

# LEED v4.1 Cities and Communities: Plan and Design

## Education Module

### Energy and Greenhouse Gas Emissions (EN) Prerequisite





# Learning Objectives

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- Understand the concept of Greenhouse gas emissions calculations.
- Understand the EN Prerequisite: Energy and Greenhouse Gas Emissions Management in LEED v4.1 Cities and Communities Plan and Design rating system.
- Understand step-by-step guidance on EN Prerequisite: Energy and Greenhouse Gas Emissions Management.
- Understand the documentation requirements and common errors.

# Presenter

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GBCI

# LEED v4.1 Cities and Communities Categories

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Integrative Process



Natural Systems and Ecology



Transportation and Land Use



Water Efficiency



Energy and Greenhouse Gas Emissions



Materials and Resources



Quality of Life



Innovation



Regional Priority

# ***Plan and Design***

- Smart cities
- Eco-cities
- Urban infill projects
- Economic Zones
- Neighborhoods
- Campuses
- Military Installations
- Mixed Use Development
- Industrial townships
- Hospitality and Entertainment/ Sports/ Tourist development
- Aerotropolis

## LEED for Cities and Communities: Plan and Design

Cities Communities



## INTEGRATIVE PROCESS

POSSIBLE: 5 POSSIBLE: 5

Prereq	Integrative Planning and Design Process	REQUIRED	REQUIRED
Credit	Green Building Policy and Incentives	5	5



## NATURAL SYSTEMS &amp; ECOLOGY

POSSIBLE: 13 POSSIBLE: 13

Prereq	Ecosystem Assessment	REQUIRED	REQUIRED
Prereq	Construction Activity Pollution Prevention	REQUIRED	REQUIRED
Prereq	Green Spaces	REQUIRED	REQUIRED
Credit	Natural Resources Conservation and Restoration	5	5
Credit	Light Pollution Reduction	2	2
Credit	Resilience Planning	6	6



## TRANSPORTATION &amp; LAND USE

POSSIBLE: 18 POSSIBLE: 18

Credit	Compact, Mixed Use & Transit Oriented Development	6	6
Credit	Walkability and Bikeability	4	4
Credit	Access to Quality Transit	2	2
Credit	Alternative Fuel Vehicles	2	2
Credit	Smart Mobility and Transportation Policy	2	2
Credit	High Priority Site	2	2



## WATER EFFICIENCY

POSSIBLE: 12 POSSIBLE: 12

Prereq	Integrated Water Management	REQUIRED	REQUIRED
Prereq	Water Access and Quality	REQUIRED	REQUIRED
Credit	Stormwater Management	5	5
Credit	Wastewater Management	5	5
Credit	Smart Water Systems	2	2



## ENERGY AND GREENHOUSE GAS EMISSIONS

POSSIBLE: 31 POSSIBLE: 31

Prereq	Power Access, Reliability and Resiliency	REQUIRED	REQUIRED
Prereq	Energy and Greenhouse Gas Emissions Management	15	19
Credit	Energy Efficiency	4	4

## LEED for Cities and Communities: Plan and Design

Cities Communities

Credit	Renewable Energy	6	6
Credit	Low Carbon Economy	4	-
Credit	Grid Harmonization	2	2



## MATERIALS AND RESOURCES

POSSIBLE: 11 POSSIBLE: 11

Prereq	Construction and Demolition Waste Management	REQUIRED	REQUIRED
Prereq	Solid Waste Management	REQUIRED	REQUIRED
Credit	Organic Waste Treatment	2	2
Credit	Recycling Infrastructure	5	5
Credit	Responsible Sourcing for Infrastructure	2	2
Credit	Smart Waste Management Systems	2	2



## QUALITY OF LIFE

POSSIBLE: 10 POSSIBLE: 10

Prereq	Demographic Assessment	REQUIRED	REQUIRED
Prereq	Social Infrastructure	REQUIRED	REQUIRED
Prereq	Economic Growth	REQUIRED	-
Credit	Affordable Housing	2	2
Credit	Public Health	6	6
Credit	Emergency Management and Response	2	2



## INNOVATION

POSSIBLE: 6 POSSIBLE: 6

Credit	Innovation	6	6
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## REGIONAL PRIORITY

POSSIBLE: 4 POSSIBLE: 4

Credit	Regional Priority	4	4
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## TOTAL

