Technical Appendix - Chile:

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

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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 in Chile. This sector includes the following subsectors:

Buildings and Stationary Energy Sector	
Residential buildings	Estimated
Commercial buildings	Estimated
Municipal buildings	Not Estimated
Industry	Not Estimated
Agriculture, forestry and fisheries	Not 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.

Inclusions:

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

- **Natural gas**, **Liquid Petroleum Gas, biomass** and **kerosene** consumption by households, based on annual fuel consumption from residential customers at National level.
- **Grid-supplied electricity** consumption by households, based on annual electricity consumption from residential customers at national level.

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 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	Definition	Units	Scope
Natural Gas	All-natural gas consumption within community boundary for a single year for all households.	kWh	Scope 1
Liquid Petroleum Gas	All Liquid Petroleum Gas consumption within community boundary for a single year for all households.		
Kerosene	All kerosene consumption within community boundary for a single year for all households.		
Biomass	All Biomass consumption within community boundary for a single year for all households.		
Grid Electricity	All grid-supplied electricity consumption within community boundary for a single year for all households	kWh	Scope 2

Calculation Methodologies:

Scope 1: Liquid Petroleum Gas

Methodology Notes

Residential building Liquid Petroleum Gas consumption is taken from Chile´s National Energy Balance 2016 data located at the Ministry of Energy webpage. This initial input data is allocated to communities based on:

- the **number of households (by type)** in the comuna relative to national totals, and
- a computed **weighted community fuel intensity,** designed to account for differences in fuel mix between urban and rural communities.

Total counts of households, by housing type, are sourced from the 2017 INE Census data. In addition, the average annual national Liquid Petroleum Gas consumption estimates (in kWh/household) for discrete housing demographics (urban and rural) that are derived from the "Caracterización del consumo energético residencial en la región metropolitana y análisis de escenarios de eficiencia energética 2016. These data are used to calculate **weighted community fuel intensities** that control for the average fuel mixes used in urban and rural communities. Weighted averages are calculated for all communities relative to their national average.

The following equation is utilized to estimate household Liquid Petroleum Gas consumption.

Equation 1: Household LPG Consumption

$$\text{Community-scale household consumption} = \text{aggregate residential consumption}_{\text{LPG}} \times \left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{state}}}\right) \times (\text{weighted community fuel intensities})$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale household consumption	All Liquid Petroleum Gas consumption within community boundary for a single year for all households	Equation 1	kWh
$\text{aggregate residential consumption}_{\text{LPG}}$	Amount of LPG fuel consumed in 2016 by the residential sector in an entire country	CNE (2018)	kWh
$\left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{state}}}\right)$	Ratio representing the number of households within the community in 2017 over the number of	INE (2017)	households

	households within the entire state in the year 2017		
weighted community fuel intensities	Percentage associated with weighted community fuel intensity by fuel type per housing demographic	Equation 6	percentage

Methodology Assumptions

General assumptions and limitations

- Number of households, by housing type, is proportionally related to the amount of Liquid Petroleum Gas consumed in the residential sector at national level.
- Average weighted energy intensities by community type (urban and rural) remain consistent within national weighted energy intensities (urban and rural). Hence, we assume a useful relationship between community type and energy intensity

Scope 1: Natural Gas

Methodology Notes

Residential building Natural Gas consumption is taken from Chile´s National Energy Balance 2016 data located at the Ministry of Energy webpage. This initial input data is then allocated to communities based on:

- the **number of households (by type)** in the comuna relative to national totals, and
- a computed **weighted community fuel intensity** designed to account for differences in fuel mix between urban and rural communities.

Total counts of households, by housing type, are sourced from the 2017 INE Census data. In addition, the average annual national Natural Gas consumption estimates (in kWh/household) for discrete housing demographics (urban and rural) that are derived from the "Caracterización del consumo energético residencial en la región metropolitana y análisis de escenarios de eficiencia energética 2016. These data are used to calculate **weighted community fuel intensities** that control for the average fuel mixes used in urban and rural communities. Weighted averages are calculated for all communities relative to their national average.

The following equation is utilized to estimate household Natural Gas consumption.

Equation 2: Household NG Consumption

$$\text{Community-scale household consumption} = \text{aggregate residential consumption}_{\text{NG}} \times \left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{state}}}\right) \times (\text{weighted community fuel intensities})$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale household consumption	All NG consumption within community boundary for a single year for all households	Equation 2	kWh
$\text{aggregate residential consumption}_{NG}$	Amount of NG fuel consumed in 2016 by the residential sector in an entire country	CNE (2018)	kWh
$\left(\frac{\text{total households}_{community}}{\text{total households}_{state}}\right)$	Ratio representing the number of households within the community in 2017 over the number of households within the entire state in the year 2017	INE (2017)	households
weighted community fuel intensities	Percentage associated with weighted community fuel intensity by fuel type per housing demographic	Equation 6	percentage

Methodology Assumptions

General assumptions and limitations

- Number of households, by housing type, is proportionally related to the amount of Natural Gas consumed in the residential sector at national level.
- Average weighted energy intensities by community type (urban and rural) remain consistent within national weighted energy intensities (urban and rural). Hence, we assume a useful relationship between community type and energy intensity.

