	Distillate fuel oil consumption within community boundary for a single year for all commercial buildings	Equation 6	MJ
Province level fuel consumption commercial sector	Amount of fuel consumed by commercial customers within the province	Statistics Canada 2018	MJ
Commercial employees - community	Estimated number of commercial sector employees for the community	Statistics Canada 2017	Employees
Commercial employees - province	Estimated number of commercial sector employees within the province	Statistics Canada 2017	Employees

Methodology Assumptions

General assumptions

- Number of households correlates positively with amount of fuel consumed (i.e. regional fuel consumption increases or decreases with number of households)
- Housing units are assumed to have an occupancy rate of 100%
- Household types are assumed to have the same average energy consumption, regardless of size of the household (in terms of number of household members)
- Within a province boundary, factors of climate and individual housing infrastructure that may otherwise impact relative fuel consumption – e.g. relative mix of natural gas or fuel oil used for heating – are not accounted for in the method.
- Province Fuel totals from Statistics Canada are assumed to encompass the vast majority of fuel sales within an entire province.

Scope 1: Residual Fuel Oil

Methodology Notes

Commercial building residual fuel oil consumption is calculated using Canadian province/territory-level residual fuel oil consumption totals for the commercial end-use sector—available through Statistics Canada's *Supply and demand of primary and secondary energy* data table—as initial input data. This

initial input data is allocated to communities based on the **proportion of employees** in the community relative to the province totals.

Total counts of employees, by community, was obtained upon request from Statistics Canada's business and employee counts data for 2017. This data is not publicly available.

The following equation is utilized to estimate commercial sector residual fuel oil consumption.

Equation 7: Commercial RFO consumption

$$\text{Community-scale commercial consumption} = \text{aggregate province sales}_{commercial} \times \left(\frac{\text{sector employees}_{community}}{\text{sector employees}_{province}} \right)$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale commercial consumption	Residual fuel oil consumption within community boundary for a single year for all commercial buildings	Equation 7	MJ
Province fuel consumption commercial sector	Amount of fuel consumed by commercial customers within entire province	Statistics Canada 2018	MJ
Commercial employees - community	Estimated number of commercial sector employees for the community	Statistics Canada 2017	Employees
Commercial employees - province	Estimated number of commercial sector employees within province	Statistics Canada 2017	Employees

Methodology Assumptions

General assumptions

- Number of households correlates positively with amount of fuel consumed (i.e. regional electricity consumption increases or decreases with number of households)
- Housing units are assumed to have an occupancy rate of 100%
- Household types are assumed to have the same average energy consumption, regardless of size of the household (in terms of number of household members)
- Within a province boundary, factors of climate and individual housing infrastructure that may otherwise impact relative fuel consumption – e.g. relative mix of natural gas or fuel oil used for heating – are not accounted for in the method.

- Province Fuel Totals from Statistics Canada are assumed to encompass the vast majority of fuel sales within an entire province.

Scope 1: Kerosene

Methodology Notes

Commercial building kerosene consumption is calculated using Canadian province/territory-level kerosene consumption totals for the commercial end-use sector—available through Statistics Canada's *Supply and demand of primary and secondary energy* data table—as initial input data. This initial input data is allocated to communities based on the **proportion of employees** in the community relative to the province totals.

Total counts of employees, by community, was obtained upon request from Statistics Canada's business and employee counts data for 2017. This data is not publicly available.

The following equation is utilized to estimate commercial sector kerosene consumption.

Equation 8: Commercial Kerosene consumption

$$\text{Community-scale commercial consumption} = \text{aggregate province sales}_{commercial} \times \left(\frac{\text{sector employees}_{community}}{\text{sector employees}_{province}}\right)$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale commercial consumption	Kerosene consumption within community boundary for a single year for all commercial buildings	Equation 8	MJ
province fuel consumption commercial sector	Amount of fuel consumed by commercial customers within entire province	Statistics Canada 2018	MJ
Commercial employees - community	Estimated number of commercial sector employees for the community	Statistics Canada 2017	Employees
Commercial employees - province	Estimated number of commercial sector employees within province	Statistics Canada 2017	Employees

Methodology Assumptions

General assumptions

- Number of households correlates positively with amount of kerosene consumed (i.e. regional electricity consumption increases or decreases with number of households)
- Housing units are assumed to have an occupancy rate of 100%
- Household types are assumed to have the same average energy consumption, regardless of size of the household (in terms of number of household members)
- Within a province boundary, factors of climate and individual housing infrastructure that may otherwise impact relative fuel consumption – e.g. relative mix of natural gas or fuel oil used for heating – are not accounted for in the method.
- Province Fuel Totals from Statistics Canada are assumed to encompass the vast majority of kerosene sales within an entire province.

Scope 2: Electricity

Methodology Notes

Commercial building electricity consumption is calculated using Canadian province/territory-level electricity consumption totals for the residential end-use sector—available through Statistics Canada's *Supply and demand of primary and secondary energy* data table—as initial input data. This initial input data is allocated to communities based on the **proportion of employees** in the community relative to the province totals.

Total counts of employees, by community, was obtained upon request from Statistics Canada's business and employee counts data for 2017. This data is not publicly available.

The following equation is utilized to estimate commercial sector electricity consumption.

Equation 9: Commercial Electricity Consumption

The below equation represents the calculation method utilized to estimate commercial electricity consumption.

$$\text{Community-scale commercial consumption} = \text{aggregate province sales}_{commercial} \times \left(\frac{\text{sector employees}_{community}}{\text{sector employees}_{province}} \right)$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale commercial consumption	Electricity consumption within community boundary for a single year for all commercial buildings	Equation 9	MJ

Aggregate province sales	Amount of electricity distributed to commercial customers within entire province	Statistics Canada 2018	MJ
Commercial employees - community	Estimated number of commercial sector employees for the community in 2017	Statistics Canada 2017	Employees
Commercial employees - provincial	Estimated number of commercial sector employees within province in 2017	Statistics Canada 2017	Employees

Methodology Assumptions

General assumptions

- Number of households correlates positively with amount of electricity consumed (i.e. regional electricity consumption increases or decreases with number of households)
- Housing units are assumed to have an occupancy rate of 100%
- Household types are assumed to have the same average energy consumption, regardless of size of the household (in terms of number of household members)
- Within a province boundary, factors of climate and individual housing infrastructure that may otherwise impact relative fuel consumption – e.g. relative mix of natural gas or fuel oil used for heating – are not accounted for in the method.
- Province Fuel Totals from Statistics Canada are assumed to encompass the vast majority of electricity sales within an entire province.

