Technical Appendix – Costa Rica:

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 the Costa Rica. 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[1] 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 Costa Rica, based on data availability and occurrence in-country, estimates for the following activity data points were produced:

- **Liquid Petroleum Gas, Biogas, Wood, Kerosene and Charcoal** 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 were 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
Liquid Petroleum Gas	All Liquid Petroleum Gas consumption within community boundary for a single year for all households.	MJ	Scope 1
Kerosene	All kerosene consumption within community boundary for a single year for all households.		
Wood	All Wood consumption within community boundary for a single year for all households.		
Biogas	All Biogas consumption within community boundary for a single year for all households.	MJ	

[1] For the purposes of this methodology, households correspond to all categories of "housing units" as defined in the National Institute of Statistics and Geography (INEGI Spanish acronym), including single family units, apartments in multi-unit buildings, etc.

Charcoal	All Charcoal consumption within community boundary for a single year for all households.	MJ	
Grid Electricity	All grid-supplied electricity consumption within community boundary for a single year for all households	MJ	Scope 2

Calculation Methodologies:

Scope 1: Liquid Petroleum Gas

Methodology Notes

Residential building Liquid Petroleum Gas consumption is taken from Costa Rica´s National Energy Balance 2016 data located at the Secretaría de Planificación Subsector Energía. This initial input data is then allocated to communities based on:

- the **number of households (by type)** in the municipality relative to national totals, and
- a computed **weighted (urban or rural) community intensity** relative to the national.

Total counts of households, by housing type, are sourced from the 2011 INEC Census data. In addition, the annual national Liquid Petroleum Gas consumption is weighted (MJ * community type) with two community categories (urban and rural) that are derived from the Encuesta Nacional de Hogares. These data are then combined to calculate **weighted community fuel intensities**. Weighted averages are calculated for all communities relative to their national average. This is done so that estimates are reflective of the housing context (rural or urban) within individual communities.

Equation 1

The below equation represents the calculation method utilized to estimate household Liquid Petroleum Gas consumption.

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

Equation Data Elements

Data element	Description	Source	Units
Community-scale household consumption	All liquefied petroleum gas consumption within community boundary for a single year for all households.	Equation 1	MJ

$\text{aggregate residential consumption}_{\text{LPG}}$	Amount of liquefied petroleum gas fuel consumed by the residential sector in an entire country	SPSE 2017	MJ
$\left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{national}}}\right)$	Ratio representing the number of households within the community over the number of households within the entire country	INEC 2011	households
Weighted community fuel intensities	Percentage associated with weighted fuel use 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 LPG consumed in the residential sector at national level.
- Average weighted energy intensities by community type (urban, mixed and rural) remain consistent within national weighted energy intensities (urban/rural) and are an appropriate weighting factor in determining consumption patterns from one community to the next.
- SPSE national totals are assumed to encompass all LPG national residential consumption.
- The number of households by type at community level from 2016 can be improved with a more recent census.

Scope 1: Wood

Methodology Notes

Residential building wood consumption is taken from Costa Rica´s National Energy Balance 2016 data located at the Secretaría de Planificación Subsector Energía. This initial input data is then allocated to communities based on:

- the **number of households (by type)** in the municipality relative to national totals, and
- a computed **weighted (urban or rural) community fuel intensity** relative to the national.

Total counts of households, by housing type, are sourced from the 2011 INEC Census data. In addition, the annual national wood consumption is weighted (MJ * community type) with two community categories (urban and rural) that are derived from the Encuesta Nacional de Hogares. These data are then combined to calculate **weighted community fuel intensities**. Weighted averages are calculated for all communities relative to their national average. This is done so that estimates are reflective of the housing context (rural or urban) within individual communities.

Equation 2

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

$$\text{Community-scale household consumption} = \text{aggregate residential consumption}_{\text{wood}} \times \left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{national}}}\right) \times (\textit{Weighted community fuel intensities})$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale household consumption	All wood consumption within community boundary for a single year for all households.	Equation 2	MJ
$\text{aggregate residential consumption}_{\text{wood}}$	Amount of wood fuel consumed by the residential sector in an entire country	SPSE 2017	MJ
$\left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{national}}}\right)$	Ratio representing the number of households within the community over the number of households within the entire country	INEC 2011	households
Weighted Community Fuel intensities	Percentage associated with weighted fuel use 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 wood consumed in the residential sector at national level.
- Average weighted energy intensities by community type (urban/rural) remain consistent within national weighted energy intensities (urban/rural) and are an appropriate weighting factor in determining consumption patterns from one community to the next.
- SPSE national totals are assumed to encompass all wood national residential consumption.
- The number of households by type at community level from 2016 can be improved with a more recent census.