110 110

40- 49 Points

50-59 Points

60-79 Points

80+ Points

CERTIFIED

SILVER

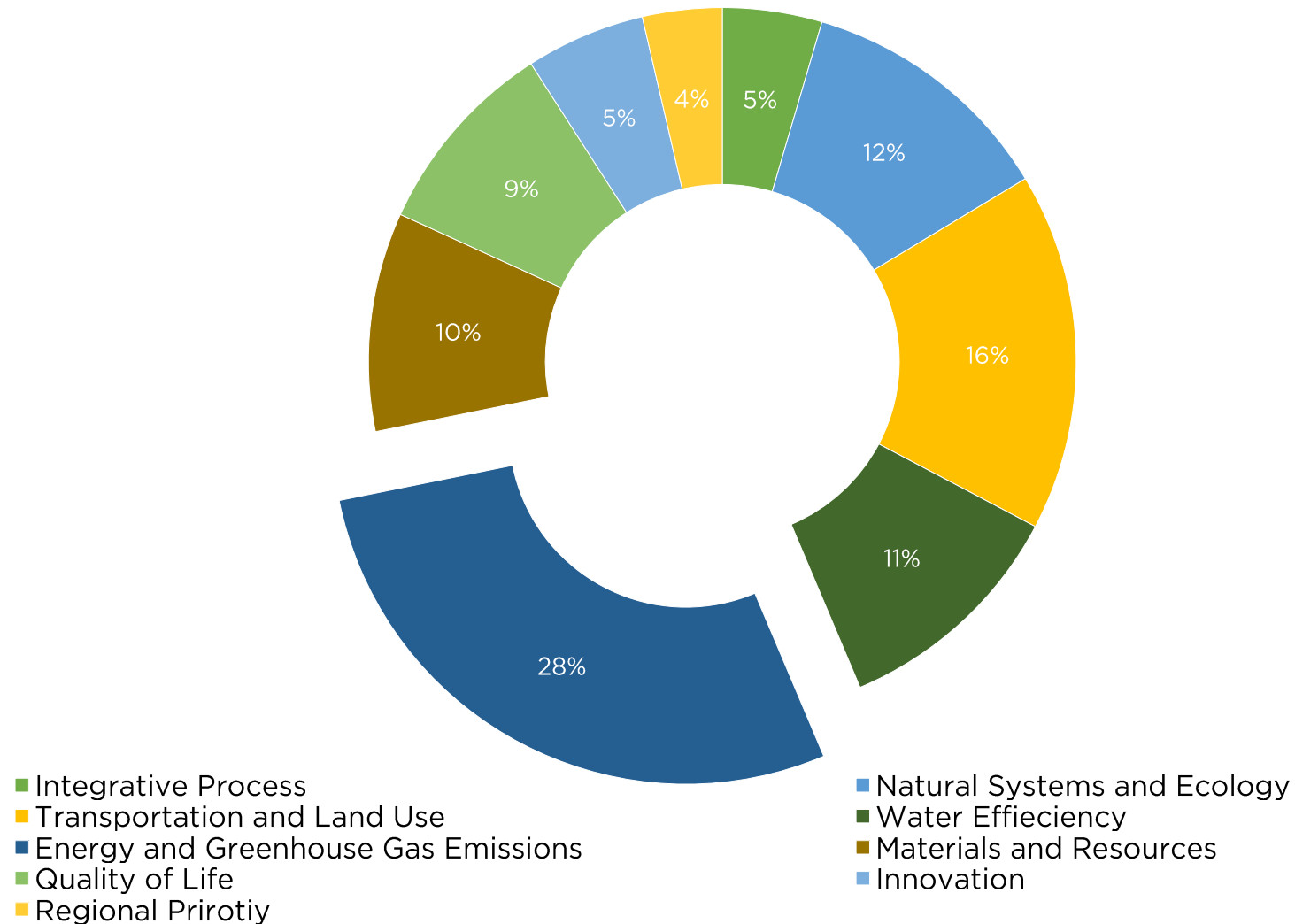
GOLD

PLATINUM

# LEED v4.1 Cities and Communities: Plan and Design

## Category wise point weightage

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# ENERGY AND GREENHOUSE GAS EMISSIONS CATEGORY

ENERGY AND GREENHOUSE GAS EMISSIONS		CITIES	COMMUNITIES
Prerequisite	Power Access, Reliability and Resiliency	-	-
Prerequisite	Energy and Greenhouse Gas Emissions Management	15	19
Credit	Energy Efficiency	4	4
Credit	Renewable Energy	6	6
Credit	Low Carbon Economy	4	-
Credit	Grid Harmonization	2	2

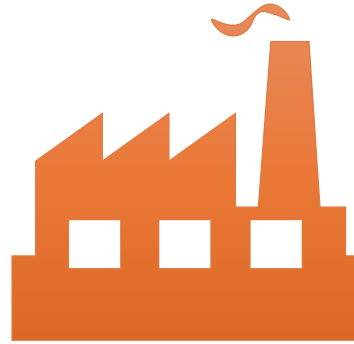


# EN Prerequisite: Energy and Greenhouse Gas Emissions Management

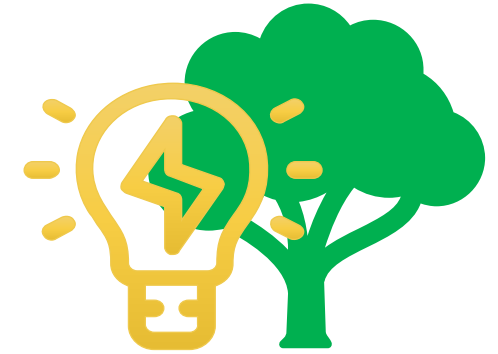
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Cities account for up to **70%\*** of the world's anthropogenic GHG emissions.