Emission Factors:

The following table provides IPCC 2006 emission factor values for the list of fuels used in the buildings and stationary sector methodology for Canada.

Emission Factor Data Elements

Fuel type	Carbon Dioxide (CO2) kg/GJ	Methane (CH4) kg/GJ	Nitrous Oxide (N2O) kg/GJ	Heating Value Mass GJ/ton	Heating Value Liquid Volume GJ/liter	Heating Value Gaseous Volume GJ/m3
Fossil						
Coal	96.1	0.01	0.0015			
Natural Gas	56.1	0.005	0.0001			0.03360
Oil	73.3	0.01	0.0006		0.03384	

Residual Fuel Oil	77.4	0.01	0.0006		0.03798	
Distillate Fuel Oil	74.1	0.01	0.0006		0.03612	
Kerosene	71.9	0.01	0.0006		0.03504	
Liquified Natural Gas (LNG)						
Liquified Petroleum Gas (LPG)	63.1	0.005	0.0001	47.3	0.02554	0.03360
Compressed Natural Gas (CNG)						
Diesel	74.1	0.01	0.0006		0.03612	
Gasoline	69.3	0.01	0.0006		0.03278	
Jet Fuel						
Non-fossil						
Solid biomass						
Liquid Biofuel (Stationary)						
Biogas	54.6	0.005	0.0001			0.03360
Biodiesel	70.8	0.01	0.0006		0.03570	
Ethanol	64.8	0.001	0.0001		0.02343	

The following table provides province-specific electricity grid emission factors, provided by the National Inventory Report 1990-2016.

Province	kg CO_2/MWh	kg CH_4/MWh	kg N_2O/MWh
Newfoundland and Labrador	32	0.0005	0.001
Prince Edward Island	20	0.0008	0.0003
Nova Scotia	600	0.02	0.01
New Brunswick	280	0.02	0.005
Quebec	1.1	0	0.0001
Ontario	40	0.01	0.001
Manitoba	3.3	0.0003	0.0001
Sasketchewan	660	0.04	0.02
Alberta	790	0.04	0.02
British Columbia	12.6	0.003	0.0007
Yukon	39	0.002	0.006
Northwest Territories	370	0.02	0.05
Nunavut	720	0	0

References:

Statistics Canada. 2018. Supply and demand of primary and secondary energy in terajoules, annual (terajoules)
https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2510002901

Environment and Climate Change Canada. 2018. Electricity in Canada: Summary and Intensity Tables
https://unfccc.int/documents/65715

IPCC. 2006. IPCC Guidelines for National Greenhouse Gas Inventories. Volume 2: Energy. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change
https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html

Statistics Canada 2017. Employee counts by sector at community level and province level obtained upon request.

Industrial Buildings

Subsector Summary

The industrial buildings subsector encompasses all GHG emitting activities from energy use in industrial buildings, including heating, cooling, and lighting. The two primary categories of GHG emitting activities within the subsector are: scope 1 emissions from fuel combustion associated with industrial buildings within the community boundary and scope 2 emissions from consumption of grid-supplied electricity.

Inclusions

For Canada, based on data availability and occurrence in-country, estimates for the following activity data points are produced:

- **Natural gas**, **distillate fuel oil** and **residual fuel oil** used by industrial buildings, based on annual fuel consumption by customers in each Canadian Province/Territory
- **Grid-supplied electricity** used by industrial businesses, based on annual electricity consumed by industrial customers in each Canadian Province/Territory

Exclusions

Due to lack of data availability or occurrence in-country, estimates for the following activity data points are not produced:

- **Off-highway motor gasoline** consumption, e.g. for use in landscaping equipment
- **District heating, cooling,** or other non-electricity grid-supplied energy

Activity Data Coverage

The specific data points and energy sources covered by the methodology are outlined in the table below.

Fuels/Energy Source	Definition	Units	Scope
Natural Gas	Natural gas consumption within community boundary for a single year for all industrial buildings	MJ	Scope 1
Distillate Fuel Oil	Distillate fuel oil consumption within community boundary for a single year for all industrial buildings	MJ	Scope 1
Residual Fuel Oil	Residual Fuel Oil consumption within community boundary for a single year for all industrial buildings	MJ	Scope 1
Grid Electricity	Grid-supplied electricity consumption within community boundary for a single year for all industrial buildings	MJ	Scope 2

Calculation Methodologies

Scope 1: Natural Gas (NG)

Methodology Notes

Industrial building natural gas consumption is calculated using Canadian province/territory-level natural gas consumption totals for the industrial end-use sector—available through Statistics Canada's *Supply and demand of primary and secondary energy* data table—as initial input data. This initial input data is allocated to communities based on the **proportion of employees in the industrial sector** in the community relative to the province totals. The industrial energy sales data is disaggregated by industry type at a province level in Canada. The totals by subtype (manufacturing, construction, or mining/quarrying/oil & gas) are multiplied by the share of employees in that subsector in community and then summed up to obtain the community scale industrial fuel consumption.

Total counts of employees, by community, was obtained upon request from Statistics Canada's business and employee counts data for 2017. This data is not publicly available. For industrial sector, employee counts were available by industrial sub sectors (manufacturing, construction, etc.) which were summed up together to obtain the final industrial employee count.

The following equation is utilized to estimate industrial sector natural gas consumption.