Scope 1: Biogas

Methodology Notes

Residential building biogas consumption is taken from Costa Rica´s National Energy Balance 2016 data located at the Secretaría de Planificación Subsector Energía. This initial input data is then allocated to communities based on:

- the **number of households (by type)** in the municipality relative to national totals, and
- a computed **weighted (urban or rural) community fuel intensity** relative to the national.

Total counts of households, by housing type, are sourced from the 2011 INEC Census data. In addition, the annual national biogas consumption is weighted (MJ * community type) with two community categories (urban and rural) that are derived from the Encuesta Nacional de Hogares. These data are then combined to calculate **weighted community fuel intensities**. Weighted averages are calculated for all communities relative to their national average. This is done so that estimates are reflective of the housing context (rural or urban) within individual communities.

Equation 3

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

$$\text{Community-scale household consumption} = \text{aggregate residential consumption}_{\text{biogas}} \times \left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{national}}}\right) \times (\textit{Weighted community fuel intensities})$$

Equation Data Elements

Data element	Description	Source	Units
Community-scale household consumption	All biogas consumption within community boundary for a single year for all households.	Equation 3	MJ
$\text{aggregate residential consumption}_{\text{biogas}}$	Amount of biogas fuel consumed by the residential sector in an entire country	SPSE 2016	MJ
$\left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{national}}}\right)$	Ratio representing the number of households within the community over the number of households within the entire country	INEC 2011	households

Weighted Community Fuel Intensities	Percentage associated with weighted fuel use 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 biogas consumed in the residential sector at national level.
- Average weighted energy intensities by community type (urban/rural) remain consistent within national weighted energy intensities (urban/rural) and are an appropriate weighting factor in determining consumption patterns from one community to the next.
- SPSE national totals are assumed to encompass all biogas national residential consumption.
- The number of households by type at community level from 2016 can be improved with a more recent census. Because, it was calculated by extrapolating INEC 2016 Census with the national growth rate. As a result, the number of households by community lightly defers from the national and state 2016 totals.
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Scope 1: Kerosene

Methodology Notes

Residential building Kerosene consumption is taken from Costa Rica´s National Energy Balance 2016 data located at the Secretaría de Planificación Subsector Energía. This initial input data is then allocated to communities based on:

- the **number of households (by type)** in the municipality relative to national totals, and
- a computed **weighted (urban or rural) community fuel intensity** relative to the national.

Total counts of households, by housing type, are sourced from the 2011 INEC Census data. In addition, the annual national kerosene consumption is weighted (MJ * community type) with two community categories (urban and rural) that are derived from the Encuesta Nacional de Hogares. These data are then combined to calculate **weighted community fuel intensities**. Weighted averages are calculated for all communities relative to their national average. This is done so that estimates are reflective of the housing context (rural or urban) within individual communities.

Equation 4

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

$$\text{Community-scale household consumption} = \text{aggregate residential consumption}_{\text{kerosene}} \times \left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{national}}}\right) \times (\textit{Weighted community fuel intensities})$$

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	MJ
$\text{aggregate residential consumption}_{\text{keros}}$	Amount of kerosene fuel consumed by the residential sector in an entire country	SPSE 2017	MJ
$\left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{national}}}\right)$	Ratio representing the number of households within the community over the number of households within the entire country	INEC 2011	households
Weighted Community Fuel Intensities	Percentage associated with weighted fuel use 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/rural) remain consistent within national weighted energy intensities (urban/rural) and are an appropriate weighting factor in determining consumption patterns from one community to the next.
- SPSE national totals are assumed to encompass all kerosene national residential consumption.
- The number of households by type at community level from 2016 can be improved with a more recent census. Because, it was calculated by extrapolating INEC 2016 Census with the national growth rate. As a result, the number of households by community lightly defers from the national and state 2016 totals.

Scope 2: Electricity

Methodology Notes

Residential building electricity consumption is taken from Costa Rica´s National Energy Balance 2016 data located at the Secretaría de Planificación Subsector Energía. This initial input data is then allocated to communities based on:

- the **number of households (by type)** in the municipality relative to national totals, and
- a computed **weighted (urban or rural) community fuel intensity** relative to the national.