Scope 1: Biomass

Methodology Notes

Residential building Biomass consumption is taken from Chile´s National Energy Balance 2016 data located at the Ministry of Energy webpage. This initial input data is then allocated to communities based on:

- the **number of households (by type)** in the comuna relative to national totals, and
- a computed **weighted community fuel intensity** designed to account for differences in fuel mix between urban and rural communities.

Total counts of households, by housing type, are sourced from the 2017 INE Census data. In addition, the average annual national Biomass consumption estimates (in kWh/household) for discrete housing demographics (urban and rural) that are derived from the "Caracterización del consumo energético residencial en la región metropolitana y análisis de escenarios de eficiencia energética 2016. These data are used to calculate **weighted community fuel intensities** that

control for the average fuel mixes used in urban and rural communities. Weighted averages are calculated for all communities relative to their national average.

The following equation is utilized to estimate household Biomass consumption.

Equation 3: Household Biomass Consumption

$$\text{Community-scale household consumption} = \text{aggregate residential consumption}_{\text{Biomass}} \times \left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{state}}}\right) \times (\text{weighted community fuel intensities})$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale household consumption	All Biomass consumption within community boundary for a single year for all households	Equation 3	kWh
$\text{aggregate residential consumption}_{\text{Biomass}}$	Amount of Biomass fuel consumed in 2016 by the residential sector in an entire country	CNE (2018)	kWh
$\left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{state}}}\right)$	Ratio representing the number of households within the community in 2017 over the number of households within the entire state in the year 2017	INE (2017)	households
$\text{weighted community fuel intensities}$	Percentage associated with weighted community fuel intensity by fuel type per housing demographic	Equation 6	percentage

Methodology Assumptions

General assumptions and limitations

- Number of households, by housing type, is proportionally related to the amount of Biomass consumed in the residential sector at national level.
- Average weighted energy intensities by community type (urban and rural) remain consistent within national weighted energy intensities (urban and rural). Hence, we assume a useful relationship between community type and energy intensity.

Scope 1: Kerosene

Methodology Notes

Residential building Kerosene consumption is taken from Chile´s National Energy Balance 2016 data located at the Ministry of Energy webpage. This initial input data is then allocated to communities based on:

- the **number of households (by type)** in the comuna relative to national totals, and
- a computed **weighted community fuel intensity** designed to account for differences in fuel mix between urban and rural communities.

Total counts of households, by housing type, are sourced from the 2017 INE Census data. In addition, the average annual national Kerosene consumption estimates (in kWh/household) for discrete housing demographics (urban and rural) that are derived from the "Caracterización del consumo energético residencial en la región metropolitana y análisis de escenarios de eficiencia energética 2016. These data are used to calculate **weighted community fuel intensities** that control for the average fuel mixes used in urban and rural communities. Weighted averages are calculated for all communities relative to their national average.

The following equation is utilized to estimate household Kerosene consumption.

Equation 4: Household Kerosene Consumption

$$\text{Community-scale household consumption} = \text{aggregate residential consumption}_{\text{Kerosene}} \times \left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{state}}}\right) \times (\text{weighted community fuel intensities})$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale household consumption	All Kerosene consumption within community boundary for a single year for all households	Equation 4	kWh
$\text{aggregate residential consumption}_{\text{Kerosene}}$	Amount of Kerosene fuel consumed in 2016 by the residential sector in an entire country	CNE (2018)	kWh
$\left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{state}}}\right)$	Ratio representing the number of households within the community in 2017 over the number of households within the entire state in the year 2017	INE (2017)	households
$\text{weighted community fuel intensities}$	Percentage associated with weighted community fuel intensity by fuel type per housing demographic	Equation 6	percentage

Methodology Assumptions

General assumptions and limitations

- Number of households, by housing type, is proportionally related to the amount of Kerosene consumed in the residential sector at national level.
- Average weighted energy intensities by community type (urban and rural) remain consistent within national weighted energy intensities (urban and rural). Hence, we assume a useful relationship between community type and energy intensity.

Scope 2: Electricity

Methodology Notes

Residential building Electricity consumption is taken from Chile´s National Energy Balance 2016 data located at the Ministry of Energy webpage. This initial input data is then allocated to communities based on:

- the **number of households (by type)** in the comuna relative to national totals, and
- a computed **weighted community fuel intensity** designed to account for differences in fuel mix between urban and rural communities.

Total counts of households, by housing type, are sourced from the 2017 INE Census data. In addition, the average annual national Electricity consumption estimates (in kWh/household) for discrete housing demographics (urban and rural) that are derived from the "Caracterización del consumo energético residencial en la región metropolitana y análisis de escenarios de eficiencia energética 2016. These data are used to calculate **weighted community fuel intensities** that control for the average fuel mixes used in urban and rural communities. Weighted averages are calculated for all communities relative to their national average.

The following equation is utilized to estimate household Electricity consumption.