Equation 10:Industrial Natural Gas consumption

$$\text{Community-scale industrial consumption} =$$
$$\sum_{\text{sub sectors}} \text{aggregate province sales}_{\text{industrial sub sector}} \times \left(\frac{\text{sub sector employees}_{\text{community}}}{sub \text{ sector employees}_{\text{Province}}} \right)$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale industrial consumption	Natural gas consumption within community boundary for a single year for all industrial buildings	Equation 10	MJ
Province fuel consumption industrial sector	Amount of fuel consumed by industrial customers within entire province	Statistics Canada 2018	MJ
Industrial employees - community	Estimated number of industrial sector employees for the community	Statistics Canada 2017	Employees

Industrial employees - province	Estimated number of industrial sector employees within province	Statistics Canada 2017	Employees

Methodology Assumptions

General assumptions

- Number of households correlates positively with amount of natural gas consumed (i.e. regional natural gas consumption increases or decreases with number of households)
- Housing units are assumed to have an occupancy rate of 100%
- Household types are assumed to have the same average energy consumption, regardless of size of the household (in terms of number of household members)
- Within a province boundary, factors of climate and individual housing infrastructure that may otherwise impact relative fuel consumption – e.g. relative mix of natural gas or fuel oil used for heating – are not accounted for in the method.
- Province Fuel Totals from Statistics Canada are assumed to encompass the vast majority of natural gas sales within an entire province.

Scope 1: Distillate Fuel Oil

Methodology Notes

Industrial building distillate fuel oil consumption is calculated using Canadian province/territory-level distillate fuel oil consumption totals for the industrial end-use sector—available through Statistics Canada's *Supply and demand of primary and secondary energy* data table—as initial input data. This initial input data is allocated to communities based on the **proportion of employees** in the industrial sector in the community relative to the province totals. The industrial energy sales data is disaggregated by industry type at a province level in Canada. The totals by subtype (manufacturing, construction, or mining/quarrying/oil & gas) are multiplied by the share of employees in that subsector in community and then summed up to obtain the community scale industrial fuel consumption.

Total counts of employees, by community, was obtained upon request from Statistics Canada's business and employee counts data for 2017. This data is not publicly available. For industrial sector, employee counts were available by industrial sub sectors (manufacturing, construction, etc.) which were summed up together to obtain the final industrial employee count.

The following equation is utilized to estimate industrial distillate fuel oil consumption.

Equation 11: Industrial DFO consumption

$$\text{Community-scale industrial consumption} = \sum_{\text{sub sectors}} \text{aggregate province sales}_{\text{industrial sub sector}} \times$$

$$\left(\frac{\text{sub sector employees}_{\text{community}}}{\text{sub sector employees}_{\text{Province}}}\right)$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale industrial consumption	Distillate fuel oil consumption within community boundary for a single year for all industrial buildings	Equation 11	MJ
Province fuel consumption industrial sector	Amount of fuel consumed by industrial customers within entire province	Statistics Canada 2018	MJ
Industrial employees - community	Estimated number of industrial sector employees for the community	Statistics Canada 2017	Employees
Industrial employees - province	Estimated number of industrial sector employees within province	Statistics Canada 2017	Employees

Methodology Assumptions

General assumptions

- Number of households correlates positively with amount of fuel consumed (i.e. regional fuel consumption increases or decreases with number of households)
- Housing units are assumed to have an occupancy rate of 100%
- Household types are assumed to have the same average energy consumption, regardless of size of the household (in terms of number of household members)
- Within a province boundary, factors of climate and individual housing infrastructure that may otherwise impact relative fuel consumption – e.g. relative mix of natural gas or fuel oil used for heating – are not accounted for in the method.
- Province Fuel Totals from Statistics Canada are assumed to encompass the vast majority of fuel sales within an entire province.

Scope 1: Residual Fuel Oil

Methodology Notes

Industrial building residual fuel oil consumption is calculated using Canadian province/territory-level residual fuel oil consumption totals for the industrial end-use sector—available through Statistics Canada's *Supply and demand of primary and secondary energy* data table—as initial input data. This initial input data is allocated to communities based on the **proportion of employees** in the community relative to the province totals. The industrial energy sales data is disaggregated by industry type at a province level in Canada. The totals by subtype (manufacturing, construction, or mining/quarrying/oil & gas) are multiplied by the share of employees in that subsector in community and then summed up to obtain the community scale industrial fuel consumption.

Total counts of employees, by community, was obtained upon request from Statistics Canada's business and employee counts data for 2017. This data is not publicly available. For industrial sector, employee counts were available by industrial sub sectors (manufacturing, construction, etc.) which were summed up together to obtain the final industrial employee count.

The following equation is utilized to estimate industrial sector residual fuel oil consumption.

Equation 12: Industrial RFO consumption

$$\text{Community-scale industrial consumption} = \sum_{\text{sub sectors}} \text{aggregate province sales}_{\text{industrial sub sector}} \times \left(\frac{\text{sub sector employees}_{\text{community}}}{\textit{sub} \text{ sector employees}_{\text{Province}}} \right)$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale industrial consumption	Residual fuel oil consumption within community boundary for a single year for all industrial buildings	Equation 12	MJ
Aggregate province sales	Amount of fuel consumed by industrial customers within entire province	Statistics Canada 2018	MJ
Industrial employees - community	Estimated number of industrial sector employees for the community	Statistics Canada 2017	Employees
Industrial employees - province	Estimated number of industrial sector employees within province	Statistics Canada 2017	Employees

Methodology Assumptions

General assumptions

- Number of households correlates positively with amount of fuel consumed (i.e. regional fuel consumption increases or decreases with number of households)
- Housing units are assumed to have an occupancy rate of 100%
- Household types are assumed to have the same average energy consumption, regardless of size of the household (in terms of number of household members)
- Within a province boundary, factors of climate and individual housing infrastructure that may otherwise impact relative fuel consumption – e.g. relative mix of natural gas or fuel oil used for heating – are not accounted for in the method.
- Province Fuel Totals from Statistics Canada are assumed to encompass the vast majority of fuel sales within an entire province.