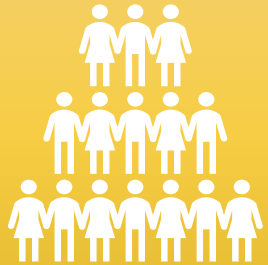
Zero emissions city



Sources and sinks of GHG emissions



Greenhouse gases, or GHGs, are gases that trap heat or longwave radiation in the atmosphere.  
The principal GHGs are CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, and the fluorinated gases.



High greenhouse gas emissions, exponential human population growth, and climate change are inexorably linked.



Sources : Anthropogenic activities, Deforestation, Intensive livestock farming, Industrial processes, Use of synthetic fertilizers.

## Greenhouse Gas Emissions Management

# EN Prerequisite: Energy and Greenhouse Gas Emissions Management

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## INTENT

To move towards a zero emissions city and reduce environmental and economic harms associated with excessive energy use.

## REQUIREMENTS

### **Estimate**

Estimate the annual energy consumption and Greenhouse Gas (GHG) emissions for the city.

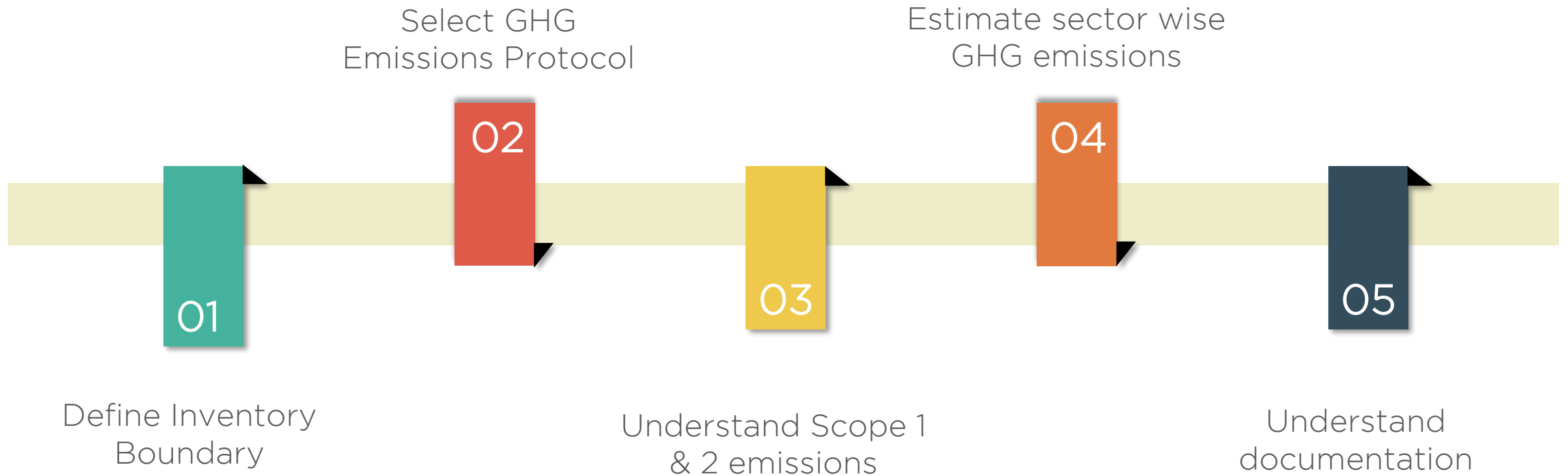
### **Criteria to be followed**

Include Scope 1 and Scope 2 GHG emissions in the calculations.

Address all sectors present within the city.

# Step by Step Guidance

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# Defining Inventory Boundary

The inventory boundary identifies the following parameters:



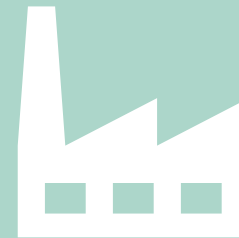
## Geographic area

Consider LEED boundary as inventory boundary



## Emission Sources

Classified in 6 categories (buildings, transportation, street lighting & public area lighting, water & waste water, waste management, and any other sector )



## Greenhouse gases

Seven gases mentioned in the Kyoto protocol ( $\text{CO}_2$ ,  $\text{CH}_4$ ,  $\text{N}_2\text{O}$ , HFCs, PFCs,  $\text{SF}_6$ ,  $\text{NF}_3$ )



## Time span

Minimum reporting time should be continuous 12 months, ideally calendar year.

# Protocols for GHG Emissions



2006 IPCC Guidelines for National Greenhouse Gas Inventories



International Local Government GHG Emissions Analysis Protocol (IEAP)



International Standard for Determining Greenhouse Gas Emissions for Cities (UNEP & World Bank)



Baseline Emissions Inventory/Monitoring Emissions Inventory methodology (BEI/MEI)



U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions (USA Community Protocol)



PAS 2070: Specification for the assessment of greenhouse gas emissions of a city



GHG Protocol for Cities (Greenhouse Gas Protocol)

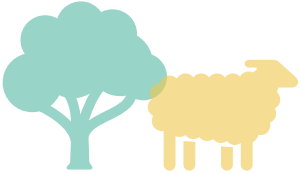











Bilan Carbone (Association Bilan Carbone)



Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC)