Equation 5: Household Electricity Consumption

$$\text{Community-scale household consumption} = \text{aggregate residential consumption}_{\text{Electricity}} \times \left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{state}}}\right) \times (\text{weighted community fuel intensities})$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale household consumption	All Electricity consumption within community boundary for a single year for all households	Equation 5	kWh
$\text{aggregate residential consumption}_{\text{Electricity}}$	Amount of Electricity fuel consumed in 2016 by the	CNE (2018)	kWh

	residential sector in an entire country		
$\left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{state}}}\right)$	Ratio representing the number of households within the community in 2017 over the number of households within the entire state in the year 2017	INE (2017)	households
$\text{weighted community fuel intensities}$	Percentage associated with weighted community fuel intensity by fuel type per housing demographic	Equation 6	percentage

Methodology Assumptions

General assumptions and limitations

- Number of households, by housing type, is proportionally related to the amount of Electricity consumed in the residential sector at national level.
- Average weighted energy intensities by community type (urban and rural) remain consistent within national weighted energy intensities (urban and rural). Hence, we assume a useful relationship between community type and energy intensity.

Weighting Factors

This method uses national-level values for fuel use by residential sector and incorporates weighting factors, which help control for unexpected variation in fuel use across city types. Chile's 2016 census disaggregates each comuna in terms of percentage designated as urban versus rural. Each of these percentages are applied to the total number of households in the comuna to determine urban vs rural fraction of households. Since fuel use varies in urban vs rural households,

we use data from INE on the average residential fuel mix by city type, and control for the total national housing stock in order to estimate the relative impact of city type on the average fuel consumption mix. The results are integrated into one combined weighting factor which can be applied to each community:

Equation 6: Weighting Factors

$$\text{Weighting Factor}_{\text{city type, fuel type}} = \frac{\text{M}_{\text{city type, fuel type}} * \text{C}_{\text{city type}}}{\sum_{\text{city type}}\left(\text{M}_{\text{city type, fuel type}} * \text{C}_{\text{city type}} * \text{HH}_{\text{city type}}\right)}$$

Equation Data Elements

Data element	Description	Source	Units
$\text{Weighting Factor}_{\text{city type, fuel type}}$	Fuel consumption adjustment factor, by city type and fuel type	Equation 6	Unitless

$M_{city\ type,\ fuel\ type}$	The average residential fuel mix in 2016, by city type	CNE (2018)	%
$C_{city\ type}$	The average annual energy consumption of one household in 2016, by city type	CNE (2018)	MJ
$HH_{city\ type}$	The total national count of households in 2017, by city type	INE (2017)	households

Emission Factors:

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

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						
Natural Gas	56.1	0.001	0.0001			0.039
Kerosene	71.9	0.003	0.0006		0.038	
Liquified Petroleum Gas (LPG)	63.1	0.001	0.0001	47.3	0.0255	0.0336
Non-fossil						
Solid biomass	100	0.03	0.04			

References

CNE (2016). Balances energéticos. Comisión Nacional de Energía. available at http://www.cne.cl/estadisticas/balances-energeticos.

Reports residential energy consumption by comuna This information was then used to disaggregate each fuel type down to a municipality level.

Instituto Nacional de Estadística, INE. Censo por país, regions y comunas 2017. Available at http://resultados.censo2017.cl/Home/Download

Provides statistics on the housing stock and population by comuna.

IPCC (2006). IPCC Guidelines for National Greenhouse Gas Inventories. Volume 2: Energy. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan. Available at https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html

Provides default emission factor values for a range of fuel types.

Obrecht Ihl, R. (2016). Caracterización del consumo energético residencial en la Región Metropolitana y análisis de escenarios de eficiencia energética. Available at http://repositorio.uchile.cl/bitstream/handle/2250/142776/Caracterizaci%c3%b3n-del-consumo-energ%c3%a9tico-residencial-en-la-Regi%c3%b3n-Metropolitana-y-an%c3%a1lisis-de-escenarios.pdf?sequence=1&isAllowed=y

Provides information on community categories.

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

- **Natural gas, distillate fuel oil, Biomass, Kerosene, Biogas** and **Liquid Petroleum Gas** consumption by commercial buildings, based on annual fuel consumption at national level
- **Electricity** consumption by commercial buildings, based on annual commercial electricity consumption at national level

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	MWh	Scope 1
Distillate Fuel Oil	Distillate fuel oil consumption within community boundary for a single year for all commercial buildings	MWh	Scope 1
Liquid Petroleum Gas	Liquid Petroleum Gas consumption within community boundary for a single year for all commercial buildings	MWh	Scope 1

Biomass	Biomass consumption within community boundary for a single year for all commercial buildings	MWh	Scope 1
Kerosene	Kerosene consumption within community boundary for a single year for all commercial buildings	MWh	Scope 1
Biogas	Biogas consumption within community boundary for a single year for all commercial buildings	MWh	Scope 1
Grid Electricity	Grid-supplied electricity consumption within community boundary for a single year for all commercial buildings	MWh	Scope 2

Calculation Methodologies:

Scope 1: Natural Gas

Methodology Notes

Commercial building Natural Gas consumption is taken from Chile´s National Energy Balance 2016 data located at the Ministry of Energy webpage. This initial input data is allocated to communities based on the commercial sector employees in the community relative to the national totals. Total counts of employees, by community, are sourced from the Tax Intern Service. The national building Natural Gas consumption is scaled by **the percentage of employees by each community to estimate the building natural gas consumption by each community.**

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

Equation 7: Commercial Natural Gas consumption

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

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 7	MWh

National fuel consumption commercial sector	Amount of fuel consumed by commercial customers within entire country in 2016	CNE (2018)	MWh
Commercial employees - community	Estimated number of commercial sector employees for the community in 2015	INE, (2017)	MWh
Commercial employees - national	Estimated number of commercial sector employees within the state in 2015	SII, 2016)	MWh

Methodology Assumptions and Potential Improvement

General assumptions

- Number of commercial sector employees is proportionally related to the amount of natural gas consumed.
- CNE national totals are assumed to encompass all NG national commercial consumption.
- All natural gas sold to commercial customers is consumed within the year it is delivered
- Weights used in the current iteration partially do not take account of differences in the building context of each community in terms of the size of establishments. Additional weighting and calibration are necessary, however, in order to account for differences in per-employee intensities not just based on establishment sizes, but by different categories of commercial enterprises such as finance, education, and retail trade. Future iterations will incorporate these additional into final estimates.

Scope 1: Distillate Fuel Oil

Methodology Notes

Commercial building Distillate Fuel Oil consumption is taken from Chile´s National Energy Balance 2016 data located at the Ministry of Energy webpage. This initial input data is allocated to communities based on the **proportion of employees** in the community relative to the national totals. Total counts of employees, by community, are sourced from the Tax Intern Service. The national building Distillate fuel oil consumption is scaled by **the percentage of employees by each community to estimate the building distillate fuel oil consumption by each community.**

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

Equation 8: Commercial Natural Gas consumption

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

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 1	MWh
National fuel consumption commercial sector	Amount of fuel consumed by commercial customers within entire country in 2016	CNE (2018)	MWh
Commercial employees - community	Estimated number of commercial sector employees for the community in 2015	INE, (2017)	MWh
Commercial employees - national	Estimated number of commercial sector employees within the state in 2015	SII, 2016)	MWh

Methodology Assumptions and Potential Improvement

General assumptions

- Number of commercial sector employees is proportionally related to the amount of Distillate Fuel Oil consumed.
- CNE national totals are assumed to encompass all fuel oil national commercial consumption.
- All Distillate Fuel Oil sold to commercial customers is consumed within the year it is delivered
- Weights used in the current iteration partially do not take account of differences in the building context of each community in terms of the size of establishments. Additional weighting and calibration are necessary, however, in order to account for differences in per-employee intensities not just based on establishment sizes, but by different categories of commercial enterprises such as finance, education, and retail trade. Future iterations will incorporate these additional into final estimates.

Scope 1: Liquefied Petroleum Gas (LPG)

Methodology Notes

Commercial building Liquefied Petroleum Gas consumption is taken from Chile´s National Energy Balance 2016 data located at the Ministry of Energy webpage. This initial input data is allocated to communities based on the **proportion of employees** in the community relative to the national totals. Total counts of employees, by community, are sourced from the Tax Intern Service. The national building LPG consumption is scaled by **the percentage of employees by each community to estimate the building LPG consumption by each community.**

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

Equation 9: Commercial Liquid Petroleum Gas consumption

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

Equation Data Elements

Data element	Description	Source	Units
Community-scale commercial consumption	LPG consumption within community boundary for a single year for all commercial buildings	Equation 9	MWh
National fuel consumption commercial sector	Amount of fuel consumed by commercial customers within entire country in 2016	CNE (2018)	MWh
Commercial employees - community	Estimated number of commercial sector employees for the community in 2015	INE, (2017)	MWh
Commercial employees - national	Estimated number of commercial sector employees within the state in 2015	SII, 2016)	MWh

Methodology Assumptions and Potential Improvement

General assumptions

- Number of commercial sector employees is proportionally related to the amount of LPG consumed.
- CNE national totals are assumed to encompass all LPG national commercial consumption.
- All LPG sold to commercial customers is consumed within the year it is delivered

- Weights used in the current iteration partially do not take account of differences in the building context of each community in terms of the size of establishments. Additional weighting and calibration are necessary, however, in order to account for differences in per-employee intensities not just based on establishment sizes, but by different categories of commercial enterprises such as finance, education, and retail trade. Future iterations will incorporate these additional into final estimates.