Scope 2: Electricity

Methodology Notes

Industrial building electricity consumption is calculated using Canadian province/territory-level electricity consumption totals for the industrial end-use sector—available through Statistics Canada's *Supply and demand of primary and secondary energy* data table—as initial input data. This initial input data is allocated to communities based on the **proportion of employees** in the community relative to the province totals. The industrial energy sales data is disaggregated by industry type at a province level in Canada. The totals by subtype (manufacturing, construction, or mining/quarrying/oil & gas) are multiplied by the share of employees in that subsector in community and then summed up to obtain the community scale industrial fuel consumption.

Total counts of employees, by community, was obtained upon request from Statistics Canada's business and employee counts data for 2017. This data is not publicly available. For industrial sector, employee counts were available by industrial sub sectors (manufacturing, construction, etc.) which were summed up together to obtain the final industrial employee count.

The following equation is utilized to estimate industrial sector electricity consumption.

Equation 13: Industrial Electricity Consumption

The below equation represents the calculation method utilized to estimate industrial electricity consumption.

$$\text{Community-scale industrial consumption} = \sum_{\text{sub sectors}} \text{aggregate province sales}_{\text{industrial sub sector}} \times \left(\frac{\text{sub sector employees}_{\text{community}}}{\text{sub sector employees}_{\text{Province}}} \right)$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale industrial consumption	Electricity consumption within community boundary for a single year for all industrial buildings	Equation 13	MJ
Aggregate province sales	Amount of electricity distributed to commercial customers within entire province	Statistics Canada 2018	MJ
Industrial employees - community	Estimated number of industrial sector employees for the community	Statistics Canada 2017	Employees
Industrial employees - provincial	Estimated number of industrial sector employees within province	Statistics Canada 2017	Employees

Methodology Assumptions

General assumptions

- Number of households correlates positively with amount of electricity consumed (i.e. regional electricity consumption increases or decreases with number of households)
- Housing units are assumed to have an occupancy rate of 100%
- Household types are assumed to have the same average energy consumption, regardless of size of the household (in terms of number of household members)
- Within a province boundary, factors of climate and individual housing infrastructure that may otherwise impact relative fuel consumption – e.g. relative mix of natural gas or fuel oil used for heating – are not accounted for in the method.
- Province Fuel Totals from Statistics Canada are assumed to encompass the vast majority of electricity sales within an entire province.

Emission Factors:

The following table provides IPCC 2006 emission factor values for the list of fuels used in the buildings and stationary sector methodology for Canada.

Emission Factor Data Elements

Fuel type	Carbon Dioxide (CO2) kg/GJ	Methane (CH4) kg/GJ	Nitrous Oxide (N2O) kg/GJ	Heating Value Mass GJ/ton	Heating Value Liquid Volume GJ/liter	Heating Value Gaseous Volume GJ/m3
Fossil						
Coal	96.1	0.01	0.0015			
Natural Gas	56.1	0.005	0.0001			0.03360
Oil	73.3	0.01	0.0006		0.03384	
Residual Fuel Oil	77.4	0.01	0.0006		0.03798	
Distillate Fuel Oil	74.1	0.01	0.0006		0.03612	
Kerosene	71.9	0.01	0.0006		0.03504	
Liquified Natural Gas (LNG)						
Liquified Petroleum Gas (LPG)	63.1	0.005	0.0001	47.3	0.02554	0.03360
Compressed Natural Gas (CNG)						
Diesel	74.1	0.01	0.0006		0.03612	
Gasoline	69.3	0.01	0.0006		0.03278	
Jet Fuel						
Non-fossil						
Solid biomass						
Liquid Biofuel (Stationary)						
Biogas	54.6	0.005	0.0001			0.03360
Biodiesel	70.8	0.01	0.0006		0.03570	
Ethanol	64.8	0.001	0.0001		0.02343	

The following table provides province-specific electricity grid emission factors, provided by the National Inventory Report 1990-2016.

Province	kg CO_2/MWh	kg CH_4/MWh	kg N_2O/MWh
Newfoundland and Labrador	32	0.0005	0.001
Prince Edward Island	20	0.0008	0.0003
Nova Scotia	600	0.02	0.01
New Brunswick	280	0.02	0.005
Quebec	1.1	0	0.0001
Ontario	40	0.01	0.001

Manitoba	3.3	0.0003	0.0001
Sasketchewan	660	0.04	0.02
Alberta	790	0.04	0.02
British Columbia	12.6	0.003	0.0007
Yukon	39	0.002	0.006
Northwest Territories	370	0.02	0.05
Nunavut	720	0	0

References:

Statistics Canada. 2018. Supply and demand of primary and secondary energy in terajoules, annual (terajoules)
https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2510002901

Environment and Climate Change Canada. 2018. Electricity in Canada: Summary and Intensity Tables
https://unfccc.int/documents/65715

IPCC. 2006. IPCC Guidelines for National Greenhouse Gas Inventories. Volume 2: Energy.   The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change
https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html

Statistics Canada 2017. Employee counts by sector at community level and province level obtained upon request.

AFF Buildings

Subsector Summary

The AFF buildings subsector encompasses all GHG emitting activities from energy use in AFF buildings, including heating, cooling, and lighting. The two primary categories of GHG emitting activities within the subsector are: scope 1 emissions from fuel combustion associated with AFF buildings within the community boundary and scope 2 emissions from consumption of grid-supplied electricity.

Inclusions

For Canada, based on data availability and occurrence in-country, estimates for the following activity data points are produced:

- **Natural gas**, **distillate fuel oil** and **residual fuel oil** used by AFF buildings, based on annual fuel consumption by customers in each Canadian Province/Territory
- **Grid-supplied electricity** used by industrial businesses, based on annual electricity consumed by AFF customers in each Canadian Province/Territory

Exclusions

Due to lack of data availability or occurrence in-country, estimates for the following activity data points are not produced:

- **Off-highway motor gasoline** consumption, e.g. for use in landscaping equipment
- **District heating, cooling,** or other non-electricity grid-supplied energy

Activity Data Coverage

The specific data points and energy sources covered by the methodology are outlined in the table below.