# Understanding Scope 1 & Scope 2 emissions

SCOPE 1	SCOPE 2	SCOPE 3
Inside the inventory boundary	Inside the inventory boundary	Outside the identified boundary
<div> Agriculture, Industry, and other land use</div> <div> Waste and waste water</div> <div> Industrial processes and product use</div> <div> Stationary fuel combustion</div> <div> In- boundary transportation</div>	<div> Grid supplied energy</div>	<div> Out of boundary waste and waste water</div> <div> Transmission and Distribution</div> <div> Other indirect emissions</div> <div> Out of boundary transportation</div>

# GHG emissions : Data collection & Calculation

- 1 Buildings
- 2 Transportation
- 3 Street lighting and public area lighting
- 4 Water and wastewater
- 5 Waste management
- 6 Any other sector



# GHG emissions : Terminology

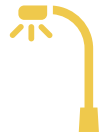
Greenhouse  
Gas Emissions

=

Activity data

×

Emission factor



- Quantitative measure
  - Kilometers driven
  - Tonnes of solid waste sent to landfill
  - Gallons of diesel used
  - MWh of electricity used
  - Tonnes of Methane emitted

- Measure of the mass of GHG emissions relative to a unit of activity
- Example:
  - Activity data for electricity is in megawatt hours (MWh), therefore emission factor of electricity is in tons CO<sub>2</sub>e/MWh

# GHG emissions : Emissions Factor

For cities or communities in US and Canada:

- Use U.S. Environmental Protection Agency's (EPA) regional grid mix coefficients to calculate GHG emissions by energy source;
- or
- Use hourly emissions profiles from U.S. Environmental Protection Agency's (EPA) AVOIDed Emissions and geneRation Tool (AVERT)

For other International cities:

- Use national grid mix coefficients from the International Energy Agency CO<sub>2</sub> Emissions from Fuel Combustion 2017 report to calculate GHG emissions by energy source.
- ISO 52000-1:2017 – Greenhouse gas emission factors for each building energy source shall be determined consistently with ISO Standard 52000-1:2017 and published for the country or region where the project is located.

# Buildings



The electricity (including renewable energy) used in all building types such as residential, industrial, institutional, commercial, and any other type



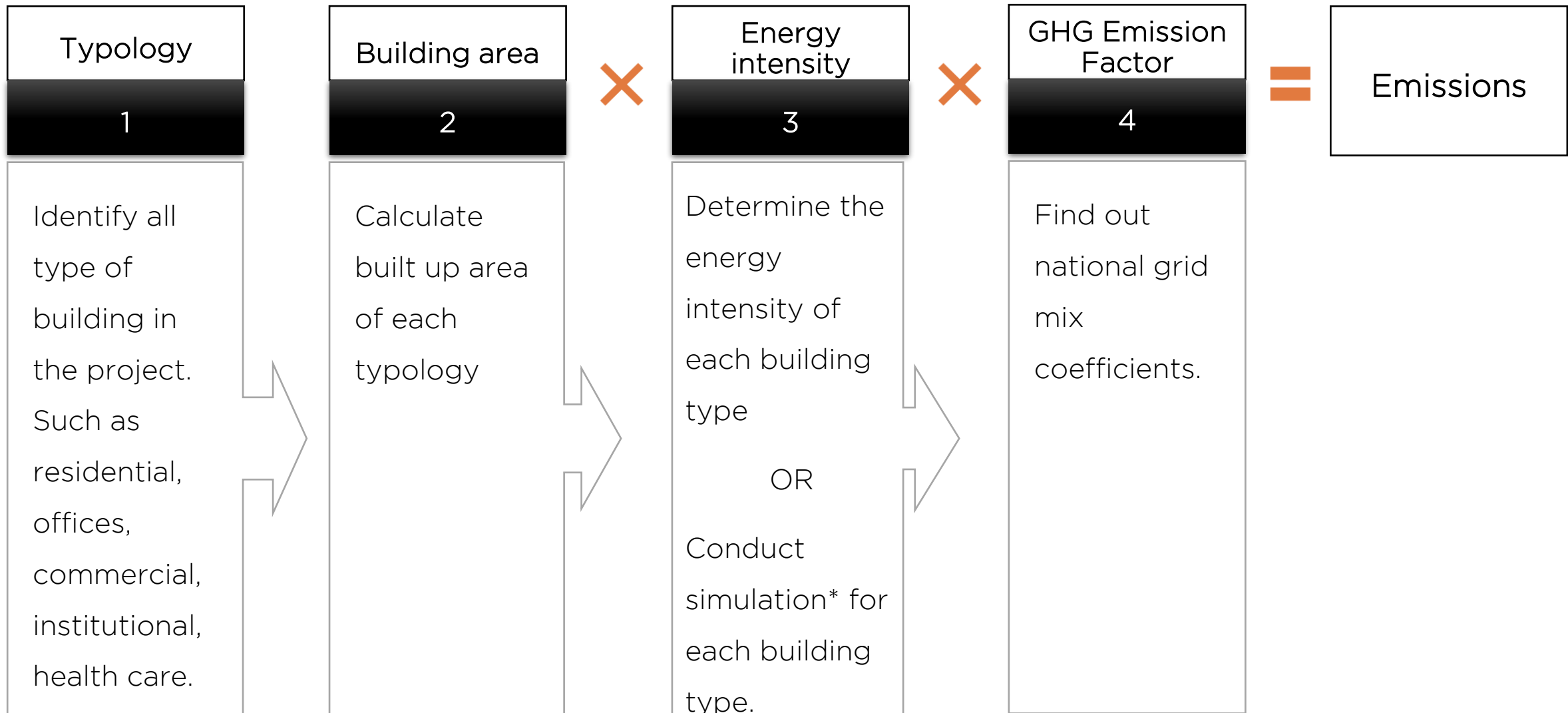
Includes fuel consumed for cooling, heating, lighting, and any other use in the buildings.