Scope 1: Biomass

Methodology Notes

Commercial building Biomass is taken from Chile´s National Energy Balance 2016 data located at the Ministry of Energy webpage. This initial input data is allocated to communities based on the **proportion of employees** in the community relative to the national totals. Total counts of employees, by community, are sourced from the Tax Intern Service. The national building Biomass consumption is scaled by **the percentage of employees by each community to estimate the building Biomass consumption by each community.**

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

Equation 10: Commercial Biomass consumption

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

Equation Data Elements

Data element	Description	Source	Units
Community-scale commercial consumption	Biomass consumption within community boundary for a single year for all commercial buildings	Equation 10	MWh
National fuel consumption commercial sector	Amount of fuel consumed by commercial customers within entire country in 2016	CNE (2018)	MWh
Commercial employees - community	Estimated number of commercial sector employees for the community in 2015	INE, (2017)	MWh

Commercial employees - national	Estimated number of commercial sector employees within the state in 2015	SII, 2016)	MWh

Methodology Assumptions and Potential Improvement

General assumptions

- Number of commercial sector employees is proportionally related to the amount of Biomass consumed.
- CNE national totals are assumed to encompass all biomass national commercial consumption.
- All Biomass sold to commercial customers is consumed within the year it was delivered
- Weights used in the current iteration partially do not take account of differences in the building context of each community in terms of the size of establishments. Additional weighting and calibration are necessary, however, in order to account for differences in per-employee intensities not just based on establishment sizes, but by different categories of commercial enterprises such as finance, education, and retail trade. Future iterations will incorporate these additional into final estimates.

Scope 1: Kerosene

Methodology Notes

Commercial building Kerosene is taken from Chile´s National Energy Balance 2016 data located at the Ministry of Energy webpage. This initial input data is allocated to communities based on the **proportion of employees** in the community relative to the national totals. Total counts of employees, by community, are sourced from the Tax Intern Service. The national building Kerosene consumption is scaled by **the percentage of employees by each community to estimate the building Kerosene consumption by each community.**

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

Equation 11: Commercial Kerosene consumption

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

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 11	MWh
National fuel consumption commercial sector	Amount of fuel consumed by commercial customers within entire country in 2016	CNE (2018)	MWh
Commercial employees - community	Estimated number of commercial sector employees for the community in 2015	INE, (2017)	MWh
Commercial employees - national	Estimated number of commercial sector employees within the state 2015	SII, 2016)	MWh

Methodology Assumptions and Potential Improvement

General assumptions

- Number of commercial sector employees is proportionally related to the amount of Kerosene consumed.
- CNE national totals are assumed to encompass all Kerosene national commercial consumption.
- All Kerosene sold to commercial customers is consumed within the year it is delivered
- Weights used in the current iteration partially do not take account of differences in the building context of each community in terms of the size of establishments. Additional weighting and calibration are necessary, however, in order to account for differences in per-employee intensities not just based on establishment sizes, but by different categories of commercial enterprises such as finance, education, and retail trade. Future iterations will incorporate these additional into final estimates.

Scope 1: Biogas

Methodology Notes

Commercial building Biogas is taken from Chile´s National Energy Balance 2016 data located at the Ministry of Energy webpage. This initial input data is allocated to communities based on the **proportion of employees** in the community relative to the national totals. Total counts of employees, by community, are sourced from the Tax Intern Service. The national building Biogas

consumption is scaled by **the percentage of employees by each community to estimate the building Biogas consumption by each community.**

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

Equation 12: Commercial Biogas consumption

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

Equation Data Elements

Data element	Description	Source	Units
Community-scale commercial consumption	Biogas consumption within community boundary for a single year for all commercial buildings	Equation 12	MWh
National fuel consumption commercial sector	Amount of fuel consumed by commercial customers within entire country in 2016	CNE (2018)	MWh
Commercial employees - community	Estimated number of commercial sector employees for the community in 2015	INE, (2017)	MWh
Commercial employees - national	Estimated number of commercial sector employees within the state 2015	SII, 2016)	MWh

Methodology Assumptions and Potential Improvement

General assumptions and limitations

- Number of commercial sector employees is proportionally related to the amount of Biogas consumed.
- CNE national totals are assumed to encompass all Biogas national commercial consumption.
- All Biogas sold to commercial customers is consumed within the year it is delivered
- Weights used in the current iteration partially do not take account of differences in the building context of each community in terms of the size of establishments. Additional weighting and calibration are necessary, however, in order to account for differences in per-employee intensities not just based on establishment sizes, but by different categories

of commercial enterprises such as finance, education, and retail trade. Future iterations will incorporate these additional into final estimates.

Scope 2: Electricity

Methodology Notes

Commercial building Electricity is taken from Chile´s National Energy Balance 2016 data located at the Ministry of Energy webpage. This initial input data is allocated to communities based on the **proportion of employees** in the community relative to the national totals. Total counts of employees, by community, are sourced from the Tax Intern Service. The national building electricity consumption is scaled by **the percentage of employees by each community to estimate the building electricity consumption by each community.**

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

Equation 13: Commercial Electricity consumption

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

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 13	MWh
National fuel consumption commercial sector	Amount of fuel consumed by commercial customers within entire country in 2016	CNE (2018)	MWh
Commercial employees - community	Estimated number of commercial sector employees for the community in 2015	INE, (2017)	MWh
Commercial employees - national	Estimated number of commercial sector employees within the state in 2015	SII, 2016)	MWh

Methodology Assumptions

General assumptions and limitations

- Number of commercial sector employees is proportionally related to the amount of Electricity consumed.
- CNE national totals are assumed to encompass all Electricity national commercial consumption.
- All Electricity sold to commercial customers is consumed within the year it is delivered
- Weights used in the current iteration partially do not take account of differences in the building context of each community in terms of the size of establishments. Additional weighting and calibration are necessary, however, in order to account for differences in per-employee intensities not just based on establishment sizes, but by different categories of commercial enterprises such as finance, education, and retail trade. Future iterations will incorporate these additional into final estimates.