Total counts of households, by housing type, are sourced from the 2011 INEC Census data. In addition, the annual national electricity consumption is weighted (MJ * community type) with two community categories (urban and rural) that are derived from the Encuesta Nacional de Hogares. These data are then combined to calculate **weighted community fuel intensities**. Weighted averages are calculated for all communities relative to their national average. This is done so that estimates are reflective of the housing context (rural or urban) within individual communities.

Equation 5

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

$$\text{Community-scale household consumption} = \text{aggregate residential consumption}_{\text{electricity}} \times \left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{national}}}\right) \times (\textit{Weighted community fuel intensities})$$

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	MJ
$\text{aggregate residential consumption}_{\text{Electr}}$	Amount of electricity fuel consumed by the residential sector in an entire country	SPSE 2017	MJ
$\left(\frac{\text{total households}_{\text{community}}}{\text{total households}_{\text{national}}}\right)$	Ratio representing the number of households within the community over the number of households within the entire country	INEC 2011	households
Weighted Community Fuel Intensities	Percentage associated with weighted fuel use 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/rural) remain consistent within national weighted energy intensities (urban/rural) and are an appropriate weighting factor in determining consumption patterns from one community to the next.
- SPSE national totals are assumed to encompass all electricity national residential consumption.
- The number of households by type at community level from 2016 can be improved with a more recent census. Because, it was calculated by extrapolating INEC 2016 Census with the national growth rate. As a result, the number of households by community lightly defers from the national and state 2016 totals.

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 populations in various city types. Costa Rica's 2011 census identifies a proportion of urban and rural areas in each canton, however for the purpose of this methodology, we have bucketed communities into one of two categories:

- Rural – cantons where rural population is above 50% of the total population in that canton
- Urban – cantons where urban population is above 50% of the total population in that canton

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

Equation 6

$$\text{Weighting Factor}_{\text{city type, fuel type}} = \frac{M_{\text{city type, fuel type}} * C_{\text{city type}}}{\sum_{\text{city type}} \left(M_{\text{city type, fuel type}} * C_{\text{city type}} * HH_{\text{city type}} \right)}$$

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
$M_{\text{city type, fuel type}}$	The average residential fuel mix in 2017, by city type	SPSE 2017	%
$C_{\text{city type}}$	The average annual energy consumption of one household in 2017, by city type	SPSE 2017	MJ

$HH_{city\ type}$	The total national count of households in 2016, by city type	INEC, 2011	households

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 Costa Rica.

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			
Non-fossil						
Solid biomass	100	0.03	0.04			

References:

Instituto Nacional de Estadística y Censos (INEC) 2011. Available at http://www.inec.go.cr/vivienda

Provides information on housing stock

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.

Secretaría planificacion del subsector energía de Costa Rica (2016). Available at https://sepse.go.cr/ciena/balances-energeticos/

Provides information on national energy balance

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 Costa Rica, based on data availability and occurrence in-country, estimates for the following activity data points were produced:

- **Liquid Petroleum Gas, Wood, Fuel Oil** and **Diesel** 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 were 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
Fuel Oil	Fuel oil consumption within community boundary for a single year for all commercial buildings	MJ	Scope 1
Liquid Petroleum Gas	Liquid Petroleum Gas consumption within community boundary for a single year for all commercial buildings	MJ	

Wood	Wood consumption within community boundary for a single year for all commercial buildings	MJ	
Diesel	Diesel consumption within community boundary for a single year for all commercial buildings	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: Liquid Petroleum Gas

Methodology Notes

Residential building Liquid Petroleum Gas consumption is taken from Costa Rica´s National Energy Balance 2016 data located at the Secretaría de Planificación Subsector Energía. Initial input data is then allocated to communities based on the **proportion of employees** in the community relative to the state totals.Total counts of employees, by community, are sourced from the 2011 INEC Census data. The national building LPG consumption is **scaled by the percentage of employees in each community to estimate the building natural gas consumption by each community.**

Equation 7

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

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

Equation Data Elements

Data element	Description	Source	Units
Community-scale commercial consumption	Liquid Petroleum Gas consumption within community boundary for a single year for all commercial buildings	Equation 7	MJ
National fuel consumption commercial sector	Amount of fuel consumed by commercial customers within entire country in 2017	SPSE 2017	MJ

Commercial employees - community	Estimated number of commercial sector employees for the community in 2011	INEC 2011	MJ
Commercial employees - state	Estimated number of commercial sector employees within the state	INEC 2011	MJ

Methodology Assumptions and Potential Improvement

- Number of commercial sector employees is proportionally related to the amount of LPG consumed.
- SIE national totals are assumed to encompass all NG national commercial consumption.
- All LPG sold to commercial customers is consumed within the year it was delivered
- Finally, 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: Wood

Methodology Notes

Residential building Liquid Petroleum Gas consumption is taken from Costa Rica´s National Energy Balance 2016 data located at the Secretaría de Planificación Subsector Energía.