Energy consumption data:

- Simulation
- Referred from industry “standard practice”
- Existing codes, standards or regulatory requirements
- Published data
- Projects of similar scope and size operating within the same geographical area or within a geographical area with similar operating conditions

# Buildings: Calculation



\*Modelling methodology must comply with ANSI/ASHRAE/IESNA Standard 90.1-201634, with errata or a USGBC-approved equivalent standard.



# Buildings: Example

Sectors in the project	Energy Intensity	Built up area	Electricity consumption (MWh)	CO <sub>2</sub> emissions factor (Tons CO <sub>2</sub> e/MWh)	Total CO <sub>2</sub> Emissions (tCO <sub>2</sub> per year)
1	2	3	4 = 2 X 3	5	6 = 4 X 5
Residential	120	1000	120000	0.3	36000
Industrial	190	800	152000	0.3	45600
Commercial	90	500	45000	0.3	13500
Institutional	80	980	78400	0.3	23520
Street lighting	0.5	100	50	0.3	15
District heating	110	320	35200	0.3	10560
Add additional sectors					
Total emissions					129195

# Transportation

Transportation emissions cover the emissions from transportation and from energy used in the project for transportation such as electric rail.



On road transportation : Passenger vehicles, freight trucks



Railways : Inter-city passenger rail, freight rail, trams



Water borne navigation: Sightseeing ferries, domestic or international water borne vehicles



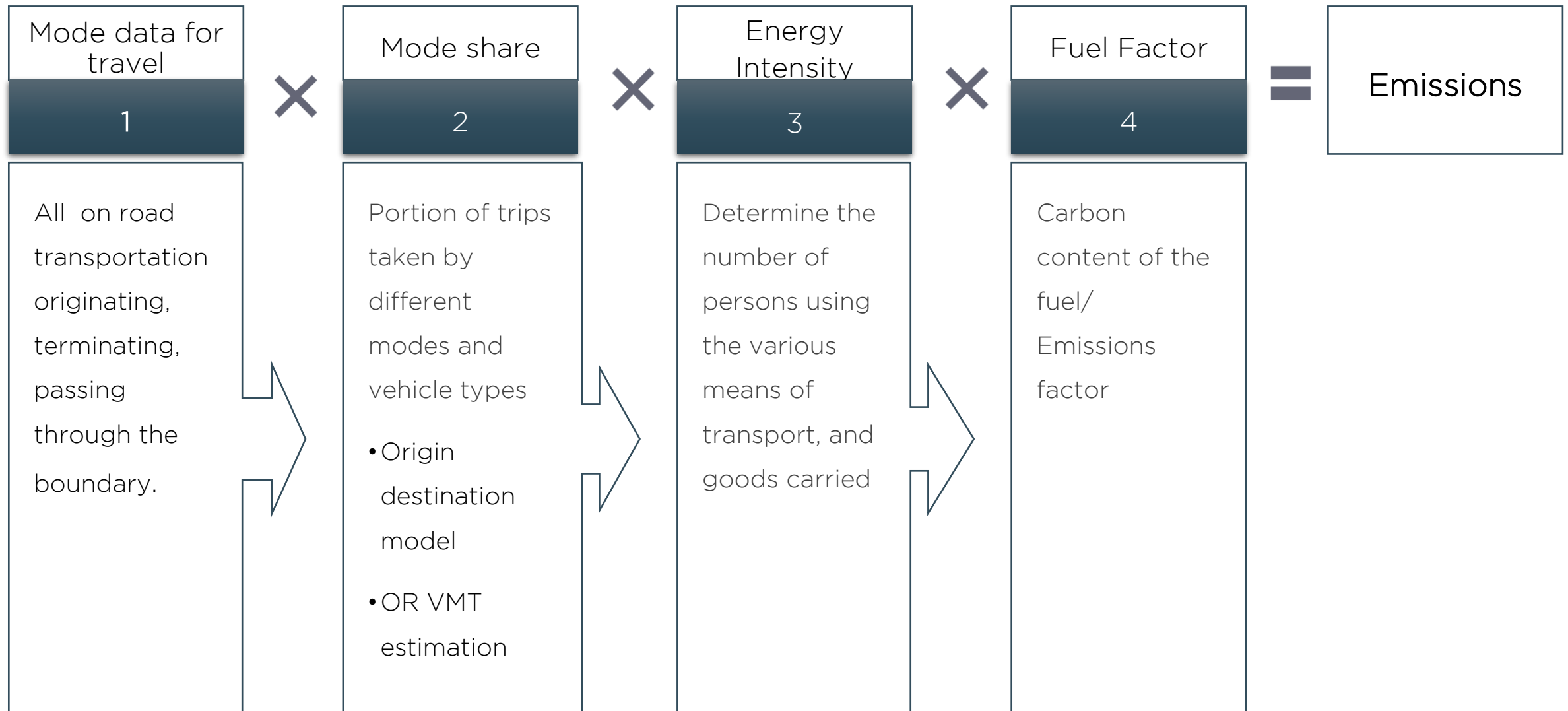
Aviation : Helicopters



Off road : All-terrain vehicles, bulldozers, tractors, snowmobiles, landscaping and construction equipment