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 Chile.

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						
Natural Gas	56.1	0.001	0.0001			0.039
Distillate Fuel Oil	74.1	0.01	0.0006		0.0361	
Liquified Petroleum Gas (LPG)	63.1	0.001	0.0001	47.3	0.0255	0.0336
Kerosene	71.9	0.003	0.0006		0.038	
Non-fossil						
Solid biomass	100	0.03	0.04			

References:

CNE (2018). Balances energéticos. Comisión Nacional de Energía. available at http://www.cne.cl/estadisticas/balances-energeticos.

Reports commercial energy consumption by region. This information was then used to disaggregate each fuel type down to a municipality level.

Instituto Nacional de Estadística, INE. Censo por laborales 2017. Available at https://www.ine.cl/estadisticas/laborales/ene

Provides statistics on employee by comuna and nationally.

IPCC (2006). IPCC Guidelines for National Greenhouse Gas Inventories. Volume 2: Energy. The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan. Available at https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html

Provides default emission factor values for a range of fuel types.

Servicio de impuestos internos 2016. 2015 Estadísticas de empresas por regíon Available at http://www.sii.cl/estadisticas/empresas_region.htm

Provides information on the number of business and employees by region

Transportation and Mobile Energy Sector

This document details the calculation approaches and data sources for producing community-level (comuna) activity data for the transportation and mobile energy sector in Chile. 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 fuel sales for on-road vehicles such as passenger cars, light trucks, motorcycles, buses, heavy trucks, and vans and all terrain. This methodology describes the process for generating estimates of total fuel consumption comprised by these vehicle types within the community boundary (scope 1) including gasoline, diesel, and alternative fuels. This subsector methodology does not cover grid electricity consumed for on-road vehicles used within the community boundary (scope 2), which is instead included in the Stationary Energy sector.

Inclusions

For Chile, based on available data and methods, estimates of activity data produced include:

- **Gasoline and diesel oil** sales for private and commercial owned passenger cars, motorcycles, buses, trucks by comuna.

Exclusions

- Grid electricity consumed for on-road vehicles used within the community boundary (scope 2). This is instead included in the Stationary Energy sector.

Activity Data Coverage

Table 1 shows the emissions sources covered by this methodology.

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

Emissions Source	Definition	Units	Scope
Passenger car gasoline	The amount of gasoline sold for a single year by private and commercial passenger cars in a municipality boundary.	liters	Scope 1
Passenger car diesel	The amount of diesel sold for a single year by private and commercial passenger cars in a municipality boundary.	liters	Scope 1
Light commercial vehicles gasoline	The amount of gasoline sold for a single year by light commercial vehicles in a municipality boundary	liters	Scope 1
Light commercial vehicles diesel	The amount of diesel sold for a single year by light commercial vehicles in a municipality boundary	liters	Scope 1
Motorcycles gasoline	The amount of gasoline sold for a single year by private and commercial motorcycles in a municipality boundary	liters	Scope 1
Buses gasoline	The amount of gasoline sold for a single year by buses in a municipality boundary	liters	Scope 1

Buses diesel	The amount of diesel sold for a single year by buses a municipality boundary	liters	Scope 1
Heavy vehicles gasoline	The amount of gasoline sold for a single year by heavy vehicles in a municipality boundary	liters	Scope 1
Heavy vehicles diesel	The amount of diesel sold for a single year by heavy vehicles in a municipality boundary	liters	Scope 1

Fuel Consumption

The fuel input data from the Secretaría de Planificación de Transporte SECTRA provides values for the volume of gasoline and diesel sold within each state.

Vehicle Registrations

The list of vehicle registrations provided by the Secretaría de Planificación de Transporte SECTRA provides community specific contextual data with which the state fuel consumed can be disaggregated to the city and vehicle level, with the use of appropriate weighting factors.

Weighting Factors

This method uses state-level values for fuel use by the on-road transport sector and incorporates weighting factors, which help control for unexpected variation in fuel use across vehicle types in various city types. According to Chile's Secretary of Planning and Transport department, vehicles tend to fall into one of the following category types and uses either diesel or gasoline for fuel:

- Passenger Cars
- Light Trucks
- Heavy Trucks
- Buses
- Motorcycles

These vehicle types, and the associated fuel use, are then compared against the national average fuel use and the results are then integrated into one combined weighting factor formula identified below:

Equation 1: Community Gasoline Consumption by vehicle type

$$\text{Community gasoline consumption}_{\text{vehicle type}} = \text{State gasoline consumption} * \frac{\text{Community VC}_{\text{vehicle type}} * \text{GFP}_{\text{vehicle type}} * \frac{\text{VKT}_{\text{vehicle type}}}{\text{VE}_{\text{vehicle type}}}}{\sum_{\text{vehicle type}} \left(\text{State VC}_{\text{vehicle type}} * \text{GFP}_{\text{vehicle type}} * \frac{\text{VKT}_{\text{vehicle type}}}{\text{VE}_{\text{vehicle type}}} \right)}$$

Table 2: Equation Data Elements (Gasoline Fuel)

Data element	Description	Source	Units
$\text{Community gasoline consumption}_{\text{vehicle type}}$	Consumption of gasoline within the community boundary, by vehicle type	Estimated	L
State gasoline consumption	Consumption of gasoline by all on-road vehicles within the state	SECTRA, 2017a	L
$\text{Community VC}_{\text{vehicle type}}$	The count of all vehicles registered within the community, by vehicle type	SECTRA, 2017b	vehicles
$\text{GFP}_{\text{vehicle type}}$	The proportion of each vehicle type that uses gasoline[1]	SECTRA, 2014	%
$\text{VKT}_{\text{vehicle type}}$	The average vehicle kilometers travelled by each vehicle type, for gasoline	SECTRA, 2014	km
$\text{VE}_{\text{vehicle type}}$	The average vehicle fuel efficiency, by vehicle type, for gasoline	SECTRA, 2014	km/L
$\text{State VC}_{\text{vehicle type}}$	The count of all vehicles registered within the state, by vehicle type	SECTRA, 2017b	vehicles

Equation 2: Community Diesel Consumption by vehicle type

$$\text{Community diesel consumption}_{\text{vehicle type}} = \text{State diesel consumption} * \frac{\text{Community VC}_{\text{vehicle type}} * \text{GFP}_{\text{vehicle type}} * \frac{\text{VKT}_{\text{vehicle type}}}{\text{VE}_{\text{vehicle type}}}}{\sum_{\text{vehicle type}} \left(\text{State VC}_{\text{vehicle type}} * \text{GFP}_{\text{vehicle type}} * \frac{\text{VKT}_{\text{vehicle type}}}{\text{VE}_{\text{vehicle type}}} \right)}$$

[1] Information is obtained from the Secretary of Planning and Transport's Destination Survey completed in Santiago in 2012. Of the vehicle categories present in Santiago, the percentage of those that use gasoline are incorporated into our calculation and then applied to other comunas in Chile.

Table 3: Equation Data Elements (Diesel Fuel)

Data element	Description	Source	Units
$\text{Community diesel consumption}_{\text{vehicle type}}$	Consumption of diesel within the community boundary, by vehicle type	Estimated	L
State diesel consumption	Consumption of diesel by all on-road vehicles within the state	SECTRA, 2017a	L
$\text{Community VC}_{\text{vehicle type}}$	The count of all vehicles registered within the community, by vehicle type	SECTRA, 2017b	vehicles
$\text{GFP}_{\text{vehicle type}}$	The proportion of each vehicle type that uses diesel[2]	SECTRA, 2014	%
$\text{VKT}_{\text{vehicle type}}$	The average vehicle kilometers travelled by each vehicle type, for diesel	SECTRA, 2014	km
$\text{VE}_{\text{vehicle type}}$	The average vehicle fuel efficiency, by vehicle type, for diesel	SECTRA, 2014	km/L
$\text{State VC}_{\text{vehicle type}}$	The count of all vehicles registered within the state, by vehicle type	SECTRA, 2017b	vehicles

[2] Information is obtained from the Secretary of Planning and Transport's Destination Survey completed in Santiago in 2012. Of the vehicle categories present in Santiago, the percentage of those that use diesel are incorporated into our calculation and then applied to other comunas in Chile.

Citations

Open Energy database on National sales of liquid fuel for Chile.

CNE (2017) Portal Web Institucional de la Comisión Nacional de Energía. Available at http://energiaabierta.cl/visualizaciones/combustibles-por-region/

> Open Energy is an initiative from Chile's National Energy Commission to provide statistical data, about the energy sector. This source provides data on fuel sales by fuel type, by region.

INE (2017) Instituto Nacional de Estadísticas. Available at http://historico.ine.cl/canales/chile_estadistico/estadisticas_economicas/transporte_y_comunicaciones/parquevehiculos.php

> This source provides data on the total vehicle fleet registered by vehicle type by comuna.

SECTRA (2014) Secretaria de planificación de transporte, Actualización y recolección de información del sistema de transporte urbano, IX Etapa: Encuesta Origen Destino Santiago 2014. Encuesta origen destino de viajes 2012 (Documento Difusión). Available at: http://www.sectra.gob.cl/biblioteca/detalle1.asp?mfn=3253

> The origin-destiny survey for the metropolitan area in Santiago, Chile, describes the urban travels patterns to estimate the operating conditions of the urban transport system. The data was used to estimate the travel distance and fuel efficiency Km/l.

http://www.sectra.gob.cl/biblioteca/listado_corto1.asp

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 Chile 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 Chile.