Fuels/Energy Source	Definition	Units	Scope
Natural Gas	Natural gas consumption within community boundary for a single year for all AFF buildings	MJ	Scope 1
Distillate Fuel Oil	Distillate fuel oil consumption within community boundary for a single year for all AFF buildings	MJ	Scope 1
Residual Fuel Oil	Residual Fuel Oil consumption within community boundary for a single year for all AFF buildings	MJ	Scope 1
Grid Electricity	Grid-supplied electricity consumption within community boundary for a single year for all AFF buildings	MJ	Scope 2

Calculation Methodologies

Scope 1: Natural Gas (NG)

Methodology Notes

AFF building natural gas consumption is calculated using Canadian province/territory-level natural gas consumption totals for the AFF end-use sector—available through Statistics Canada's *Supply and demand of primary and secondary energy* data table—as initial input data. This initial input data is allocated to communities based on the **proportion of employees in the AFF sector** in the community relative to the province totals.

Total counts of employees, by community, was obtained upon request from Statistics Canada's business and employee counts data for 2017. This data is not publicly available.

The following equation is utilized to estimate AFF sector natural gas consumption.

Equation 14: AFF Natural Gas consumption

$$\text{Community-scale AFF consumption} = \text{aggregate province sales}_{AFF} \times \left(\frac{\text{sector employees}_{community}}{\text{sector employees}_{Province}} \right)$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale AFF consumption	Natural gas consumption within community boundary for a single year for all AFF buildings	Equation 14	MJ
Aggregate province sales	Amount of fuel consumed by AFF customers within the province	Statistics Canada 2018	MJ
AFF employees - community	Estimated number of AFF sector employees for the community in 2014	Statistics Canada 2017	Employees
AFF employees - provincial	Estimated number of AFF sector employees within province	Statistics Canada 2017	Employees

Methodology Assumptions

General assumptions

- Number of households correlates positively with amount of natural gas consumed (i.e. regional natural gas consumption increases or decreases with number of households)

- Housing units are assumed to have an occupancy rate of 100%
- Household types are assumed to have the same average energy consumption, regardless of size of the household (in terms of number of household members)
- Within a province boundary, factors of climate and individual housing infrastructure that may otherwise impact relative fuel consumption – e.g. relative mix of natural gas or fuel oil used for heating – are not accounted for in the method.
- Province Fuel Totals from Statistics Canada are assumed to encompass the vast majority of province sales within an entire province.

Scope 1: Distillate Fuel Oil

Methodology Notes

AFF building distillate fuel oil consumption is calculated using Canadian province/territory-level distillate fuel oil consumption totals for the AFF end-use sector—available through Statistics Canada's *Supply and demand of primary and secondary energy* data table—as initial input data. This initial input data is allocated to communities based on the **proportion of employees** in the AFF sector in the community relative to the province totals.

Total counts of employees, by community, was obtained upon request from Statistics Canada's business and employee counts data for 2017. This data is not publicly available.

The following equation is utilized to estimate AFF distillate fuel oil consumption.

Equation 15: AFF DFO consumption

$$\text{Community-scale AFF consumption} = \text{aggregate province sales}_{AFF} \times \left(\frac{\text{sector employees}_{community}}{\text{sector employees}_{Province}} \right)$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale AFF consumption	Distillate fuel oil consumption within community boundary for a single year for all AFF buildings	Equation 15	MJ
Province fuel consumption AFF sector	Amount of fuel consumed by AFF customers within the province	Statistics Canada 2018	MJ
AFF employees - community	Estimated number of AFF sector employees for the community	Statistics Canada 2017	Employees

AFF employees - provincial	Estimated number of AFF sector employees within the province	Statistics Canada 2017	Employees

Methodology Assumptions

General assumptions

- Number of households correlates positively with amount of fuel consumed (i.e. regional fuel consumption increases or decreases with number of households)
- Housing units are assumed to have an occupancy rate of 100%
- Household types are assumed to have the same average energy consumption, regardless of size of the household (in terms of number of household members)
- Within a province boundary, factors of climate and individual housing infrastructure that may otherwise impact relative fuel consumption – e.g. relative mix of natural gas or fuel oil used for heating – are not accounted for in the method.
- Province Fuel Totals from Statistics Canada are assumed to encompass the vast majority of fuel sales within an entire province.

Scope 2: Electricity

Methodology Notes

AFF building electricity consumption is calculated using Canadian province/territory-level electricity consumption totals for the AFF end-use sector—available through Statistics Canada's *Supply and demand of primary and secondary energy* data table—as initial input data. This initial input data is allocated to communities based on the **proportion of employees** in the community relative to the province totals.

Total counts of employees, by community, was obtained upon request from Statistics Canada's business and employee counts data for 2017. This data is not publicly available.

The following equation is utilized to estimate AFF sector electricity consumption.

Equation 16: AFF Electricity Consumption

The below equation represents the calculation method utilized to estimate AFF electricity consumption.

$$\text{Community-scale AFF consumption} = \text{aggregate province sales}_{AFF} \times \left(\frac{\text{sector employees}_{community}}{\text{sector employees}_{province}} \right)$$

Equation Data Elements

Data element	Description	Source	Units

Community-scale AFF consumption	Electricity consumption within community boundary for a single year for all AFF buildings	Equation 16	MJ
Aggregate province sales	Amount of electricity distributed to AFF customers within entire province	Statistics Canada 2018	MJ
AFF employees - community	Estimated number of AFF sector employees for the community	Statistics Canada 2017	Employees
AFF employees - provincial	Estimated number of AFF sector employees within province	Statistics Canada 2017	Employees

Methodology Assumptions

General assumptions and limitations

- Number of households correlates positively with amount of electricity consumed (i.e. regional electricity consumption increases or decreases with number of households)
- Housing units are assumed to have an occupancy rate of 100%
- Household types are assumed to have the same average energy consumption, regardless of size of the household (in terms of number of household members)
- Within a province boundary, factors of climate and individual housing infrastructure that may otherwise impact relative fuel consumption – e.g. relative mix of natural gas or fuel oil used for heating – are not accounted for in the method.
- Province Fuel Totals from Statistics Canada are assumed to encompass the vast majority of electricity sales within an entire province.