# Transportation: Calculation

1 2 3 4 5 6

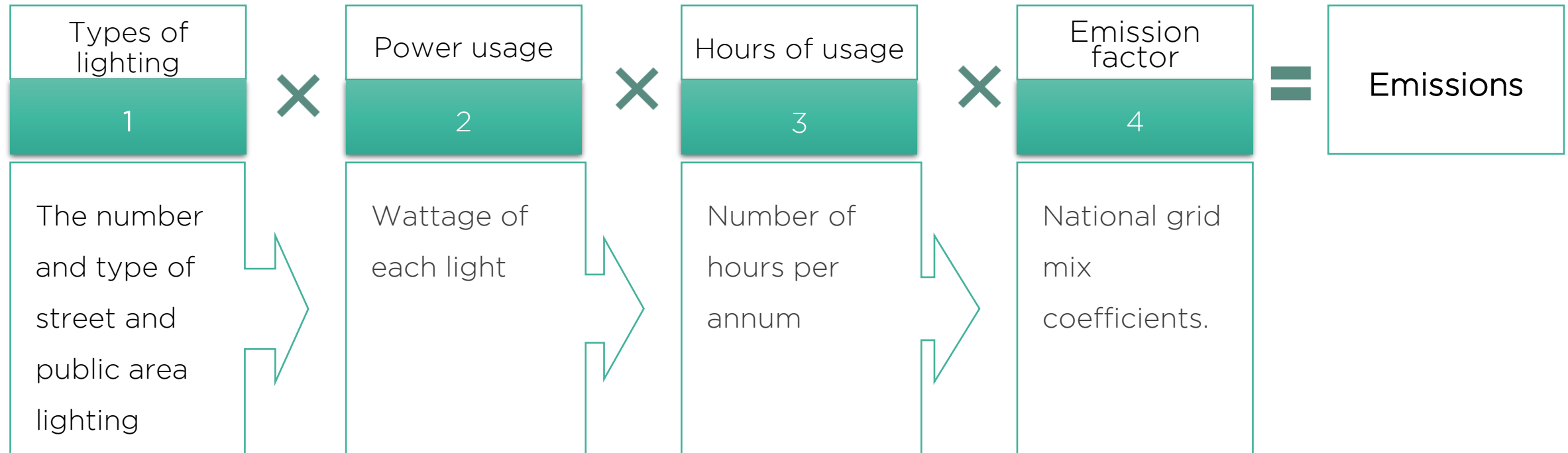


# Transportation: Example

Modes	Mode share (vehicle-kilometers)	Persons/goods carried	Emission factor (gCO <sub>2</sub> /km)	Total CO <sub>2</sub> Emissions (Metric Tonnes)
1	2	3	4	5 = 2 x 3 X 4
Cars	50 km	1000 people	4.6	230000
Bikes	190 km	800 people	2.3	349600
Trucks	90 km	500 tonnes of goods	7.5	337500
Taxis	80 Km	980 people	4.2	329280
Add additional modes				
Total emissions				1246380



# Street lighting and public area lighting



Types of lighting	Power usage	Hours of usage	Emission factor kgCO <sub>2</sub> e/KWh	Total CO <sub>2</sub> Emissions
LED street lights (150 nos.)	0.075 kilowatt	3285 hours per annum (9 hours per day)	0.3	= 150 x 0.075 x 3285 x 0.3

# Water and waste water



Emissions from  
combustion of  
digester gas, bio  
solids and sludge

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Emissions from  
pumps and other  
equipment



Emissions from  
wastewater  
treatment  
lagoons/plants



Emissions from  
septic systems,  
effluent discharge

# Water and waste water



## Stationary Emissions



## Process Emissions



## Fugitive Emissions

- Identify all equipment which is proposed to be installed.
  - Based upon their specifications, calculate the power consumption.
  - Use national grid mix coefficients to calculate the GHG emissions.
- Identify the emissions from combustion. These will be in form of various gases. Refer to the detailed methodology from any GHG protocol.

### Data to be collected:

- Quantity of water to be supplied
- Quantity of waste water generated
- Specifications of pumps, motors, and other machinery/equipment
- Specifications of waste water treatment technology and the GHG emissions related to it.

# Solid waste



Combustion of  
Municipal Solid  
Waste



Methane Emissions  
from landfills



Emissions from  
handling and wind  
erosion of outdoor  
storage piles,  
including municipal  
solid waste at  
landfills.