Inclusions

For the Chile, based on available data and methods, the data provided includes:

- Community-specific **mass of waste landfilled at managed landfill facilities**
- Community-specific **mass of waste landfilled at unmanaged/open dumping 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 data provided excludes:

- 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[3]
- The combustion of solid waste for non-energy purposes[4]

Activity Data Coverage

Nationally reported data on community specific mass of waste sent to various landfill treatment facilities is available for Chile. As a result, this MSW section provides final estimations which fall under Scope 1 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 unmanaged, managed and uncategorized landfills and open dumps within a community boundary, regardless of where the waste was generated.	Tonnes	CH_4	Scope 1

Allocation Methodology

Activity Data – Mass of Waste (Sanitary Landfills)

Comuna-Specific Mass of waste treated at sanitary landfills is obtained from the System of the Registry of Emissions and Transfers of Pollutants (RETC)[5] and from the Ministerio del Medio Ambiente (SINADER)[6] centralized platform. This platform provides information up to 2017 and helps comunas keep track of their mass of waste and composition.

Activity Data – Mass of waste (Open dumping)

Municipal solid waste in Chile is mostly disposed of through managed landfills. However, there are some unmanaged and open dumping facilities that still exist and recorded under the System of the Registry of Emissions and Transfers of Pollutants (RETC) and the Ministerio del Medio Ambiente (SINADER) centralized platform. This information was used to provide final estimates in this methodology.

[3] 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

[4] 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

[5] The RETC is a database that contains information on emissions and transfers to the environment of potentially harmful chemicals

[6] SINADER creates a detailed report that includes waste composition, waste management, and final disposition site, by Comuna, using a centralized platform

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. Because data on both managed and unmanaged landfills is provided by RETC and SINADER for Chile, the IPCC (2006) unitless MCF values of 1.0 and 0.4 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 1

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

Table 2: Data elements and sources

Data Element	Definition	Units	Data Source
L_O	Methane Generation Potential – the amount of methane generated per tonne of waste	Tonnes CH_4/tonne waste	Equation 2
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 landfills in Chile are either managed or unmanaged shallow, both managed and unmanaged oxidation values are used in this methodology.

Methane Generation Potential (L_0)

Methane generation potential (L0) 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 Chile using equation 2 below:

Equation 2

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

Table 3: 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 3
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. The final DOC value is estimated by using the fraction of the total mass of the waste and apportioning it with the DOC fractions. Equation 3 below provides the IPCC designated DOC fractions while table 5 provides the final state-specific DOC's which is applied to the respective comunas.

Equation 3

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

Table 4: Data elements and definitions

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 5: State-specific DOC applied to each Comuna

State	State Specific DOC
Antofagasta	0.208
Arica y Parinacota	0.217
Atacama	0.219
Aysén Del General Carlos Ibáñez Del Campo	0.204
Biobío	0.210
Coquimbo	0.217
La Araucanía	0.201
Libertador General Bernardo O'Higgins	0.222
Los Lagos	0.205
Los Ríos	0.211
Magallanes de y la Antártica Chilena	0.247
Maule	0.232
Metropolitana de Santiago	0.214
Ñuble	0.201
Tarapacá	0.221
Valparaíso	0.199

Additionally, emissions are produced from industrial wastes, which have their unique set of DOC values. However, in the absence of data for this category, this methodology omits community-specific activity data or emission factors for industrial waste.

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.
- Certain remote municipalities lack reporting on waste produced, such as those with very few inhabitants.

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 Chile. In the absence of national or community-specific datasets on industrial, clinical, sludge, and fossil liquid waste this methodology is unable to determine a community-specific DOC estimate for these waste streams.

Methane Recovery

- The RETC database does not provide information for methane recovered therefore our methodology does not estimate it.

Citations

IPCC (2006). IPCC Guidelines for National Greenhouse Gas Inventories. Volume 5: Waste, Chapter 3: Solid Waste Disposal, The National Greenhouse Gas Inventories Programme, The Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T. Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan. Available at http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_3_Ch3_SWDS.pdf

Provides default values for the fraction of degradable organic content present in waste stream.

IPCC. (2000). Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. Chapter 5: Waste. Available at https://www.ipcc-nggip.iges.or.jp/public/gp/english/5_Waste.pdf

Includes an updated method for estimating methane emissions from MSW using the methane commitment estimate model.

IPCC (1996). IPCC Guidelines for National Greenhouse Gas Inventories. Volume. 1: Greenhouse gas inventory reporting instructions. Volume. 2: Greenhouse gas inventory workbook. Volume 3: Greenhouse gas inventory reference manual. Available at http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.html

Provides a method for estimating methane emissions from MSW using the methane commitment estimate model.

RETC (2019). Registro de Emisiones y Transferencias de Contaminantes. Available at http://www.retc.cl

Database which provides information on waste collected by comuna

SINADER (2016) Sistema Nacional de Declaración de Residuos, Ministerio de Medio ambiente. Available at https://vu.mma.gob.cl/Documentos/Capacitacion_RETC_VU_SINADER_version_publicada_2016.pdf

Report which provides information on waste collected by comuna