Initial input data is then allocated to communities based on the **proportion of employees** in the community relative to the state totals.Total counts of employees, by community, are sourced from the 2011 INEC Census data. The national building wood consumption is **scaled by the percentage of employees in each community to estimate the building natural gas consumption by each community.**

Equation 8

The below equation represents the calculation method utilized to estimate commercial sector wood 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	wood consumption within community boundary for a single year for all commercial buildings	Equation 8	MJ
National fuel consumption commercial sector	Amount of fuel consumed by commercial customers within entire country in 2017	SPSE 2017	MJ
Commercial employees - community	Estimated number of commercial sector employees for the community in 2011	INEC 2011	MJ
Commercial employees - State	Estimated number of commercial sector employees within the state	INEC 2011	MJ

Methodology Assumptions and Potential Improvement

- Number of commercial sector employees is proportionally related to the amount of diesel consumed.
- SIE national totals are assumed to encompass all wood national commercial consumption.
- All diesel gas sold to commercial customers is consumed within the year it was delivered
- Finally, 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: Diesel

Methodology Notes

Residential building diesel consumption is taken from Costa Rica´s National Energy Balance 2016 data located at the Secretaría de Planificación Subsector Energía. Initial input data is then allocated to communities based on the **proportion of employees** in the community relative to the state totals.Total counts of employees, by community, are sourced from the 2011 INEC Census data. The national building Diesel consumption is **scaled by the percentage of employees in each community to estimate the building natural gas consumption by each community.**

Equation 9

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

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

Equation Data Elements

Data element	Description	Source	Units
Community-scale commercial consumption	diesel consumption within community boundary for a single year for all commercial buildings	Equation 9	MJ
National fuel consumption commercial sector	Amount of fuel consumed by commercial customers within entire country in 2017	SPSE 2017	MJ
Commercial employees - community	Estimated number of commercial sector employees for the community in 2011	INEC 2011	MJ
Commercial employees - State	Estimated number of commercial sector employees within the state	INEC 2011	MJ

Methodology Assumptions and Potential Improvement

- Number of commercial sector employees is proportionally related to the amount of diesel consumed.
- SIE national totals are assumed to encompass all diesel national commercial consumption.
- All diesel sold to commercial customers is consumed within the year it was delivered
- Finally, 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: Fuel Oil

Residential building fuel oil consumption is taken from Costa Rica´s National Energy Balance 2016 data located at the Secretaría de Planificación Subsector Energía. Initial input data is then allocated to communities based on the **proportion of employees** in the community relative to the state totals.Total counts of employees, by community, are sourced from the 2011 INEC Census data. The national building Fuel Oil consumption is **scaled by the percentage of employees in each community to estimate the building natural gas consumption by each community.**

Equation 10

The below equation represents the calculation method utilized to estimate commercial sector fuel oil consumption.

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

Equation Data Elements

Data element	Description	Source	Units
Community-scale commercial consumption	Fuel oil consumption within community boundary for a single year for all commercial buildings	Equation 10	MJ
National fuel consumption commercial sector	Amount of fuel consumed by commercial customers within entire country in 2017	SPSE 2017	MJ
Commercial employees - community	Estimated number of commercial sector employees for the community in 2011	INEC 2011	MJ
Commercial employees - state	Estimated number of commercial sector employees within the state	INEC 2011	MJ

Methodology Assumptions and Potential Improvement

- Number of commercial sector employees is proportionally related to the amount of natural gas consumed.
- SIE national totals are assumed to encompass all fuel oil national commercial consumption.
- All fuel oil sold to commercial customers is consumed within the year it was delivered
- Finally, 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: Electricity

Methodology Notes

Residential building electricity consumption is taken from Costa Rica´s National Energy Balance 2017 data located at the Secretaría de Planificación Subsector Energía. Initial input data is then allocated to communities based on the **proportion of employees** in the community relative to the state totals.Total counts of employees, by community, are sourced from the 2011 INEC Census data. The national building Electricity consumption is **scaled by the percentage of employees in each community to estimate the building natural gas consumption by each community.**

Equation 11

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

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

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 11	MJ
National fuel consumption commercial sector	Amount of fuel consumed by commercial customers within entire country in 2017	SEPSE 2017	MJ
Commercial employees - community	Estimated number of commercial sector employees for the community in 2011	INEC 2011	MJ
Commercial employees - state	Estimated number of commercial sector employees within the state	INEC 2011	MJ

Methodology Assumptions and Potential Improvement

- Number of commercial sector employees is proportionally related to the amount of electricity consumed.
- SIE national totals are assumed to encompass all electricity national commercial consumption.
- All electricity sold to commercial customers is consumed within the year it was delivered
- Finally, 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 Costa Rica.