Data to be collected:

- Quantity of solid waste generated
- Specifications of waste treatment technology and the GHG emissions related to it.

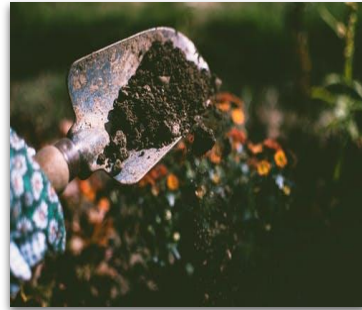
# Agricultural and Livestock



Methane Associated with Enteric Fermentation



Methane Associated with Manure Management



Methane Associated with Anaerobic Digestion



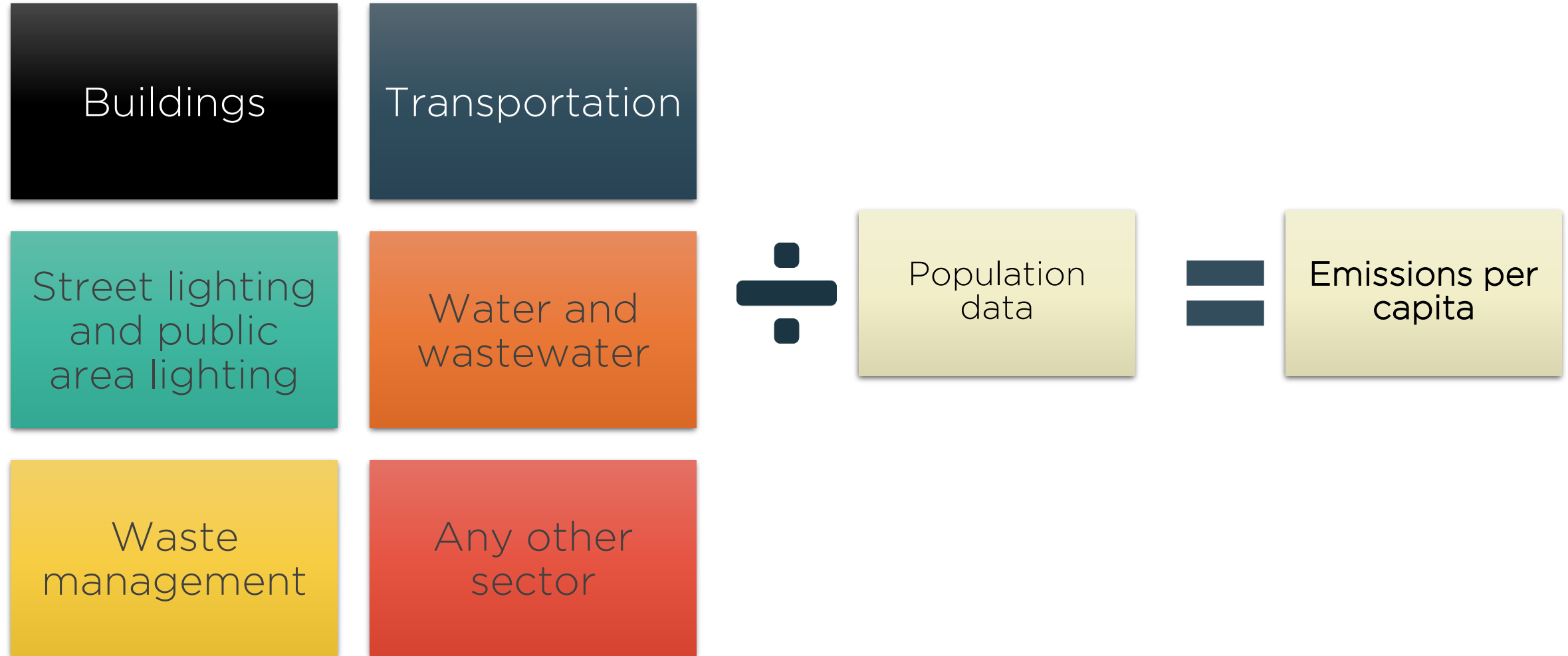
Direct Nitrous Oxide Associated with Manure Management



Indirect Nitrous Oxide Associated with Manure Management

- CO<sub>2</sub> emissions from livestock are not estimated and assumed to be zero.
- The amount of CH<sub>4</sub>, N<sub>2</sub>O generated will depend on the number of animals, type of digestive system, type and quantity of feed.

# Energy and GHG Emissions Calculation





# Requirements

- 1 USGBC calculator for total annual greenhouse gas emissions from all sectors
- 2 Documentation (such as policies, ordinance or research) to support strategies for GHG emissions estimation.
- 3 Detailed calculations for per capita emissions

# Points for projected energy performance of the city

GHG emissions per capita	Energy and GHG Management Points	
	Cities	Communities
No greater than 9.5	Prerequisite	Prerequisite
9.0 - 9.4	1	1
8.5 - 8.9	2	2
8.0 - 8.4	3	3
7.5 - 7.9	4	4
7.0 - 7.4	5	5
6.5 - 6.9	6	6
6.0 - 6.4	7	7
5.5 - 5.9	8	8
5.0 - 5.4	9	9
4.5 - 4.9	10	10
4.0 - 4.4	11	11
3.5 - 3.9	12	12
3.0 - 3.4	13	13
2.5 - 2.9	14	14
2.0 - 2.4	15	15
1.5 - 1.9	-	16
1.0 - 1.4	-	17
0.5 - 0.9	-	18
0 - 0.4	-	19