Emission Factors:

The following table provides IPCC 2006 emission factor values for the list of fuels used in the buildings and stationary sector methodology for Canada.

Emission Factor Data Elements

Fuel type	Carbon Dioxide (CO2) kg/GJ	Methane (CH4) kg/GJ	Nitrous Oxide (N2O) kg/GJ	Heating Value Mass GJ/ton	Heating Value Liquid Volume GJ/liter	Heating Value Gaseous Volume GJ/m3
Fossil						
Coal	96.1	0.01	0.0015			
Natural Gas	56.1	0.005	0.0001			0.03360
Oil	73.3	0.01	0.0006		0.03384	
Residual Fuel Oil	77.4	0.01	0.0006		0.03798	
Distillate Fuel Oil	74.1	0.01	0.0006		0.03612	
Kerosene	71.9	0.01	0.0006		0.03504	
Liquified Natural Gas (LNG)						
Liquified Petroleum Gas (LPG)	63.1	0.005	0.0001	47.3	0.02554	0.03360
Compressed Natural Gas (CNG)						
Diesel	74.1	0.01	0.0006		0.03612	
Gasoline	69.3	0.01	0.0006		0.03278	
Jet Fuel						
Non-fossil						
Solid biomass						
Liquid Biofuel (Stationary)						
Biogas	54.6	0.005	0.0001			0.03360
Biodiesel	70.8	0.01	0.0006		0.03570	
Ethanol	64.8	0.001	0.0001		0.02343	

The following table provides province-specific electricity grid emission factors, provided by the National Inventory Report 1990-2016.

Province	kg CO_2/MWh	kg CH_4/MWh	kg N_2O/MWh
Newfoundland and Labrador	32	0.0005	0.001
Prince Edward Island	20	0.0008	0.0003
Nova Scotia	600	0.02	0.01
New Brunswick	280	0.02	0.005
Quebec	1.1	0	0.0001
Ontario	40	0.01	0.001

Manitoba	3.3	0.0003	0.0001
Sasketchewan	660	0.04	0.02
Alberta	790	0.04	0.02
British Columbia	12.6	0.003	0.0007
Yukon	39	0.002	0.006
Northwest Territories	370	0.02	0.05
Nunavut	720	0	0

References:

Statistics Canada. 2018. Supply and demand of primary and secondary energy in terajoules, annual (terajoules)
https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2510002901

Environment and Climate Change Canada. 2018. Electricity in Canada: Summary and Intensity Tables
https://unfccc.int/documents/65715

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https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html

Statistics Canada 2017. Employee counts by sector at community level and province level obtained upon request.

Transportation and Mobile Energy Sector

This document details the calculation approaches and data sources for producing community-level activity data and emission factors for the transportation and mobile energy sector. This sector contains the following subsectors:

Transportation and Mobile Energy Sector	
On-road	Estimated
Rail	Not Estimated
Waterborne navigation	Not Estimated
Aviation	Not Estimated
Off-road	Not Estimated

On-Road

Subsector Summary

GHG emissions within the On-Road subsector result from the consumption of fuel for on-road vehicles such as passenger cars, light trucks, motorcycles, mopeds, buses, heavy trucks, and combination trucks within a community boundary. The GHG emitting activity we focus on in this subsector is fuel consumption (scope 1) from fuels such as gasoline and diesel.

Inclusions

For Canada, based on available data and method, activity data produced includes:

- **Gasoline** and **diesel fuel** consumption for private and commercial and publicly owned passenger cars, light trucks, motorcycles, buses, heavy trucks, and combination trucks within a community boundary.

Exclusions

Due to lack of data, this methodology does not include:

- **Fuel consumption disaggregated by fleet type** from all on-road vehicles.
- **The vehicle kilometers traveled by** all on-road vehicles.

Activity Data Coverage

Table 1 includes the emissions sources covered by this methodology.

Table 1 – Allocated activity data, units, and emission sources

Emissions Source	Definition	Units	Scope
Private and commercial vehicle gasoline	The amount of gasoline consumed for a single year by all private and commercial vehicles in a community boundary	Liters	Scope 1
Public vehicle gasoline	The amount of gasoline consumed for a single year by publicly owned vehicles in a community boundary	Liters	Scope 1
Private and commercial vehicle diesel	The amount of diesel consumed for a single year by all private and commercial vehicles in a community boundary	Liters	Scope 1
Public vehicle diesel	The amount of diesel consumed for a single year by all publicly owned vehicles in a community boundary	Liters	Scope 1

Fuel Consumption

On road gasoline and diesel consumption is calculated using Canadian province/territory-level fuel consumption totals for the on road transportation end-use sector—available through Statistics Canada's

Supply and demand of primary and secondary energy data table—as initial input data. This input data is further disaggregated using a ratio of households in the community relative to the province and data on average of household expenditures on fuel and transportation.

Calculation Methodologies:

Scope 1: Gasoline

The equation 1 represents the calculation method utilized to estimate gasoline consumption within a city boundary. The community fuel sales is calculated for private and public use, separately.