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			
Non-fossil						
Solid biomass	100	0.03	0.04			

References:

Instituto Nacional de Estadística y Censos (INEC) 2011. Encuestas continua de empleo. Available at https://www.inec.cr/empleo?keys=&shs_term_node_tid_depth=All&field_periodo_tid=All&field_anio_documento_value%5Bvalue%5D%5Bdate%5D=2011

Provides information on the percentage of employees in the commercial and services sector

Instituto Nacional de Estadística y Censos (INEC) 2011. Available at http://www.inec.go.cr/vivienda

Provides information on housing stock and population

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.

Secretaría planificacion del subsector energía de Costa Rica (2017). Available at https://sepse.go.cr/ciena/balances-energeticos/

Provides information on national energy balance

Transportation and Mobile Energy Sector for Costa Rica

This document details the calculation approaches and data sources for producing community-level (canton) activity data and emission factors for the transportation and mobile energy sector in Costa Rica. 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, microbuses, buses, single-unit 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 hydrous ethanol, gasoline, and diesel oil.

Inclusions

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

- **Gasoline** and **diesel fuel** sales for all private and commercial vehicles 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.
- **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
All registered vehicles (Gasoline consumption)	The amount of gasoline sold for a single year by all registered vehicles in a canton boundary.	m^3	Scope 1
All registered vehicles (Diesel consumption)	The amount of diesel sold for a single year by all registered vehicles in a canton boundary.	m^3	Scope 1

Allocation Methodology

Fuel Consumption

The input data from La Refinadora Costarricense de Petróleo (RECOPE) Informe Annual de Ventas 2016 provides values for the volume of gasoline and diesel oil sold within each canton. Due to limited data availability related to vehicle-specific use patterns—which include vehicle type, fuel economy (based on fuel type and vehicle type), vehicle miles travelled, and vehicle registrations—we are unable to further disaggregate the fuel consumption data by vehicle type.

Methodological and Data Assumptions & Limitations

This methodology assumes that:

- All vehicles use only diesel and gasoline fuel.
- In the absence of state or community-specific vehicle registrations, further disaggregated emission estimates could not be provided.

Emission Factors

This methodology uses emission factors from the IPCC *Guidelines for National Greenhouse Gas Inventories Volume 2: Energy* (IPCC, 2006). These are globally recognized default emission factor values. All passenger vehicle fuels are considered to have the same emission conversion factors despite the canton the fuels are sold. As a result, there is no need to adapt the emission factors produced by the IPCC 2006.

Table 2 shows the fuels used in Costa Rica and their corresponding emission factor values.

Table 2 – IPCC Emission Factors for Fuels

Fuel type	Carbon Dioxide (CO2) kg/GJ	Methane (CH4) kg/GJ	Nitrous Oxide (N2O) kg/GJ
Fossil			
Gasoline	69.3	0.12	0.002
Diesel	74.1	0.01	0.0006

Citations

INEC, 2017. Vehículos Automotores En Circulación, Según Estilo 2015-2017 Available at: http://inec.cr/documento/cuadro-924-costa-rica-vehiculos-automotores-en-circulacion-segun-estilo-2015-2017

This source provides data on the total vehicle fleet registered by vehicle type at a national level.

RECOPE, 2016. Informe Annual de Ventas 2016 Available at: https://www.recope.go.cr/wp-content/uploads/2017/03/INFORME-ANUAL-DE-VENTAS-2016.pdf

This source provides data on annual national fuel sales by fuel type.

SEPSE 2016. Balance Energético Nacional. Available at: https://sepse.go.cr/ciena/balances-energeticos/#1544807135084-f2a106c1-7ce4

The National Energy Balance is an annual analysis of the country's energy structure. This source provides data on fuel use in the transport sector at a national level.

Waste Sector

Table 1: Waste Sector categories.

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