# Points to note in documentation

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Include all emissions from Scope 1 and 2



Reference data



Specify protocol adopted



Mention units

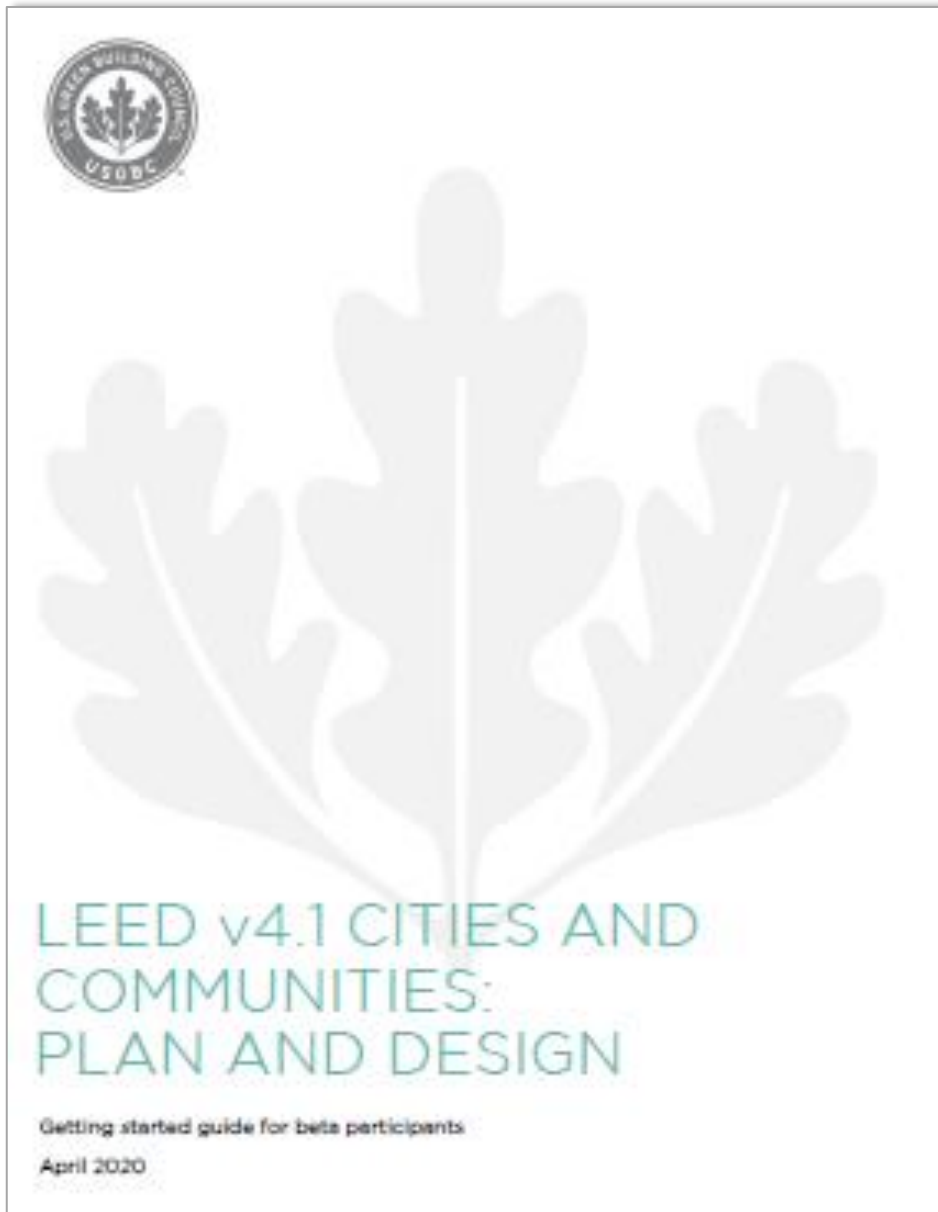


Narrative

# References

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- ICLEI Community Protocol Version 1.2
- Appendix C - Built Environment Emission Activities and Sources - U.S. Community Protocol
- Appendix D - Transportation and Other Mobile Emission Activities and Sources - U.S. Community Protocol
- Appendix E - Solid Waste Emission Activities and Sources - U.S. Community Protocol
- Appendix F - Wastewater and Water Emission Activities and Sources - U.S. Community Protocol
- Appendix G - Agricultural Livestock Emission Activities and Sources - U.S. Community Protocol
- Global Protocol for Community-Scale Greenhouse Gas Emission Inventories



Download the Rating Systems and Guides:

<https://www.usgbc.org/leed/v41>

LEED for Cities and Communities Page:

<https://www.usgbc.org/leed/rating-systems/leed-for-cities>

Overview Video:







Visit us at <https://www.usgbc.org/leed/v41>

Reach out to us at [cities@usgbc.org](mailto:cities@usgbc.org)