Equation 1: Community fuel sales for Gasoline

$$\text{Community fuel sales}_{(private\ or\ public)}$$
$$= \text{Aggregate province sales} \times \left(\frac{\text{Total HH}_{Community}}{\text{Total HH}_{province}} \right)$$
$$\times \left(\frac{\text{Avg HH expenditure}_{(population\ class)}}{\text{Province level weighted average}_{(private\ or\ public)}} \right)$$

Data element	Definition	Units	Source
Community fuel sales	Gasoline sales within the community boundary, by vehicle type (passenger car, trucks, bus, or motorcycle)	Liters	Equation 1
Aggregate province sales	Gasoline sales within the province boundary, by vehicle type (passenger car, trucks, bus, or motorcycle)	Liters	Statistics Canada 2018
$\left(\dfrac{\text{Total HH}_{Community}}{\text{Total HH}_{province}} \right)$	Ratio of households in the community to the households in the province	Unitless	Canada Census 2016
$\left(\dfrac{\text{Avg HH expenditure}_{(population\ class)}}{\text{Province level weighted average}_{(private\ or\ public)}} \right)$	Calculated weighting factor, using avg household expenditures of different population class & state level weighted averages by usage.	Unitless	Statistics Canada 2017(b)

Scope 1: Diesel

The equation 1 represents the calculation method utilized to estimate Diesel consumption within a city boundary. The community fuel sales is calculated for private and public use, separately.

Equation 2: Community fuel sales for Diesel

$$\text{Community fuel sales}_{(private\ or\ public)}$$
$$= \text{Aggregate province sales} \times \left(\frac{\text{Total HH}_{Community}}{\text{Total HH}_{province}} \right)$$
$$\times \left(\frac{\text{Avg HH expenditure}_{(population\ class)}}{\text{State level weighted average}_{(private\ or\ public)}} \right)$$

Data element	Definition	Units	Source
Community fuel sales	Diesel sales within the community boundary	Liters	Equation 2
Aggregate province sales	Diesel sales within the province boundary	Liters	Statistics Canada 2018
$\left(\dfrac{\text{Total HH}_{Community}}{\text{Total HH}_{Province}} \right)$	Ratio of households in the community to the households in the province	unitless	Canada Census 2016
$\left(\dfrac{\text{Avg HH expenditure}_{(population\ class)}}{\text{Province level weighted average}_{(private\ or\ public)}} \right)$	Calculated weighting factor, using avg household expenditures of different population class & state level weighted averages by usage.	Unitless	Statistics Canada 2017(b)

Methodological Assumptions & Limitations

General assumptions
- The distribution of state level of on-road fuel consumption occurring within community boundaries is proportionally related to the number of households in the community.
- Fuel is consumed within the same year it is sold.
- Average household expenditure on fuel is a viable proxy for actual fuel consumed.
- Community-level average household expenditures on public transportation and fuel for private vehicles do not deviate significantly from national averages within a given population class (e.g. rural, urban).

Emission Factors

Fuel type	Carbon Dioxide (CO2) kg/GJ	Methane (CH4) kg/GJ	Nitrous Oxide (N2O) kg/GJ	Heating Value Mass GJ/ton	Heating Value Liquid Volume GJ/liter	Heating Value Gaseous Volume GJ/m3
Fossil						
Diesel	74.1	0.01	0.0006		0.03612	
Gasoline	69.3	0.01	0.0006		0.03278	

Citations

Statistics Canada. 2017a. Population and Dwelling Count Highlight Tables. 2016 Census.
https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/hlt-fst/pd-pl/comprehensive.cfm

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Statistics Canada. 2017(b) Table 11-10-0226-01 Household spending by size of area of residence.
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Waste Sector

This document details the calculation approaches and data sources for producing community-level activity data and emission factors for the waste sector. This sector contains the following subsectors:

Waste Sector	
Solid waste	Estimated
Biological waste	Not currently estimated
Incinerated and burned waste	Not currently estimated
Wastewater	Not currently estimated

Solid Waste

Subsector Overview

This section covers the activity data and emission factors needed for communities in Canada to estimate emissions from the disposal of municipal solid waste (MSW). While other gases are also emitted through the collecting, sorting, and transporting of solid waste to treatment facilities— namely biogenic carbon dioxide, non-methane volatile organic compounds, and nitrous oxide— this methodology focuses on estimating values related to MSW treated at landfill facilities or open dumps only. If desired, communities may consult international resources such as the IPCC guidelines for national reporting or local guidance documents, if available, to estimate non-methane GHG emissions from solid waste disposal. Hence, emissions under this sub-sector are influenced by the following five factors:

1) The mass of community-generated waste disposed in landfills or open dumps;
2) The methane generation potential
3) The methane correction factors; influenced by waste composition
4) The oxidation factors
5) The amount of methane recovered (for facilities with existing technology to do so).

Methane (CH_4) is the main gas emitted during the MSW treatment processes. The following section discusses methods for estimating the mass of waste, methane correction factor, oxidation factor and methane recovery fraction—where applicable—at a community level. All of these variables impact the final total of methane emissions reported in Canada.

Inclusions

For Canada, based on available data, this methodology provides estimates on:

- Community-specific **mass of waste landfilled at managed landfill facilities**
- **Methane Correction Factor** based on historical landfill management characteristics such as managed, unmanaged deep, unmanaged shallow, and uncategorized landfills.
- **Methane Generation Potential (L_0)** based on degradable organic carbon, landfill management type and fraction of methane in landfill gas nationally.
- **Oxidation Factors (OX)** based on waste disposal management practice.

Exclusions

Due to the unavailability of data, the methods exclude:

- Community-specific **mass of industrial, sludge, clinical, and fossil liquid waste.**
- **Landfill methane recovery fraction** at landfill facilities with recovery systems in place.

- The combustion, or flaring, of landfill gas for non-energy purposes[2]
- The combustion of solid waste for non-energy purposes[3]

Activity Data Coverage

Nationally reported data on community specific mass of waste sent to various landfill treatment facilities is available for Canada. As a result, this MSW section provides final estimations which fall under Scope 3 emissions.

Table 1: Activity data, units, and scope covered under solid waste disposal

Activity Data	Definition	Units	Gases Reported	Emissions Scope
Mass of Waste	The mass of waste disposed at managed, unmanaged, and uncategorized landfills and open dumps within a community boundary, regardless of where the waste is generated.	Tonnes	CH_4	Scope 3

Allocation Methodology

Activity Data – Mass of Waste (Managed Landfills)

The community-specific mass of waste sent to landfills is obtained from Canada's National Inventory Report (NIR), 2017 data.

Equation 1

$$\text{Landfilled Waste}_{\text{Community}} = \text{Landfilled Waste}_{\text{State}} \times \left(\frac{\text{Total Population}_{\text{Community}}}{\text{Total Population}_{\text{State}}} \right)$$

Data Element	Definition	Units	Data Source
Landfilled Waste$_{\text{Community}}$	Waste landfilled at a community level	Tonnes	Equation 1
Landfilled Waste$_{\text{Province}}$	Waste landfilled at a province/ territory level	Tonnes	NIR, 2017

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[2] While the flaring of landfill gas is typically reported under the waste sector, to burning of landfill gas for energy purposes is reported under the stationary energy sector

[3] Similar to above, the burning of waste for non-energy purposes falls under the waste sector, whereas any waste burned for energy (e.g. heat or electricity generation) falls under the stationary energy sector

Total Population$_{Community}$	Population of the community	People	Census, 2016
Total Population$_{Province}$	Population of the province/territory	People	Census, 2016

Activity Data – Methane Correction Factor (MCF)

Since CH_4 generation rates are dependent on landfill management practices, this methodology uses the IPCC (2006) default landfill management types to determine an appropriate community-specific methane correction factor. Since the National Inventory Report (NIR) 2017, identifies that Canada's waste has been deposited into managed, landfills the IPCC (2006) unitless MCF values of 1.0 is used.

Emission Factors

Under this method the solid waste disposal emission factor (EF) is a combination of two factors, the methane generation potential (L_0) and the oxidation factor (OX). In the absence of data on facility-specific emission factors, this methodology relies on the default factor for OX derived from IPCC (2006).

Equation 2

$$EF = L_o * (1 - OX)$$

Table 3: Data elements and sources

Data Element	Definition	Units	Data Source
L_0	Methane Generation Potential – the amount of methane generated per tonne of waste	Tonnes CH_4/tonne waste	Equation 3
OX	Oxidation factor (Methane Oxidized in top layer)	Unitless	IPCC (2006)

Oxidation Factor (OX)

The oxidation factor—the percentage of carbon that is oxidized during decomposition—is another EF value utilized in the estimation of methane from landfilled/or open-dumped MSW. Since Canadian landfills are managed, managed oxidation values are used in this methodology.

Methane Generation Potential (L_0)

Methane generation potential (L_0) is itself a combination of several components: The Methane Correction Factor (MCF); Degradable Organic Carbon (DOC), weighted by waste stream type (discussed below); the fraction of waste degraded anaerobically (DOCf); the fraction of landfill

gas that is methane (F); and the methane to carbon ratio. In the absence of facility-specific data, each of these values is derived from IPCC 2006 list of default values. Hence, this methodology calculates the methane generation potential of landfilled waste in the Canada using equation 4 below:

Equation 3

$$L_0 = MCF * DOC * DOC_F * F * {}^{16}\!/_{12}$$

Table 4: Data elements and sources

Data Element	Definition	Units	Data Source
MCF	Methane Correction Factor (based on management type) – part of the landfilled materials that is left to degrade anaerobically.	Unitless	IPCC (2006)
DOC	Degradable organic carbon – the portion of the waste stream that can decompose under aerobic conditions. This is estimated using the mass of waste under each waste stream and the IPCC designated DOC fractions.	Tonnes C/tonne waste	Equation 4
DOC_F	The fraction of DOC ultimately degraded anaerobically	Unitless	IPCC (2006)
F	The fraction of methane in landfill gas	Unitless	IPCC (2006)
${}^{16}\!/_{12}$	Methane to carbon ratio	Unitless	IPCC (2006)

Degradable Organic Carbon (DOC)

Degradable Organic Carbon represents the amount of organic carbon in the waste that can be degraded. Equation 4 below provides the IPCC designated DOC fractions while table 5 provides the final DOC's estimated under each of the Canadian Provinces and Territories. Table 6 provides the province specific DOC values as reported in the National Inventory Report, 2017.

Equation 4

$$DOC = (0.15 * A) + (0.2 * B) + (0.4 * C) + (0.43 * D) + (0.24 * E) + (0.15 * F)$$

Table 5: Data elements and sources

Metric	Definition
A	Mass of food waste
B	Mass of garden and plant debris
C	Mass of paper
D	Mass of wood
E	Mass of textiles
F	Mass of Industrial waste

Table 6: Province specific DOCs

Province/Territory	Abbreviation	DOC Value 2008 - Present
Newfoundland	NL	0.2
Prince Edward Island	PE	0.16
Nova Scotia	NS	0.15
New Brunswick	NB	0.18
Quebec	QC	0.21
Ontario	ON	0.21
Manitoba	MB	0.2
Sasketchewan	SK	0.19
Alberta	AB	0.22
British Columbia	BC	0.18
Territories		0.16

General Assumptions & Limitations

Mass of Waste

- We only attempt to estimate scope 1 emissions, and do not attempt to estimate scope 3 emissions from the activities of the residents within the community boundary.

Emission Factors

- The IPCC (2006) *IPCC Guidelines for National Greenhouse Gas Inventories. Volume 5: Waste, Chapter 3: Solid Waste Disposal* provides national waste composition estimates for Canada.

Methane Correction Factor

- The landfill sites are assumed to fall under the managed anaerobic IPCC landfill characteristic and were therefore assigned an MCF of 1.0.

Methane Recovery

NIR does not provide information for methane recovered, therefore our methodology does not estimate it.

Citations

National Inventory Report 1990–2016: Greenhouse Gas Sources and Sinks in Canada. Environment and Climate Change Canada. 2017

This data table provides province- and territory-specific landfilled waste data as well as degradable organic carbon (DOC) values, based on nationally conduced landfilled waste composition studies.

https://unfccc.int/documents/65715